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Subdivided into GENERAL (including AUTHORS,) ENGINEERING LITERATURE AND CONTRACT PRICES

Explanatory Note

This index follows, generally, the methods adopted and more fully explained with the index for Volume 71. An asterisk (*) indicates an illustrated article, and (n), (ns), note, notes. As such are designated the articles under "Appliances and Materials" and some of the briefer ones under "News of the Engineering World," although in large type. Letters are not distinctively specified, nor are editorials usually. An editorial referring to an article may be indexed by appending the page number.

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Engineering News

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Large Roller-Crest Dam, Grand Valley Project, Colorado

By F. Teichman*

SYNOPSIS—Details of design of largest steel roller-crest dam in the United States, just completed over the Grand River in Colorado, on the Grand Valley project of the United States Reclamation Service.

The Grand River leaves its mountainous confines at Palisade, Colo., and there enters upon a large tract of valuable fruit land, the commercial center of which is the town of Grand Junction, Colo. A large part of this valley has been under irrigation for many years through the canals of different private companies. The Orchard Mesa District is a picturesque elevated irrigated bench lying on the left bank of the river, the water for the irrigation of which is taken from the river at the Orchard Mesa dam, a wicket diversion dam about 7 mi. up river from Palisade and the farthest upstream of the various irrigation structures on the river. About half a mile downstream from this dam the Grand River project of the United States Reclamation Service has its intake structure and diverts at this point 1,425 sec.-ft. for the irrigation of 53,000 acres of good farming land lying to the right of the river and higher than the land heretofore reached by irrigation, constituting a body of land 1½ to 4 mi. wide and 27 mi. long. The diversion dam and intake structure are interesting to the engineer and form a pleasing and impressive structure that attracts the eye of the traveler on the Denver & Rio Grande R.R. by the charm of its contrast with the rugged lines of the surrounding mountain scenery.

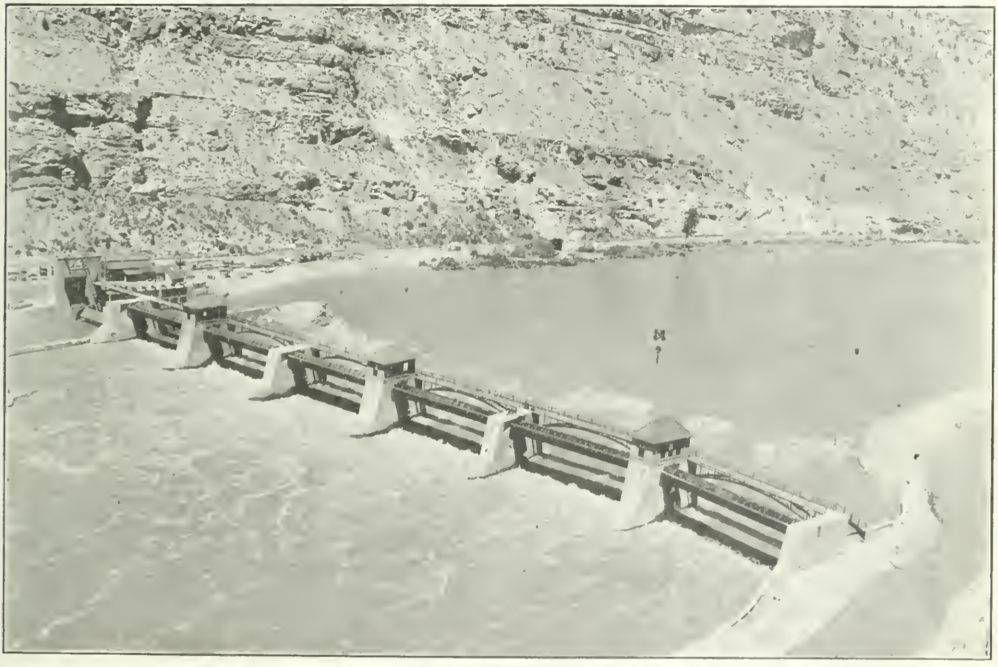

FIG. 1. VIEW OF COMPLETED ROLLER-CREST DAM ACROSS GRAND RIVER

The problem in the design of the diversion dam was to raise the level of the water in the river at times of low flow sufficiently to send 1,425 sec.-ft. into the intake and yet at times of flood to permit the maximum flow (estimated at 50,000 sec.-ft.) to pass the dam without raising the water level upstream to a plane where the adjacent roadbed of the Denver & Rio Grande R.R. (elevation of base of rail 4,797) would be endangered. The solution developed consists of a concrete weir of an elevation sufficiently low to allow the estimated maximum flood to pass with safety, superimposed upon which is a movable steel roller crest providing the additional elevation required for ordinary diversion purposes.

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*Engineer, United States Reclamation Service, Washington, D. C.

The movable steel crest over the Grand River has an aggregate net length of 480 ft., divided by six piers into seven spans, one clear span of 60 ft. near the right bank of the river and six clear spans of 70 ft. each. The 60-ft. span is across the sluiceway in front of the intake openings of the Government canal, and its movable crest is 15 ft. 4 in. high; the six 70-ft. crests are 10 ft. 3 in. high. The sill elevation of the 60-ft. opening is 4,777 and of the 70-ft. openings 4,782, thus making the spill level of the movable crest at El. 4,792.25. The sluiceway has an inclined concrete floor sloping from El. 4,779 at upstream end to El. 4,777 at the dam. The elevation of the sill of the intake gates is 4,785.25—that is, about 7½ ft. above the floor of the sluiceway. There are nine intake openings of 7x7 ft. Where the dam terminates at the left bank of the river, provision is made by four gates 7 ft. wide, 5 ft. high and of sill elevation 4,787.25 to supply the Orchard Mesa canal at this place instead of at the old Orchard Mesa dam previously mentioned.

Among the advantages of the dam as designed are the following: The dam is laid square across the river and

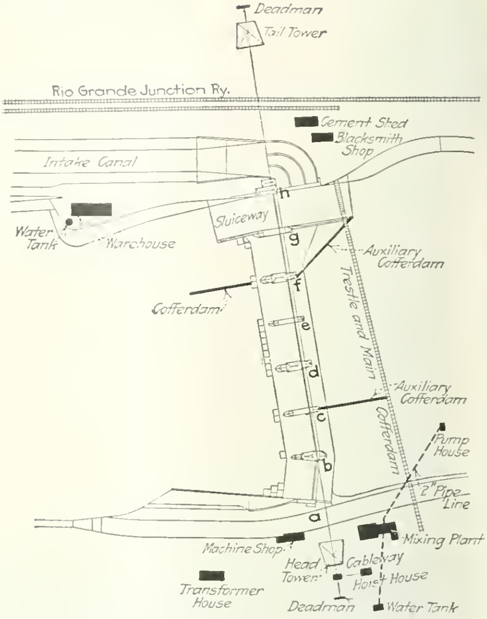

FIG. 2. GENERAL LAYOUT OF GRAND VALLEY DIVERSION DAM

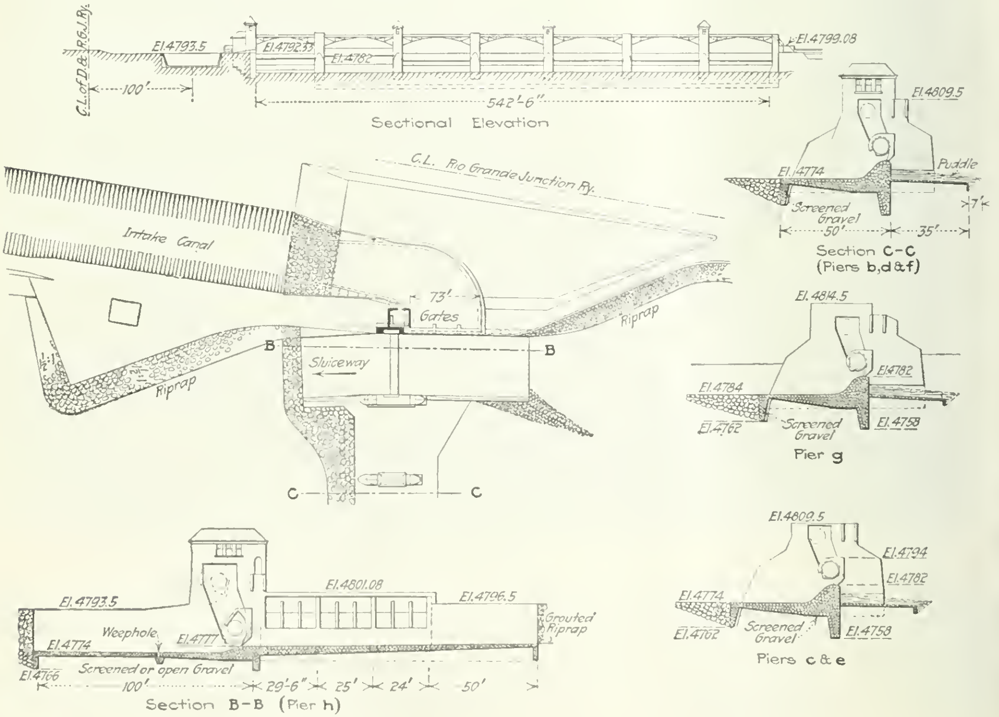

FIG. 3. DETAILS OF GRAND VALLEY DIVERSION DAM STRUCTURE

is made as long as possible in order to reduce the necessary height of the movable steel crest and to reduce also the cost of the work required to safeguard the left bank where the Orchard Mesa canal lies close to the rock cliff. The openings between piers are large enough and the movable crest can be raised high enough so that the lodging of floating trees at time of flood is precluded. The flow into the intakes on either side of the river is normal to the flow of the river, so that there will be little interference from drift; and the sill of the intake gates is sufficiently high above the floor of the sluiceway, at the right bank, to let the heavier silt pass by the gates below the level of the sill. Any silt deposit formed between the floor of the sluiceway of the Government intake and the sill of the gates can be washed downstream by opening at intervals the 60-ft. wide movable crest. (No special sluiceway is arranged for the intake of the Orchard Mesa canal.)

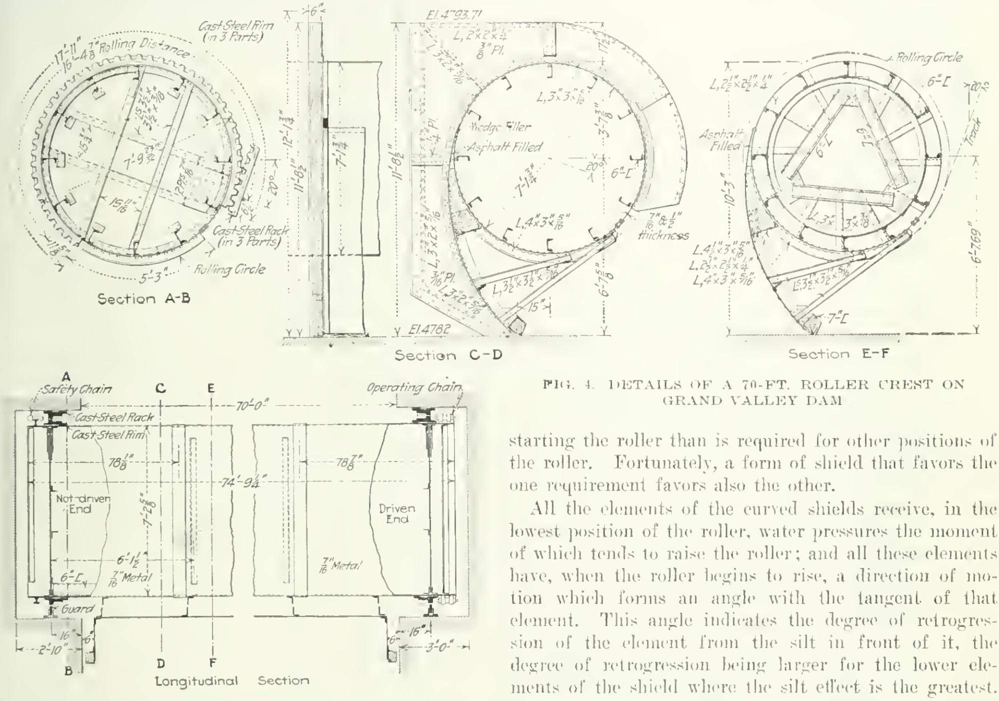

FIG. 4. DETAILS OF A 70-FT. ROLLER CREST ON GRAND VALLEY DAM

The scouring effect of the water with the sluiceway open is vigorous, and the sluiceway is freed from deposit in a short time and with a small expenditure of water.

The roller-crest dam consists of a horizontally disposed sheet steel hollow cylinder running on smooth tracks set in recesses in the piers and provided with cog rims which, engaging with racks set alongside the smooth tracks, insure a rotary motion of the cylinder as it is raised. The central cylinder is provided with an extension shield held on tangentially disposed struts. This shield when the dam is lowered comes to a bearing on the concrete sill, thus forming the bottom seal. The end seals are flexible steel shields lined at their upstream edges with timbers that are made to fit a slightly inclined plane on the face of the pier. By this arrangement the water pressure keeps the end shields tight against the piers and there will be clearance between these timbers and the pier faces as soon as the roller has risen a few feet. Fig. 1 shows the structure as a whole and Fig. 4 gives the main details of the steel work framing of the 70-ft. section.

In determining the outline of the curved shields two points were considered: (1) That the elements of the shield when the roller first rises should draw away from (not enter into) any silt deposit that may have formed in front of the shield, and (2) that the water pressure against the shield for the initial positions of the rising roller (where the resistance of silt on the curved shield and the friction of the end shields is the greatest and where the moment of the weight of the shields is great) should be such as to require no greater chain pull for starting the roller than is required for other positions of the roller. Fortunately, a form of shield that favors the one requirement favors also the other.

All the elements of the curved shields receive, in the lowest position of the roller, water pressures the moment of which tends to raise the roller; and all these elements have, when the roller begins to rise, a direction of motion which forms an angle with the tangent of that element. This angle indicates the degree of retrogression of the element from the silt in front of it, the degree of retrogression being larger for the lower elements of the shield where the silt effect is the greatest. As the roller rises, the angle of retrogression diminishes for all the elements of the shield, becomes zero and then reverses into an angle of progression, the angle of retrogression being longer retained as such for the lower element of the shield than for the upper. The reversal from retrogression to progression takes place only after the roller has risen high enough to permit the water to break through under the roller and wash out the silt deposit or keep it in agitation.

There is a stationary smooth track on the piers at an inclination of 20° to the vertical and a circular smooth rim on the drum, the latter rolling on the former as the roller moves up or down.

As the drawings show, the track is cast as one piece with a rack, and the smooth rim is cast as one piece with a gear segment. Rack and gear are in mesh, thus precluding a sliding motion of the rim on the track.

Parallel to the track, near the diametrically opposite side of the rim, there is a guard compelling the meshing of rim and rack teeth. One end of the roller has wrapped around it the operating chain, which unwinds as the roller rises and is taken up by an eight-tooth sprocket wheel forged as one piece with a heavy shaft. This shaft is placed on steel girders high enough above the rollers to clear them in their highest position and is actuated by gearing, wormwheel and worm, and electric motor.

A rolling crest of similar design is provided by the Washington Water Power Co. for the crest of the spillway of Long Lake, near Spokane (see *Engineering News*, Sept. 19, 1914), there being three rollers of 65 ft. span and 19 ft. height. The United States Reclamation Service has installed a small rolling crest 30x8 ft. in connection with the Boise project. The Grand River rolling crest seems to be the third installation of this kind of dam in this country.

Numerous dams of the rolling-crest type have been built in Europe. One remarkable instance is the dam at Kibling, Germany, which has one roller of 46 ft. clear span by 28 ft. height. Another interesting instance is that of a dam near Stuttgart, Germany, having two spans of 92 ft. by 12 ft. height. The contract for their manufacture and installation required a leakage of less than 0.53 sec.-ft. per span. Tests after erection established a leakage of less than 0.5 sec.-ft. for both spans together.

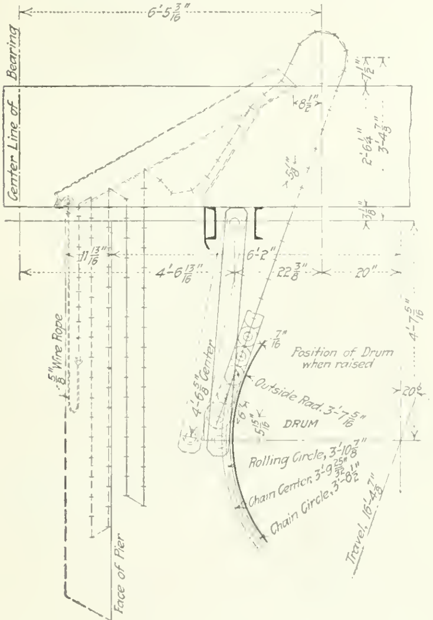

FIG. 5. HOW THE ROLLER CREST MOVES

Fig. 6 shows the 60-ft. sluiceway with roller down on sill, and the face wall of the intake structure with its nine 7x7-ft. gates. This photograph was taken before the completion of the operating house and the placing of the winch for the 60-ft. roller. The construction of the intake gates is in the form of a light cast-iron arch with occasional ribs and with three pairs of angle-irons riveted to the gate body as chords to take the arch thrust. A straight wooden sill is attached to the gate. The part of the gate body projecting upstream from the sill is attached to the gate. The part of the gate body projecting upstream from the sill (in plan) contributes sufficient buoyancy to the gate to practically balance its weight when the gate is submerged. All gates are operated by means of one line shaft and connection is made with any individual gate by placing into mesh the line shaft bevel pinion of that individual gate stand with its bevel gear.

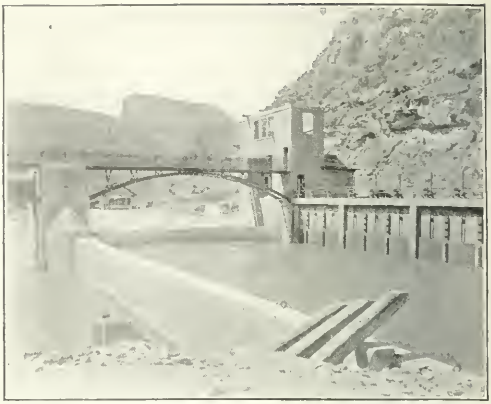

FIG. 6. SLUICEWAY WITH 60-FT. ROLLER CREST DOWN

A ½-in. wire cable weighted at either end passes by all gate stands at level of floor and at each gate stand is wound over a 10-in. wheel which carries also a socket for a hand lever. The rope leads into the engine house and there actuates the cones of a duplex friction clutch so that the line shaft may be rotated either one way or the other. Preparatory to any gate operation the attendant places in mesh the pinion of such gate or gates as he wishes to raise or lower, he starts the motor and inserts his hand-lever in the socket of one of the 10-in. wheels conveniently located to watch the motion of the gates. Pressing the lever upstream raises the gates, downstream lowers the gates. Without pressure on hand-lever the gate motion will stop due to the steepness of the cone of friction clutch.

The Grand River project is one of the enterprises of the United States Reclamation Service, A. P. Davis, Chief Engineer. R. F. Walter has been until lately the supervising engineer of this district and J. H. Miner is the project manager of the Grand River project. The general design of the diversion dam as a whole was made by the writer in coöperation with the engineers mentioned, aided by the advice of D. C. Henny, Consulting Engineer. The dam was built under the direction of O. T. Reedy, Construction Engineer, who together with the project manager also designed the piers and foot bridge, which give a monumental appearance. The intake structures and the steel structures of the rolling crest were also designed in detail by the writer, following, as to the rolling crest, the lines laid down in a general way by the German patentees of this kind of movable dam. The Riter-Conley Manufacturing Co., Pittsburgh, Penn., was the contractor for the fabrication of the rolling crest.

State Engineer's River Survey Guides Water Adjudicators

By Percy A. Cupper*

The uncertainty of property rights to the use of water in the Western states has led many of these states to enact "water codes." These statutes serve three distinct purposes: (1) The determination of existing water rights; (2) providing a definite record for all new water rights; and (3) the distribution of the water to those entitled to it.

The determination of water rights necessarily involves many judicial questions that, prior to the adoption of the water codes in the various states, were passed upon by the courts. Lack of physical and engineering data in most cases and the lack of due appreciation of their worth and their application and relation to the legal questions involved have led the courts into many grievous errors and have caused some ridiculous findings. One learned jurist in reviewing such a decision poured forth his wit and sarcasm and garnished the somber pages of legal lore with the following literary gem:

> Heroically setting aside the statute, the decisions and the evidence in the case, he assumes the role of Jupiter Pluvius, and distributes the waters of Goosberry Creek with a beneficent recklessness which makes the most successful efforts of all the rain wizards shrink into insignificance, and which would make the hearts of the ranchers on Goosberry dance with joy if only the judicial decree could be supplemented with a little more moisture. The individual who causes two blades of grass to grow where but one grew before is held in highest esteem as a benefactor of his race. How then shall we rank him who, by judicial fiat alone, can cause 400 in. of water to run where nature only put 100 in.? We veil our faces, we bow our heads before this assumption of judicial power and authority. . . . Evidently the court assumed that Goosberry Creek was as inexhaustible as the widow's cruse, or else that its decree possessed the potency of Moses' rod. (3 Ida. 255, 28 Pac. 438, Hillman vs. Hardwick.)

To avoid such mistakes on the part of the state water board, the Oregon water code, like most similar statutes, wisely requires the state engineer to make surveys and investigations as a guide to the board in its findings.

It was no easy matter at the outset to determine what information would be required in the determination of water rights. It was only after five years' experience on the various streams of the state that the plan followed on the Wallowa River survey was rounded out.

Wallowa River Conditions

Wallowa River rises in the high granite peaks of a spur of the Blue Mountains, and after flowing through a steep timbered area it widens in Wallowa Lake, of terminal moraine formation. Wallowa Lake is used for a storage basin, and water is diverted directly from the lake for municipal supply. Immediately below the lake the water is diverted for power development and the irrigation of land in what is known as the Upper Valley. The stream flows through, and together with its tributaries serves to irrigate the agricultural land in Lostine and Wallowa Valleys and furnishes water for power development, municipal and domestic supply.

To determine the legal rights requires collecting many engineering data and making a careful analysis of them. Granting to one appropriator slightly more water than he is entitled to may deprive a subsequent appropriator of water upon which he is relying to irrigate a well-improved farm. Again, while two appropriators may appear to tap the same source of supply, the lower appropriator may be fed by return seepage or springs; and to divide the flow at the upper point of diversion between the two would really deprive the upper appropriator and give to his neighbor an excess supply. The amount of land irrigated, power developed or water used for municipal supply are matters upon which the testimony of the ordinary witness throws but little light.

Beneficial use is the basis, the measure and the limit of a water right; hence not the amount of water a man uses, but the amount he beneficially uses, is the quantity he is entitled to. In order to establish these facts a survey of the irrigated land is made, the ditches and streams are measured, and variation tests are carried on to determine the proper duty of water.

Making Surveys and Stream Gagings

The survey of Wallowa River was commenced in August, 1914, and completed in September, 1914, while the stream measurements were begun in 1914 and carried through the irrigation season of 1915. The variation tests were made during 1915. A plane-table survey was made showing all irrigated land, streams, ditches, pipe lines, power plants, waterwheels, etc. The maps were made on a scale of 2 in. = 1 mi., though a scale of 4 in. = 1 mi. was adopted where it was necessary to show a great deal of detail. Elevations were not carried except for short distances along the ditches, to ascertain the grade and in determining the storage capacity of the lake. Compass control was employed, with a check on every section corner or property line that could be located. Plane-tables 18x20 in. were used, each sheet covering a township. The survey shows 39,000 acres of irrigated land. Present-ownership plats on a scale of 2 in. = 1 mi. were prepared for the county records.

Two gaging stations had been maintained on the stream for several years, and some records were available of the fluctuations of the lake surface; some of the larger ditches had also been measured. However, when the investigation in connection with the adjudication of water rights was commenced, gaging stations were established on all the important ditches and streams. These stations were rated by means of a current meter, and at most of the stations daily gage readings were taken. Weirs were established to measure the water applied in the variation tests and in a few instances to measure the water applied in the irrigation of a well-defined tract. The variation tests were made on three tracts seeded to alfalfa, oats and barley.

Water Supply of Three Valleys Found Independent

After the field work was completed and the data were assembled, a careful analysis of the results was made. The report prepared from this shows clearly that the water-supply for the three valleys through which the Wallowa River flows may be considered independently. The importance of this conclusion for the purpose in hand can hardly be over-estimated. Had the determination of the water rights on this stream been taken up without such an investigation, it would probably have been concluded that the water-supply flowing out of the lake had been distributed more or less over the entire area irrigated from the main stream. While this is true to a limited extent, the report shows that that part of the regular flow of the stream which is used for the irrigation of land in the two lower valleys is return seepage and that the diversion and use of the entire stream near the outlet of the lake do not affect the rights below.

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*Assistant State Engineer, Salem, Ore.

The report takes up in detail the flow of water through each of the ditches upon which gaging stations were established, and by means of hydrographs shows the discharge through the ditch for every day during the irrigation season and also the head in miner's inches per acre that was used. For example, in discussing one of the larger ditches diverting water near the outlet of the lake the report gives the following:

> Average head flowing in this ditch from July 15 to July 31 inclusive, 1905, was 52.6 sec.-ft., or 0.64 miner's inch per acre. The average flow during August, 1905, was 17.3 sec.-ft., or 0.21 miner's inch. The maximum head diverted during 1905, as shown by the records, was 86 sec.-ft., or 1.05 miner's inches per acre. The average head diverted through this ditch in June, 1906, was 49.3 sec.-ft., or 0.61 miner's inch per acre; and during July, 1906, the average head was 54.9 sec.-ft., or 0.69 miner's inch per acre for the area of 3,251 acres. The maximum head diverted during the season 1906, up to Aug. 1, was 74 sec.-ft., or 0.94 miner's inch per acre, for the above area.
>
> . . . .
>
> The records of the flow of this ditch during 1915 represent the amount of water diverted for use, the gage station being above all irrigated lands and below all waste gates. The average flow of water in the ditch from June 7, water being turned in on or about this date, to June 30 inclusive, 1915, was 78.4 sec.-ft., or 0.96 miner's inch per acre. During July, 1915, the average head was 60.8 sec.-ft., or 0.75 miner's inch per acre; and during August the average head was 14.8 sec.-ft., or 0.18 miner's inch per acre. The maximum head diverted during the season of 1915 was 103 sec.-ft., or 1.36 miner's inches per acre, which head was only maintained for one day. The amount of water diverted through this ditch from June 7 to Aug. 21 inclusive, 1915, was 2.49 acre-feet per acre for the area affected.

A comparison of the climatic conditions prevailing during 1915 with those of other years, as shown by the Weather Bureau station records, was made. By this means the amount of water available and the amount required were compared with the amount available and the amount required during other years.

The variation tests were carried on so as to secure practical rather than theoretical results. A tract was selected and divided into three plats. One was irrigated by the owner in the usual manner and with the usual amount of water. To one of the other plats more water was applied than the quantity used by the farmer, and to the other plat less water. The results on different tracts differed widely, but in general established the character of irrigation practice employed by the irrigators. Tracts of alfalfa, barley and oats were selected.

The maximum capacity of the ditches and the area irrigated therefrom, considered in connection with the head used in irrigation of individual tracts under the respective ditches, show conclusively that rotation is practiced.

This report, together with the maps showing the irrigated land in each 40-acre tract, ownership plats and a summary of all ditch measurements, was submitted to the superintendent having the adjudication in charge and was considered by him with the claims and evidence submitted by the water-right claimants. Under these conditions it will be an easy matter to keep the finding of the board within reasonable bounds, to the end that justice may be done to all claimants.

Thus we see that engineering data are taking their place in the judicial consideration and determination of water rights in these proceedings. The presentation of these data does not come within the often questioned and sometimes questionable class of expert testimony. It involves the presentation of facts with legal deductions therefrom rather than the expression of an expert opinion.

The entire investigations, including survey, were made and the report was prepared by C. E. Stricklin, Field Assistant for the State Engineer.

Design and Erection Costs of Steel Knock-Down Dredge

A new design of steel dredge was recently brought out by the American Steel Dredge Co., of Fort Wayne, Ind. It is of the single-line type. The improvements pertain to the so-called structural part of the dredge or the front end, embodying the dipper, dipper handle, boom and circle. Dippers in general use are of the square type, but the one on this dredge is made with an exceptionally wide mouth and narrow back. The shell is formed of one piece of flanged steel riveted to the back casting, with a flanged-steel mouthpiece and lower band (Fig. 4).

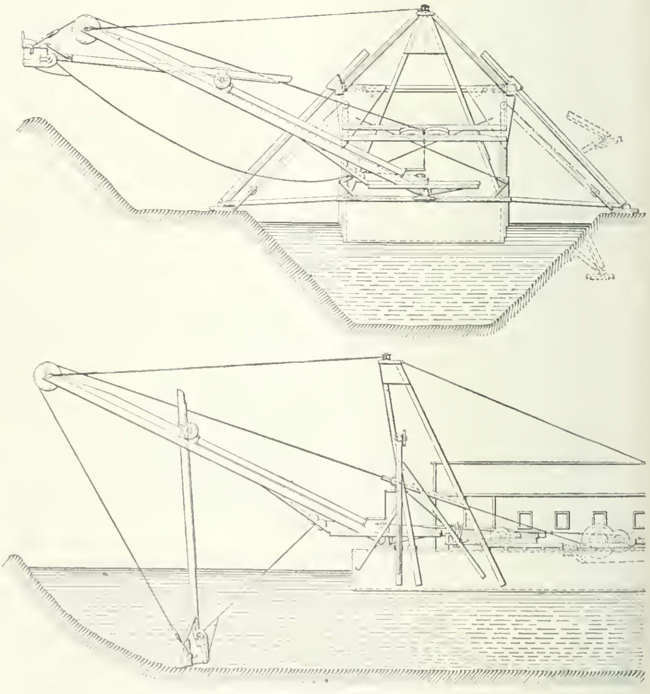

FIG. 1. DESIGN OF LATEST IMPROVED "AMERICAN" STEEL DREDGE

The design of the dipper handle is unique and opens another field for acetylene welding. Dipper handles in common use are of wood or of wood armored with steel plates on the four sides or are made of steel. In the latter instance they are usually built of I-beams reinforced to form a box section. The construction of the new handle is a hollow-steel box section devoid of rivets. The box is formed by coping the flanges of two channels, so that when the latter are placed together they form a section of the proper width. The flanges are then welded for the entire length on both edges. Two of these box sections are required for each handle. The racks are bolted on in the same manner as on a wooden handle. The dipper-handle foot casting is put in place before the channels are welded, so that when this is done the channels contract, resulting in a tight fit on the casting.

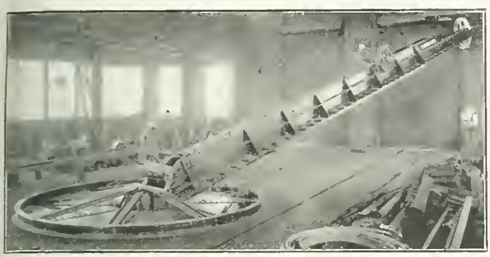

FIG. 2. NEW BOOM AND CIRCLE—NOT RIGIDLY CONNECTED

The boom as formerly used on the "American" dredge was built as an integral part of the circle, being attached by numerous small bolts to the comparatively small boom base and also having a rigid member running from the upper side of the boom at the shipper shaft down through the boom and attached rigidly to the outside of the circle.

Four angle braces were also used to brace the boom and circle. Experience showed that digging and swinging unduly stressed parts of the boom and circle on account of the rigid connection. To obviate this, the new boom and circle are built as separate parts with an exceptionally wide base and large-diameter base casting, with wide bearing surface.

The circle is of solid plate construction, securely riveted to the center casting. The boom and circle are pin-connected, with swinging cables running from the circle to the boom, thus permitting the latter to be set at any angle desired and allowing sufficient play to eliminate excessive stresses in the circle. The design of the all-steel boom was also changed by riveting gusset plates on the side and lower chord of the boom (Fig. 2), which is consequently much stiffer, so that it better withstands the stresses in service operation caused by swinging and stopping suddenly.

The dredge has a sectional hull, built entirely of flat steel sections of convenient sizes for easy handling. A complete hull 80x20 ft. in plan by 6 ft. deep can be loaded on one flat-car. The tabulation that follows gives the cost of transporting and erecting one of the new machines. The figures were furnished the manufacturer by the contractor and are for one of the new dredges, equipped with a 1½-yd. dipper and 50-ft. boom, used on a large drainage district in Arkansas.

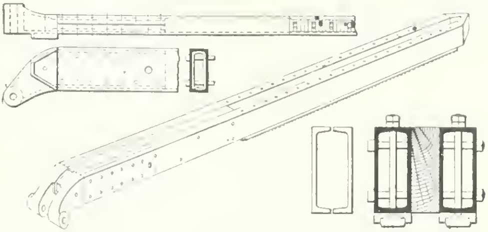

FIG. 3. DIPPER HANDLE FORMED OF TWO RIVETLESS STEEL BOXES

COST OF TRANSPORTING AND ASSEMBLING KNOCK-DOWN DREDGE

Transporting Steel Hull	
Hull, weighing 88,000 lb., arrived on job Oct. 22; hauled to bank on Oct. 23 and 24	
60 man-hours @ 20c.	$12.00
110 man-hours @ 17½c.	19.25
20 hours for foreman	8.80
Two days' teaming	19.00
Total	$59.05
Erecting and Launching the Hull	
Erection began Oct. 26; completed Nov. 4 (work delayed 1½ days by hull grounding)	
275 man-hours @ 20c.	$55.00
424 man-hours @ 17½c.	74.20
90 man-hours @ 12½c.	11.25
Total	$140.45
Hauling Machinery	
Machinery arrived on two cars Oct. 29; hauled to dredge Oct. 30 to Nov. 4	
50 man-hours @ 20c.	$10.00
110 man-hours @ 17c.	18.70
30 hours for foreman	13.20
Total	$41.90
Installing Machinery	
Began Nov. 5; completed Nov. 27	
480 man-hours @ 20c.	$96.00
170 man-hours @ 12½c.	21.25
603 man-hours @ 17½c.	105.52
Total	$222.77
Total cost of erecting dredge	$464.17

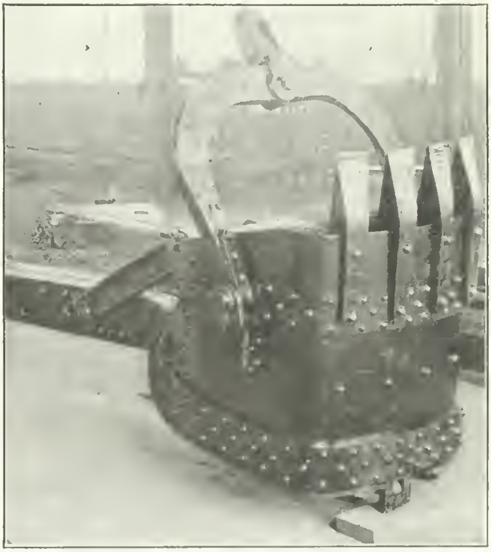

FIG. 4. DIPPER OF RECENT DESIGN HAVING WIDE MOUTH

Difficult Pump Test Made with Pitot Tube

By C. E. Grunsky*

SYNOPSIS—Difficulties include lack of gaging point outside of discharge pipe, discharge water not under pressure at all points along pipe and air trapped in discharge line. Pitot tube used in spite of high velocity and air in its tubes; velocities measured on two cross-diameters inclined 45° to vertical. Special switching device, reversing manometer connections, used to eliminate error from air accumulation in tubes. Difference in head between pump inlet and discharge measured directly by special manometer rig.

Tests of the centrifugal drainage pumps of the West Sacramento Reclamation District near Sacramento, Cal., under difficult conditions have been successfully carried out. The novelty of some of the features of these tests may be of interest to the profession and has prompted these notes which are presented for the purpose of describing the methods employed and not with any view to discussing the performance of the pump equipment.

The pumping plant consists of two units, each comprising a 48-in. centrifugal pump driven by a two-speed direct-connected electric motor. The suction is double 30-in. at the pumps, fed by a single 48-in. pipe from a sump at the end of the drainage canal. The length of the suction is about 80 ft. and the length of the discharge (riveted steel pipe) 110 ft. On the discharge, just beyond the pump, is a heavy cast-iron flap valve in a suitable enlarged chamber and counterbalanced by outside weights. An air pump is attached for priming the pump and removing accumulated air when necessary.

The two pumps were installed under a guarantee that each would deliver not less than 50,000 gal. of water per min. (111.2 ft. per sec.) under a head of 9 ft., at 194 r.p.m. and that then the average efficiency of both pumps would not be less than 69%. It was also guaranteed that, if operated at 248 r.p.m., each of the pumps would deliver not less than 50,000 gal. per min. under a head of 18 ft. and that then the average efficiency of the two pumps would not be less than 80%. The contract provided that if a test under the two heads showed an average efficiency below 74.5%, there should be a deduction from the contract price, and that in case the guaranteed average efficiency was exceeded, there should be a bonus paid. It was stipulated that the two heads referred to in the guarantee were to be determined from vacuum and pressure-gage readings taken at the inlets and outlets of the pumps, and that the power charged against the pumps was to be the power actually delivered to the pump shafts.

Difficulties of Test

Conditions were favorable in March, 1914, for making the tests. The water at that time was about 8.5 ft. lower in the drainage canals of the district than on the overflowed land outside of the district. The several difficulties of the proposed efficiency test will be briefly explained:

1. The delivery of the pumped water is into the overflow of Yolo basin, a broad expanse of water when the streams are high. There is no opportunity to make a gaging of the discharged water except in the discharge pipes.

2. The drainage canals within the district feed into a main canal leading to the pumping station which, though wide and deep, offered no convenient gaging station close by the pumphouse. A gaging at a remote point would be subject to the objection that the lowering of the water plane during the test might result in appreciable inflow of seepage water the amount of which would be difficult to determine.

3. The pumps discharge over a levee through 48-in. pipes with a summit elevation at the top of the pipe about 6.4 ft. higher than the center of the pumps. At no place on the discharge pipe except where it enters the water of the overflow could it be hoped to find the water at all points in the pipes under pressure.

4. The possibility of using a Pitot tube in the discharge pipes was affected by the common general assumption that this instrument cannot be used except when the water is under pressure. Some difficulty was expected from the high velocity in the pipes, because it would be necessary to traverse the pipe from side to side at one operation, owing to the inaccessibility of the pipe from underneath.

5. Nothing was known of the amount of air likely to be trapped at times at the high points of the discharge pipes.

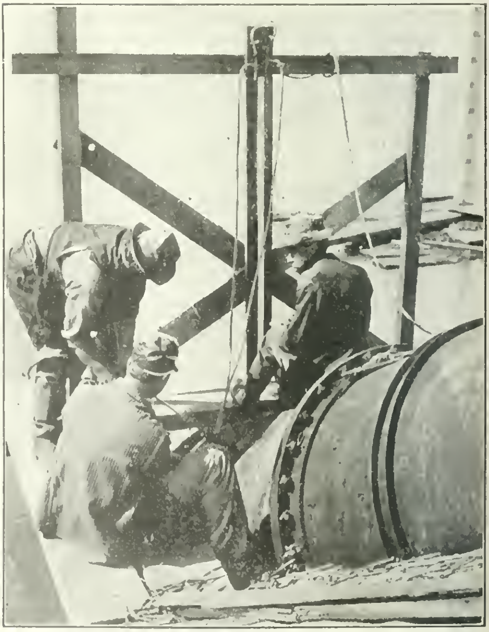

FIG. 1. PITOT-TUBE RIG, WEST SACRAMENTO PUMP TESTS

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*Consulting Engineer, President American Engineering Corporation, San Francisco.

6. The flow of water in the drainage canal at the time of the test was not equal to the capacity of one pump, consequently there was a lowering of the water during the test in the sump from which the water was drawn.

Upon study of the situation it was determined:

1. That the use of a Pitot tube would be feasible even though the velocity was high and there might be some air accumulation in its tubes due to lack of pressure in the discharge line.

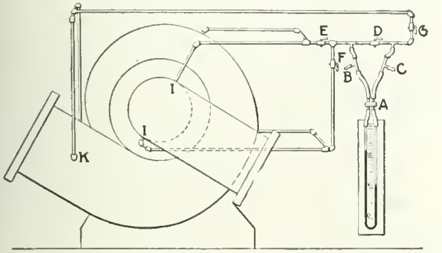

FIG. 2. MERCURY U-TUBE FOR DETERMINING INLET AND DISCHARGE PRESSURE DIFFERENCE

2. That the water measurement should be made as far from the pumps and as near the level of the discharge water as possible.

3. That the velocities should be measured on two diameters of the discharge pipe normal to each other and inclined at 45° with a vertical plane passing through the center line of the pipe. (A measurement across the pipe on a horizontal traverse seemed to be out of the question because the horizontal position would have made it necessary to gage at a point where the top of the pipe was more than 2 ft. above the surface of the discharge water and this did not seem advisable. Furthermore, velocity determination on a traverse normal to the horizontal from top to bottom of the pipe would have made it necessary to cross with the Pitot tube the zone in which air was most likely to interfere with the observation.)

4. That the errors resulting from accumulation of air in either of the two tubes leading from the Pitot tube to the manometer could be eliminated by alternate use of each tube for determining velocity head and then for suction head.

5. That a special device should be applied to measure directly the difference in head between the inlet and discharge of the centrifugal pumps.

Details of Equipment

Notwithstanding velocities in excess of 10 ft. per sec. the Pitot tube was successfully used. The instrument was of the form with upstream and downstream orifices. The only accident of note was due to the fact that at one insertion the tube turned in its support and the pressure against its flat side bent it somewhat, but without more injury than could be repaired in a few minutes.

A switching device was secured[1] equivalent to a four-way cock with which a quick exchange of connections, as demanded by requirement (4), could be effected. Under the low pressures involved this switching device was found very convenient. It consists of two flat disks, each perforated at two points and provided with nipples for the attachment of rubber hose. The disks were fastened together at the center so as to revolve with faces in contact, so that the holes in one could be successively brought into line with each of the holes in the other. A half-turn and a half-turn back was all that was required to change the manometer connection and to bring it back again to the original position.

During the test at low speed tetrachloride of carbon, with a specific gravity of 1.59 and suitably colored, was used in the U-tube manometer of the Pitot tube. But for the greater pipe velocity, at the high pump speed, it was found that a mercury column permitted sufficiently close readings and was quite satisfactory.

Two things in connection with this test will be of interest to the profession. These are, first, the use of the device to eliminate error due to the possible accumulation of air in the tubes leading from the Pitot tube to the manometer and, second, the direct measurement of the difference in head between pump inlet and pump discharge, making unnecessary the determination of the elevation of the gage in its relation to the pump.

All errors that might arise from the accumulation of air in the connections with the U-tube were eliminated by placing the switching device close to the head of the Pitot instrument. At each turn of the switch a certain amount of water was expelled through the downstream orifice of the Pitot instrument and a like amount entered through the pressure orifice. This amount varied according to the amount of change resulting in the position of the tetrachloride or of the mercury in the U-tube. Under repetition of observations it helped to eliminate error.

The elimination of error due to any trapped air in the tubes connecting the Pitot instrument with the manometer can be shown as follows:

If there was air in the hose leading to the U-tube between the switch and the U-tube and the excess of the air in one leg of the hose amounted to h expressed in water pressure, then the first reading and the second, switched to the other side, would be equivalent to

$$H' = H + h \text{ and } H'' = H - h$$

where H represents the true difference in water pressure, H' the reading with the switch in one position and H'' the reading with the switch in the other position. From these equations

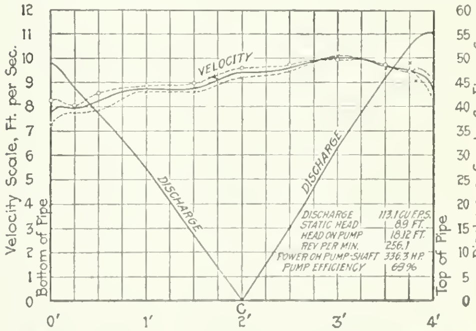

FIG. 3. RESULTS OF SOUTH PUMP TESTS: WEST SACRAMENTO DRAINAGE DISTRICT

$$H = \frac{H' + H''}{2}$$

the error h being automatically eliminated.

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[1] This was obtained from the A. Lietz Co., of San Francisco, which concern had recently been called upon to construct it for another purpose.

It should be noted that such a switching device makes possible the use of the Pitot tube under vacuum—even in the case of liquids carrying some gas, as in the case of sewage.

Fig. 1 shows the method adopted for handling the Pitot apparatus. It is to be noted that ordinarily a manometer so arranged that a mercury column in a U-tube placed at an inclination with the horizontal of about 1 in 5 will be found more convenient for use than the tetrachloride tube.

The filling of the hose connections between the Pitot instrument and the U-tube required some care. A connection was made with the air pump, and by withdrawing air or water from the highest point of one leg of the connecting hose and then from the other, the tetrachloride column was raised to full height first in one leg of the U-tube and then in the other and this process was repeated until no more air was apparent. When once in working condition no further attention was paid to complete elimination of air, since its presence had no effect on the result of the observations.

The writer could find no precedent for the direct measurement of the difference in head between the inlet and discharge of the centrifugal pump, and he therefore presents the adopted scheme as a novel and successful arrangement which will be found useful under similar conditions.

The inlet pipes of each pump were tapped at *I*, *I*, Fig. 2, for ¼-in. pipes at the top and bottom on a line normal to the plane of the elbow, and the discharge end of the pump was tapped at both sides at *K*. The pipes or tubes, in part of glass, were connected and brought to the manometer as shown in the sketch.

Use of Test Apparatus

By means of the connections as arranged and cocks placed as shown in Fig. 2, it was possible to note difference in pressure between the discharge and the bottom or the top of the inlets or between the discharge and the combined top and bottom of the inlets. By opening the clamp at *B* (Fig. 2) and the cock *G* and closing the cocks *D*, *E* and *F*, the apparatus served as a pressure gage on the discharge. By opening the clamp at *C* and the cock *E* or *F* or both *E* and *F* and closing *D* and *G*, the apparatus served as a vacuum gage on the pump inlets. But when used either for measuring the head on the discharge or for vacuum on the suction pipe, the elevation of the scale had to be taken into account.

The use of this apparatus was in every way satisfactory. There was no trouble in setting up a strong flow from the discharge toward the suction by opening the cocks *G*, *D* and *E* or *F*. Through the glass tubes the flow of water was noticeable, particularly as there was slight air leakage at some of the connections and bubbles of air could be plainly seen as they were carried along by the water.

Between each two observations the cock *D* would be opened for a moment. If any air appeared in the U-tube, as might be the case after opening *C* or *B* for an observation of head on the discharge or of vacuum on the suction, this was easily gotten rid of by manipulating the switch and letting the mercury in the U-tube play up and down a few times.

To take an observation the water was first allowed to flow for a moment through *G*, *D*, *E* and *F*, and then *D* was closed. The switch at *A* was turned so as to disconnect the U-tube and bring the mercury to complete rest, and a reading was noted. Thereupon the half-turn of switch *A* was completed, and with a reversed position of the mercury columns a second reading was taken. In order to eliminate all chance of error, 10 double readings were taken to complete a set, and a new set was taken at first every 10 min. but later every 15 or 20 min. during the continuance of a test, the full time of which was determined by the time it took to make the two traverses of each discharge gaging—generally from 1 to 1½ hr.

Some of the results of the test are presented in Table 1—for those who desire to follow the test and not for the interest in the pumps.

TABLE 1. RESULTS OF TEST; WEST SACRAMENTO DRAINAGE PUMPS

	North Pump		South Pump	
	Low Speed	High Speed	Low Speed	High Speed
Water elevation in suction sump, ft.	8 50	7.46	8.51	7 70
Water elevation at discharge, ft.	16 50	16 45	16 50	16 50
Static head, ft.	8.00	8 99	7 99	8 80
Loss of head in suction pipe, ft	3 02	6 14	2 27	3.90
Loss of head in discharge pipe, ft.	2.34	4.30	2 92	5 42
Head on pump, ft.	13 36	19 43	13.18	18 12
Revolutions per minute.	200.3	255 3	200.1	256.1
Hydr. grade at inlet, ft.	5 48	1.32	6 24	3.80
Hydr. grade at outlet, ft.	18 84	20 75	19 42	21.92
Water pumped, cu.ft. per sec.	78 0	110 1	74 7	113.1
Water pumped, gal. per min	34,900	49,400	33,500	50,800
Horsepower of water passing through pump	118 1	242 4	111.5	232 2
Electric power input, hp.	185 9	368 9	188.3	365 9
Power on pump shaft, hp	167 1	339.0	169.3	336.3
Efficiency of pump, per cent.*	70 7	71 6	65.8	69 0

* It is to be noted that neither at high speed nor at low speed could conditions be obtained in exact conformity with those intended under the contract and that therefore these efficiencies are not comparable with the guarantee without suitable modification

In Fig. 3 are shown the two velocity curves (for the separate traverses) and the discharge curves, obtained at the high speed for the south pump. The discharge as shown by this diagram is the area between the base line representing the diameter of the discharge pipe and the two parts of discharge curve which rise from the middle of this diameter and terminate at vertical lines representing the top and bottom of the pipe. The points on the discharge curve were obtained by multiplying average velocity in feet per second at any selected point, as indicated by the two curves, with the half-circumference in feet of a circle having a radius equal to the distance of that point from the center of the pipe. In the original diagrams each square inch of surface represented 5 cu.ft. per sec.

The close agreement of the velocities on the two traverses is to be noted. This agreement was somewhat better in the selected example than in the case of the other three gagings—but all were quite satisfactory. In Table 2 a sample of the readings, in inches of mercury, taken on the pressure manometer to determine head on the pump is presented.

TABLE 2. MANOMETER READINGS. PART OF LOW-SPEED TEST; NORTH PUMP, WEST SACRAMENTO RECLAMATION DISTRICT

	First Position		Second Position			First Position		Second Position	
Time	Discharge, In	Suction, In.	Discharge, In.	Suction, In.	Time	Discharge, In.	Suction, In.	Discharge, In.	Suction, In.
10 00	6 02	19 05	6 15	18 93	10 20	6 00	19 07	6 06	19 06
	6 10	19 00	6 15	18 95		6 07	19 03	6 10	19 00
	6 12	19 02	6 13	18 93		6 20	18 90	6 01	19 09
	6 20	18 90	6 06	19 04		6 00	19 10	6.10	19 00
	6 10	19 00	6 10	19 00		5 90	19 20	6 13	18 97
Average			6 11	18 98	Average.			6 06	19 04
Diff				12 87	Diff.				12 98
10 10	6 11	18 97	6 12	18 98	10 30	6 20	18 91	6 00	19 02
	6 23	18 85	6 08	19 01		6 18	18 92	6.05	19 04
	6 22	18 88	6 09	19 01		6 20	18 90	5 98	19 12
	6 13	18 97	6 14	18 94		6 10	19 00	6 02	19 02
	6 20	18 90	6 28	18 82		6 03	19 03	6 11	18 98
Average.			6 16	18 93	Average.			6 08	18 99
Diff.				12 77	Diff.				12 91

Note Multiply by 1 019 to convert inches of mercury to feet of water

There were observations taken, with the apparatus as described, to determine separately the vacuum at the inlet of the pump and the pressure in the discharge. These observations checked the result of the direct measurement of total head on the pump and afforded the means for determining the loss of head in the suction and in the discharge pipes, as noted in Table 1. Observations were also taken to determine whether there was any difference in the vacuum indicated by the connection at the bottom of the inlet elbow from that indicated by a connection at the top, but none was apparent.

The samples of the readings as noted in Table 2 show that there was but slight fluctuation in the head on the pump during the taking of each set of readings.

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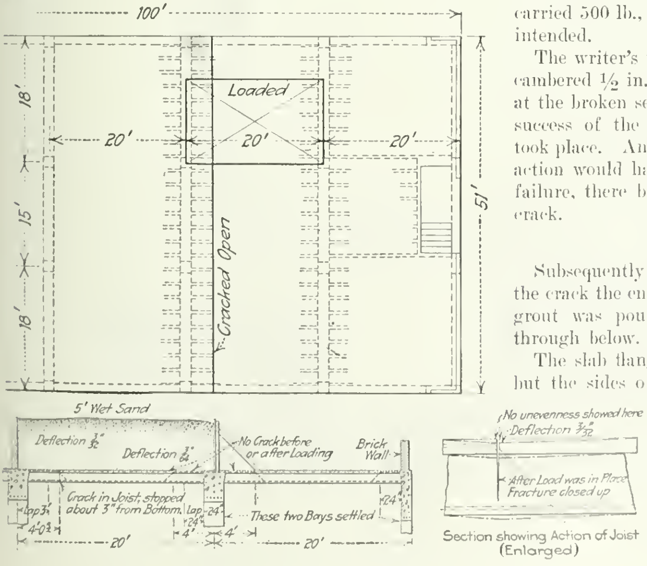
Load Test of Concrete Floor Cracked by Settlement

By J. H. Byrd*

The concrete beam-and-slab floor of a recently built paint and oil warehouse cracked soon after construction, across the line of the beams near the contraflexure point of one bay, over the whole width of the building. The crack was probably caused by settlement of one end of the building, due to yielding foundations. The safety of the structure being questioned, a load test was made. The surprising result was that the floor carried a very heavy test load—500 lb. per sq.ft.—and thus demonstrated that it was safe.

The building is shown in plan and part sections in the accompanying sketch. All supports for the contents, partitions and other dead-loads were in place. The building was practically completed when the cracks were noticed.

The building has only one floor and roof, and on this account a cheap type of foundation was adopted. The footings were placed directly on wet gumbo soil, probably about 10 ft. thick above sand, with a unit pressure of 1,500 lb. per sq.ft. They were balanced for dead-load, but this apparently did not prevent the uneven settlement. In filling the ground around the building, sand was pumped from the river; and as the water drained off to the lower levels, the footing pits provided fine sump basins.



Section showing Action of Joist (Enlarged)

PLAN AND SECTION OF FLOOR TESTED AFTER CRACKING

As shown by cracks in the loading dock at one end of the building, the ends of the building evidently settled. In spite of this a construction joint across the center of a panel near midlength of the building showed no crack. A crack appeared, however, in the second panel from one end, at the contraflexure point of the joist, as indicated in the plan. The settlement of the building is not apparent in levels taken from a benchmark or relative to the rest of the building. On the other hand, as the building was started in the winter months the cracks were evidently not caused by contraction of the concrete, but must have been caused by settlement. The crack continues all the way across the building through the wall beams and penetrates the slab sufficiently so that water can drip through. It is perpendicular to the floor and at places opens up to $\frac{1}{16}$ in.

It was at first thought necessary to build a brick or concrete wall under the broken joists to make the floor safe. However, it was decided to make a load test to gain information on the safety of the building.

An area 20x13 ft. was loaded with wet sand 5 ft. high, making 500 lb. per sq.ft., a total load of 130,000 lb. The maximum deflection at midspan was $^3/_{64}$ in.; at the crack, $\frac{3}{32}$ in. Most of the deflection occurred under the first 100 lb. The load was left on overnight, about 16 hr., and no additional deflection was noticed. After the load was removed, the crack was slightly closed. Permanent deflection was not apparent. The surface of the floor was perfectly smooth at the crack.

Thin grout will be allowed to seep through the crack; and, as the floor was designed for 250 lb. per sq.ft. and carried 500 lb., it will be considered safe for the purposes intended.

The writer's idea was that arch action (the joist being cambered ½ in.) would produce sufficient binding action at the broken section to take care of vertical shear. The success of the test seems to indicate that this action took place. Any deflection sufficient to overcome the arch action would have opened the joint and probably caused failure, there being no tension steel at the point of the crack.

Repair of the Crack

Subsequently a V-shaped slot 2 in. wide was cut along the crack the entire width of the floor. Very thin cement grout was poured into this slot. The water dripped through below.

The slab flange of the joists appears to be filled solid, but the sides of the joists show the same fracture, and the crack here can evidently be filled only by forcing in grout under air pressure. This will not be attempted.

The floor has now received nearly its full live-load, consisting of machinery, steel tanks, oil, varnish, etc. No further evidence of trouble has appeared.

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*Structural Engineer, 602 Finance Building, Kansas City, Mo.

Aërial Tramway as Substitute for a Bridge

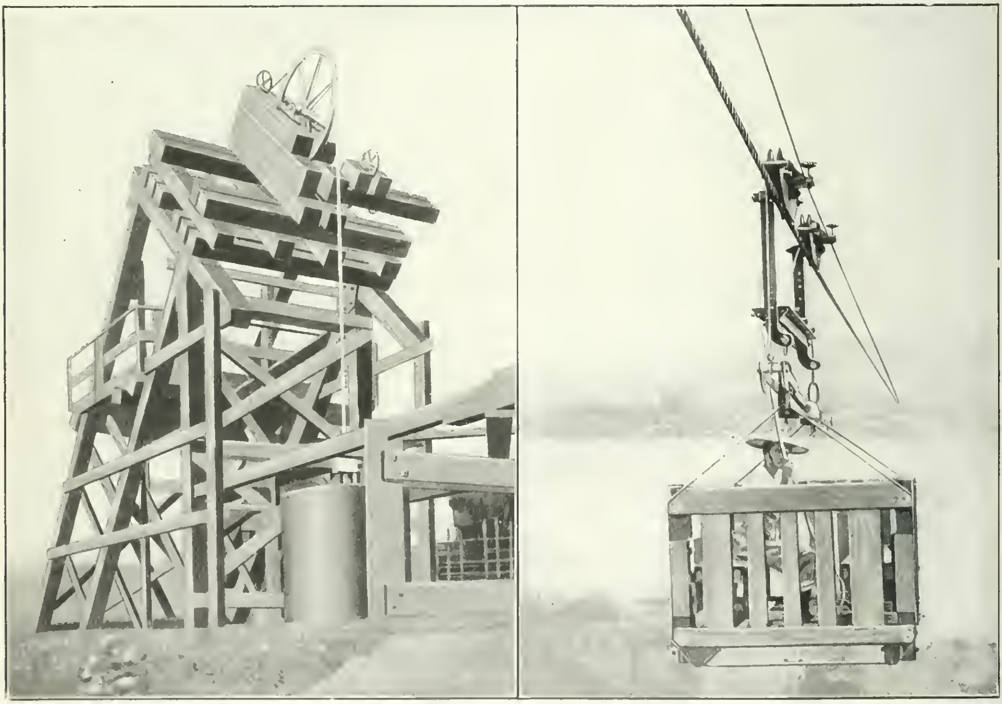
SYNOPSIS—A two-span cable tramway carries passengers across a river at times of flood. The method of erecting the 1,840-ft. cable is described.

An aërial tramway taking the place of a highway bridge is the feature of the crossing of the Naguilan River by the Bauang-Baguio road, in the Philippine Islands (La Union Province). The river is about ⅓ mi. wide between banks, has a flood rise of 25 ft. above low water, and the crossing may be unsafe for boats or rafts for several days. A steel bridge has been designed; but as conditions do not warrant its construction at this time, some means had to be devised for maintaining communication during high water. The tramway was built for this purpose. For ordinary service there is a timber trestle.

The tramway has two spans of 857 and 906 ft., the cables being supported by three timber towers—two on shore and one on a concrete pier that eventually will form one of the bridge piers. The towers are of ipil (a native hardwood) and Oregon pine, and the posts of the shore towers rest on concrete footings. At the towers the cables are carried at an elevation of about 55.76 ft. above low water. For the track cable this allows a dead-load sag of 7½ ft., a live-load sag of 14½ ft., a clearance of about 18 in. from flood level to the car and 7¼ ft. from the bottom of the car to the cable trolley. Stairs lead from the ground to the landing platform at the car level. A telephone line is carried across the towers.

The track cable is a 1¼-in. plow-steel cable (with six 19-wire strands), purchased from stock in Manila. The ultimate strength is 68 tons, and (with a factor of safety of 4) a working load of 17 tons was allowed. At the west end the cable is secured to an anchorage. Through the cable socket pass two 1½-in. eye-bolts 15 ft. long, whose ends engage a 3¼-in. pin in the head of a 1x4-in. eye-bar 26 ft. long. The lower end of the bar has a similar pin 2 ft. long, engaging a grillage of steel bars in a concrete anchor block 6x4¼x7½ ft. This block weighs about 9 tons, and the space between it and the face of the excavation was filled with concrete to insure stability.

At the east end the cable is not anchored, but passes over a grooved pulley on the tower and is attached to a cylindrical concrete counterweight 6 ft. 2 in. in diameter and 8 ft. 2 in. high. This is shown in one of the



AERIAL TRAMWAY FOR PASSENGERS: CROSSING THE NAGUILAN RIVER IN THE PHILIPPINE ISLANDS

The view at the left shows the east tower, with track cable attached to a 17-ton counterweight. The view at the right shows the car and carrier. The road and bridge (for use at low water) are shown beyond the car. The conductor is holding the safety cord for releasing the haulage rope in case of overwinding accompanying views. The counterweight weighs about 17 tons, but an annular recess in the top provides for an additional loading of about a ton of sand and gravel to compensate for stretching of the cable. Threaded rods anchored in the concrete form the attachment of the cable socket. This block was built in place and in elevated position (with its top just below the top of the tower), the form being supported on timber blocking. The cable sockets are semisteel castings 5¾x12 in. and 10 in. long. In the center is a hole tapering from 3½ to 1¼ in.; this receives the cable end, the wires being spread and bent back and the space filled with zinc. At each side is a hole for the anchor rod, these holes tapering from $2\frac{1}{16}$ in. to $1\frac{9}{16}$ in.

The car is an open timber box 5 ft. by 4 ft. 8 in., 3½ ft. deep, weighing about 400 lb. It is suspended from a carrier attached by hangers to a pair of two-wheel trolleys riding on the cable, as shown. The weight of car, carrier and trolleys is about 1,150 lb., while six passengers and a conductor bring the total live-load to 2,200 lb. At the landings the car is hooked to the tower posts to hold it steady. The conductor holds a safety cord for instantly releasing the car from the hauling cable in case of overwinding. Large animals are carried in a canvas hanger, the car body being then detached from the suspenders.

The ⅜-in. haulage cable passes around a horizontal 11-ft. driving sheave built on the ground behind the east tower and supported on a framing of timber beams. The wheel is built of three layers of Oregon pine plank, 3x12-in. for the top and bottom layers and 2x12-in. for the middle layer. The edges of the 3x12-in. planks are beveled to form a groove for the cable.

The under side of the wheel has runners that ride on hardwood (molave) rollers 5 in. long, tapering from 5 to 5½ in. in diameter. It has a pivot of ipil wood, 12 in. in diameter with a 9x9-in. bottom plate that rests on a hemispherical bearing plate bolted upon a concrete base 39x32 in. The upper bearing of the pivot is braced against the tower. Wedges allow for taking up shrinkage.

Guide pulleys lead the haulage cable to the driving sheave, around which it makes 1½ turns. This sheave is operated by two carabaos—or water buffaloes—hitched to a pair of timbers projecting on opposite sides. The stress on the haulage cable with loaded car (seven persons) is about 1,020 lb.

Preparing and Erecting the Cable

The 1¼-in. track cable (supplied in three coils) was stretched out along the road on the west side of the river, all twists and turns being taken out and each of the two splices made 50 ft. long. The required length between sockets, 1,838 ft. 5 in., was measured carefully with a 20-m. tape and checked twice. To this length was added—at each end—10 in. for the socket and 7 in. for bending back the wires into the socket. The total distance—1,810 ft. 4 in.—was marked by fine wires wound firmly around the cable, and the strands were then cut one by one. The cable was afterward hauled across the river, passing through the central tower.

After the sockets had been applied, the socket on the east end was fastened to the rods in the top of the counterweight, which was elevated on blocking, as already mentioned. Then the cable was pulled up to rest on the saddles of the west and central towers and the sheave of the east tower, the saddles and sheaves being well lubricated with axle grease. The west end was about 33 ft. from the anchorage attachment, the eye-bolts of which were held in position by a timber support, or horse.

A timber deadman 12x12 in., 15 ft. long, was placed vertically (set 10 ft. in the ground) behind the anchorage. Around this was placed a 4-ft. loop of three turns of 1¼-in. wire cable, and to this the hook of a double 24-in. diamond sheave was secured. On the main cable, beginning about 20 ft. from the socket, was lashed a 15-ft. loop of two lines of 3-in. hemp rope, the strands of which were unlaid for about 1 ft. and wrapped around the cable. The hook of a second 24-in. block was secured to this loop.

A 300-ft. length of ¾-in. steel cable was run through the two sheaves, one end being clamped at the block on the deadman and the other end being free for attachment to the axle of a 10-hp. 2½-ton motor truck, loaded with a ton of freight. Between the towers and the center pier the cable lay on the ground for about 66% of the distance. Men were sent up the center and west towers to keep the under side of the cable well lubricated with axle grease.

The motor truck then moved off; and when the cable swung free (almost simultaneously in the two spans), nearly the maximum power was needed to keep the truck moving. When the socket was within a short distance from the anchor rods, the pull of the cable was greater than the tractive effort and the truck stalled. By putting chains on the rear wheels, piling the freight directly over them and then working the engine with full admission of gasoline a little further advance was made, bit by bit.

Finally by applying full power and clamping the brakes to hold the slight advantage gained the socket was swung into such position that the eye-bolts (pivoted to the head of the anchor bar) could be passed through it, with just enough length projecting to hold the nuts. The washers and nuts were applied and turned with long-handled wrenches. As the nuts took up the thread, the truck was able to move ahead a little, thus relieving the strain on the nuts, the operations being repeated until the socket had been forced to the determined position on the bolt. The hauling line was then slacked gradually, until the anchorage took the full strain.

The next stage of operations was at the counterweight end of the cable (east end). The counterweight had been built in an elevated position, on blocking. By jacking slightly with four 60-ton hydraulic jacks the top 12-in. course of blocking was released and replaced with three 4-in. pieces, the counterweight being then jacked and lowered in 4-in. stages. This was repeated until it had been lowered about 6½ ft.

Then the car was loaded to 3,000 lb. with boulders and run out to the middle of the east span. As this did not suffice to raise the counterweight, the load was gradually increased to 7,000 lb., when the counterweight lifted ½ in. The jacks and blocking were at once removed, and the load on the car was reduced.

The total cost of this aërial tramway, including the towers and concrete pier, was $8,112. The foregoing information has been compiled from a paper in the "Bulletin" of the Bureau of Public Works (Philippine Islands), by Frank T. James, of Manila, who acted as supervising engineer.

Prorating Paving Cost Among Property Owners

By H. M. Talbott*

In 1915 the City of Owensboro, Ky., let by contract 6,124 lin.ft. of bitulithic pavement. Of this, 5,187 ft. was resurfacing on the existing concrete foundation, formerly surfaced with sheet asphalt; 270 ft. on new concrete foundation; and 667 ft. on macadam foundation, after the latter had been scarified and properly rolled.

Payment for the work was met by the abutting property owners, and the contractors were to collect the assessments according to the estimates furnished by the city engineer. This plan of payment involved 169 separate parties to the contract instead of the usual two. It is readily seen that complication could easily arise unless a systematic method of distributing quantities and figuring estimates was employed.

Measuring the Work for Assessment

Measurement was started at one end of the work, considered as Sta. 0 plus 00; and each property line was located by pluses, the property owner's front being found by subtracting the station number at each side of his property. In this way the measurement was made as a whole and the error in measurement reduced to a minimum.

The City R.R. ran over the streets where resurfacing was done, at some points single track and at others double. The street width varied in different blocks. A city ordinance required that the pavement be charged to the property owners at so much per running foot; but as the square yards per running foot varied, the estimate was figured on a square-yard basis. When the total cost to the property owner was determined, it was divided by the front feet of property, giving the cost per lineal foot.

In most Southern towns (especially the older ones) property lines do not agree with the lines shown by the deeds. In some instances there has been deeded as much as 10 ft. exceeding the block measurement. At other times there is a surplus not owned by anyone, according to the deeds; but, needless to say, the space is occupied. The measurements were made of the space actually occupied or claimed by the property owner and charged to him whether or not the distance shown agreed with his deed. Where the deed distance was more than the lineal feet as shown by the estimate, the property owner of course did not demur; but in some cases, where he was charged with more lineal feet than was shown by his deed, objections were raised. Cases of this kind were soon adjusted when he was told that he occupied more ground than he paid for and that the city would pay the assessment on the surplus, provided it could get a deed to the ground in excess of the deed distance.

In some places property lines could not be determined, as, for instance, where there was a stairway between two buildings. When this occurred, measurements were taken to what, in the judgment of the field man, was the property line; and estimates were issued on that basis. If there was an error, the property owner charged in excess was quick to have the error adjusted.

Since so many conflicting explanations were made to the field men about the location of the property line, it was thought best to get as nearly as possible the right line and let the owners adjust it between themselves. Where the property line was moved, as agreed upon by the owners, the plus was changed to conform to it; and automatically the frontage of the property on both sides or on one side was changed. The city paid for all street intersections (Fig. 2), and the City R.R. paved with concrete for 3½ ft. on each side of center line of track.

In tabulating the estimates six sheets were used similar to Table 1; one sheet, Table 2; one sheet, Table 3; and two sheets, Table 4.

Resurfacing on Existing Concrete Foundation

In resurfacing on the existing concrete foundation (Fig. 1) there were four items to be considered—top surface, binder, concrete and removing old asphalt.

The square yards fronting the property was found by the usual method of multiplying the front feet by the width of improvement and dividing by 9. Where the area was irregular, caused by the existence of turnouts in the City R.R. tracks, the usual method of triangles and trapezoids was followed, as shown by the sketch of the street on the right of Fig. 1.

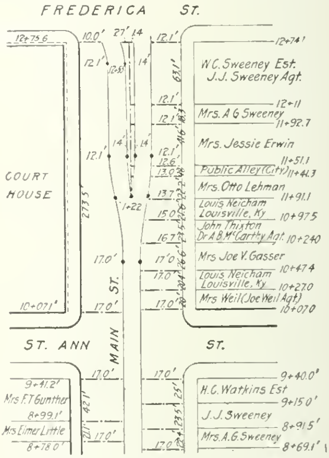


FIG. 1. SHOWING HOW ABUTTING PROPERTY OWNERS WERE ASSESSED ON MAIN ST.

The binder was brought to a uniform grade and the old concrete foundation was irregular. For these reasons the binder was not of uniform thickness. Hence it was paid for by the ton instead of by the square yard. In some cases no binder was used while in others four or five tons was laid. The manner of distributing the binder cost was as follows: The total number of tons of binder was determined by actual weight as it left the mixing plant and amounted to 858.04 tons. This was divided by the total square yards of improvement, and the decimal 0.0115 ton was applied to each square yard.

There were several places where the old foundation needed patching. The actual amount of concrete used was determined in cubic yards and the cost was distributed by the same method as that of the binder. The decimal 0.00157 cubic yard was found and applied to each square yard of improvement.

The square yards of old asphalt removed was the same as the square yards of top surface placed.

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*City Engineer, Owensboro, Ky.

TABLE 1. DATA ON BITULITHIC PAVEMENT ON MAIN ST., OWENSBORO, KY., FOR ASSESSMENT OF ABUTTING PROPERTY OWNERS

				Top Surface		Binder				Concrete				Removing Old Asphalt			
Property Owners	Lot Front, Lin.Ft.	Sq.Yd. Irregular Account, Double Track, Fig. 1	Total Sq Yd. per Lot	Price per Sq.Yd.	Cost per Lot	Weight in Tons, Binder per Sq.Yd.	Weight in Tons per Lot	Price per Ton	Cost per Lot	Cu Yd Concrete per Sq Yd of Improvement	Cost per Lot	Price per Cu.Yd.	Cost per Lot	Price per Sq Yd.	Cost per Lot	Total Cost	Cost per Lin.Ft.
W. C. Sweeney Est. (J. J. Sweeney, Agt.)	63 1	94 65	94 65	$1 45	$137 24	0 0445	4 21	$2 50	$10 53	0 00157	$0 15	$6 00	$0 90	$0 015	$1 42	$150 09	$2 38—
Mrs. A. G. Sweeney	18 3	27 45	27 45	1 45	39 80	0 0445	1 22	2 50	3 05	0 00157	05	6.00	.30	.015	.41	43 56	2 38+
Mrs. Jessie Erwin	4 16	62 40	62 40	1 45	90 48	0 0445	2 78	2 50	6 95	0 00157	.10	6 00	.60	.015	.94	98 97	2 38—
Public Alley (City)	9 8	14 75	14 75	1 45	21 39	0 0445	.66	2 50	1 65	0 00157	.02	6 00	.12	.015	.22	23 38	2 38+
Mrs. Otto Lehman	22 2	33 57	33 57	1 45	48 68	0 0445	1 49	2 50	3 73	0 00157	.05	6 00	.30	.015	.50	53.21	2 39+
Louis Neicham (Louisville, Ky., 2304 West Hill St.)	21 6	34 44	34 44	1 45	49 94	0 0445	1 53	2 50	3 83	0 00157	06	6.00	.36	015	52	54 65	2 53+
John Thixton (Dr. A. B. McCarthy, Agt.)	23 5	41.39	41 39	1 45	60 01	0 0445	1 84	2 50	4.60	0 00157	06	6 00	.36	015	62	65 56	2 79—

TABLE 2. DATA ON BITULITHIC PAVEMENT FOR ASSESSMENT AT INTERSECTIONS; WITH TYPICAL INTERSECTIONS

		Top Surface		Binder				Concrete				Removing Old Asphalt		
Street Intersection	Sq Yd. per Intersection	Price per Sq.Yd.	Cost per Intersection	Weight in Tons of Binder Sq.Yd.	Weight in Tons per Intersection	Price per Ton	Cost per Intersection	Cu Yd. Concrete Improvement	Cu Yd. per Intersection	Price per Cu Yd.	Cost per Intersection	Price per Sq.Yd.	Cost per Intersection	Cost of Intersection
Lewis and Main St.	141 80	$1 45	$205 01	0 0445	6 31	$2 50	$15 78	0 00157	0 22	$6 00	$1 32	$0 015	$2 13	$224 84
Daviess and Main St.	363 89	1 45	527 64	0 0445	16 19	2 50	40 48	0 00157	0 57	6 00	3 42	015	5 46	577 00
Allen and Main St.	354 11	1 45	513 46	0 0445	15 76	2 50	39 40	0 00157	0 56	6 00	3 36	015	5 31	561 53
St. Ann and Main St.	401 04	1 45	581 51	0 0445	17 84	2 50	44 60	0 00157	0 63	6 00	3 78	015	6 02	635 91
Frederica and Main St.	343 63	1 45	498 26	0 0445	15 29	2 50	38 22	0 00157	0 54	6 00	3 24	015	5 15	544 78
Third and Frederica St.	443 55	1 45	643 15	0 0445	19 74	2 50	49 35	0 00157	0 69	6 00	4 14	015	6 65	703 29
Fourth and Frederica St.	338.56	1 45	490 91	0 0445	15 07	2 50	37 68	0 00157	0 53	6.00	3 18	.015	5.08	536 85

TABLE 3. TYPICAL ASSESSMENT SHEET FOR PAVEMENT LAID ON NEW CONCRETE FOUNDATION

				(Bitulithic) Top Surface		Concrete		Excavation					
	Lot Front Lin. Ft.	Width of Improvement	Sq.Yd. Fronting Property	Price per Sq.Yd.	Cost per Lot	Price per Sq Yd.	Cost per Lot	Cu Yd Excavation per Sq.Yd Improvement	Cu Yd. Excavation per Lot	Price per Cu.Yd.	Cost per Lot	Total Cost per Lot	Cost per Lin Ft.
S. W. Anderson	56 9	18 5	116 96	$1 45	$169.59	$0 55	$64 33	0 272	31 81	$0 50	$15 91	$249 83	$4 39+
Lee Hart	86 8	18 5	178 42	1 45	258 71	.55	98 13	0 272	48 53		24 27	381 11	4 39+
W. A. Clark	35.7	18 5	73.38	1.45	106 40	.55	40 36	0 272	19.96	.	9 98	156 74	4 39+

TABLE 4. TYPICAL ASSESSMENT SHEET FOR PAVEMENT LAID ON EXISTING MACADAM FOUNDATION

					Top Surface		Scarifying		Foundation Stone					
Property Owner	Front Lin.Ft. Lot	Width of Improvement	Sq.Yd. Fronting Property	Sq.Yd. in Intersection	Price per Sq.Yd.	Cost per Lot or Intersection	Price per Sq.Yd.	Cost per Lot or Intersection	Cu.Yd. Stone per Sq Yd. Improvement	Cu Yd. Stone per Lot or Intersection	Price per Cu.Yd.	Cost per Lot or Intersection	Total Cost for Lots	Cost per Lin.Ft
Loven Whitley	132.1	18 5	275 21	.	$1 45	$399 05	$0 10	$27 52	0 1	27.52	$1 50	$41 28	$467 85	$3 54+

Under the head of "Laying Bitulithic on a New Concrete Foundation" the items "Top Surface (Bitulithic) in Square Yards," "Concrete in Cubic Yards," and "Excavation in Cubic Yards" were considered, as shown by Table 3. No binder was used, the top surface being laid directly on the concrete, which had been roughened to receive it.

Where pavement was laid on macadam foundation (Table 4), the items "Top Surface in Square Yards," "Scarifying in Square Yards," and "Foundation Stone in Cubic Yards" were considered. Streets where this work was done were of macadam. In surfacing them with bitulithic the old surface was scarified and brought to a uniform grade 4 in. below subgrade. Enough clean stone was placed so that when rolled the subgrade was uniform and 2 in. below the finished grade. The 2-in. top of bitulithic was then laid, no binder being used.

In the two classes of pavement just considered the method of uniform distribution of costs and quantities which was followed was similar to that on the work where bitulithic was laid on the existing concrete foundation.

This method of preparing estimates may not be new; but perhaps this description of it will offer a suggestion that may be of use to city engineers who have estimates of this kind to prepare. There is a rapid growth of city paving invading towns no larger than Owensboro (16,000) and in many cases the city engineer has not been called upon to do this kind of work before.

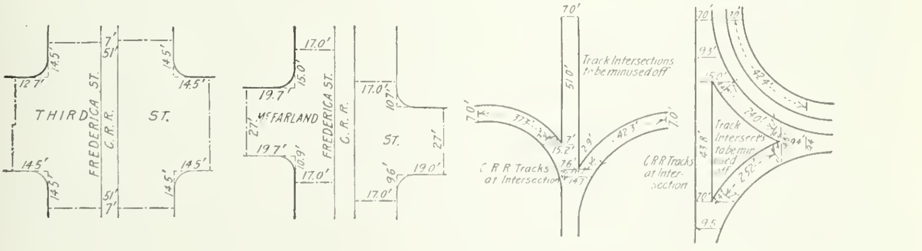
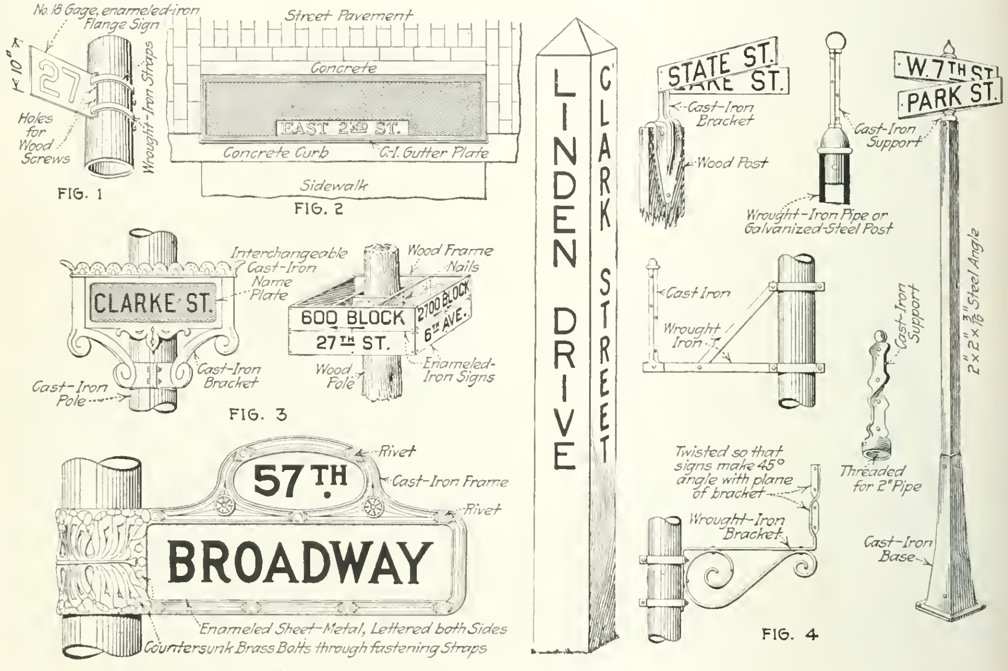


FIG. 2. TYPICAL STREET INTERSECTIONS

Miscellaneous Street Signs

Street signs are of many designs and are placed in all sorts of positions at the street corners. Rolland S. Wallis has treated this subject quite fully in a recent publication[1] of the Iowa State College. The sketches and views herewith show some of the less common methods of designating street intersections.

Fig. 1 is known as the flange sign and has been used with satisfactory results in Cleveland. It is fastened to wooden poles with screws or clamped to metal poles with thin metal straps, as illustrated, and is used to supplement the ordinary street signs placed at the intersections. In Fremont, Neb., the street names are carried on cast-iron gutter covers, as shown in Fig. 2. This plan while fairly convenient for pedestrians is of practically no value to vehicular traffic. Furthermore, in Northern cities accumulations of snow and ice will cover the names during certain portions of the winter season. Toronto discontinued the practice of sidewalk signs after some years' trial.



FIGS. 1 TO 6. STREET-NAME SIGNS OF VARIOUS PRACTICAL DESIGNS

Now that street curbs are so frequently constructed of concrete, street names are often stenciled on the curb. This method, also, has limitations, as can be readily understood. The illumination of curb signs is a new idea. Several of Fig. 7 have been installed experimentally in San Francisco and Los Angeles. It consists of a waterproof cast-iron box 40 in. long by 8 in. high, with the front face perforated. Illumination is furnished by three tubular electric lamps connected to the city lighting system. The box is provided with a removable top plate.

The box type of sign is shown in Fig. 3. The box at the right is of wood and is the type used in Syracuse, N. Y. It is nailed or bolted to wooden or metal posts.

Enameled-Iron Signs Used Extensively

Of the cities from which data were obtained by Mr. Wallis, more than one-half use enameled-iron signs to a greater or lesser extent. The cheapest signs of this construction are prone to develop such faults as fading, tarnishing, chipping, or peeling of the enamel, followed by rusting of the exposed metal. Good vitreous enamels carefully applied, each coat being fused or baked on at high temperature, are essential to permanence. One of this character should remain legible for from five to ten years and reliable manufacturers usually guarantee their signs for a period of ten years. These signs should be backed with wood to stiffen them. Several devices for supporting enameled-iron signs are shown in Fig. 4.

A square wooden post carrying the names of the streets, painted vertically, as in Fig. 5, has been found the most satisfactory sign for outlying districts of Spokane, Wash., while a similar sign is used in Los Angeles, Calif., for corresponding districts. Such a post is cheap, readily renewed or replaced, and gives a neat appearance.

The standard sign of New York City is shown in Fig. 6. It consists of a two-piece cast-iron frame, the two pieces riveted together with a double-face enameled-iron sign placed between. The two wings of the sign, only one of which is illustrated, are set at angles slightly exceeding 93° for right-angle streets. The cost of the malleable-iron frames is $5 per set, while the cost of the sign is 77c. The cast-iron signs have cost $5.75 to $6.91 in place.

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[1] Bulletin 20, "Street-Name Signs," Iowa State College, Ames, Iowa.

The standard sign used in San Francisco costs the city only $1.75 erected. The sign is of enameled iron with white letters on a brown field held in a frame of bronze.

Fig. 8 shows the bronze name-plate used in the downtown district of Denver, Colo. It is cast in one piece, has polished letters and a dark background and carries two street names. It is fastened to the combination light and trolley poles at each street intersection, being placed so that it can be read from the sidewalk side. This sign costs $3.50 set in place.

CONCRETE STREET SIGNS

The use of concrete as material for constructing street-name signs is novel at the present time, but it has proved practicable. Two such signs are shown in Fig. 9. These were designed and installed recently by the Department of Public Works of Pittsburgh. Both post and signboard are of granite-finished concrete. The design shown at the left is modified as a Lincoln Highway marker. The sign-plates are separate from the post, being so constructed that they swing about a vertical axis and may be clamped at any desired angle. The letters, of a black cement composition of permanent color, are about ⅜ in. thick and dovetailed securely into the concrete of the background.

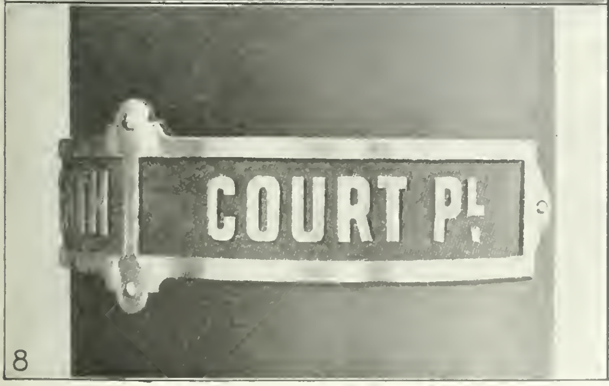
Regular Inspection of Sewers Part of Maintenance

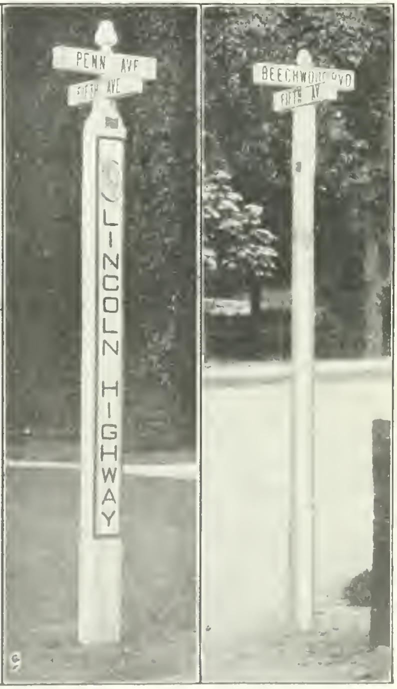
William H. Connell, chief of the Bureau of Highways, Philadelphia, Penn., is a strong advocate of sewer maintenance rather than sewer repairs. As in all the older Eastern cities, the sewers of Philadelphia are wearing out. The following paragraphs from Mr. Connell's recent annual report tell how these old sewers are being kept in service:

The number of complaints on sewer conditions received during the year 1915 were reduced about 15% compared with the three preceding years. There were several reasons, chief of which was the systematic cleaning and inspection of sewers in the central section of the city and the replacing of broken inlets and manhole castings throughout the entire city with standard castings, which are heavier and therefore better adapted to the increasing weight and speed of traffic.

The advisability of periodical inspection and cleaning is best shown through the reduction in the number of complaints in the central district, where the decrease for one year has amounted to 35%. As a result, the year's work was singularly free from extensive reconstructions, which generally follow heavy storms and freshets. These test the sewers to capacity and play havoc with the weak links of the various systems.

During 1915 the systematic cleaning of sewers was undertaken for the first time in the history of the Bureau of Highways, and splendid results were obtained. The entire Arch St. system, including all the sewers in the area from Market to Vine St. and from 13th St. to the Schuylkill River, were thoroughly cleaned and inspected. The size of these sewers varies from 6 in. to 9 ft. 6 in. in diameter, and the total length cleaned at least once amounted to 13.94 mi. Approximately one-half of the Willow St. system, beginning at the intersection of Ridge and Girard Ave., was cleaned once, the total length to Jan. 1, 1916, being 9 mi.





FIGS. 7 TO 9. ILLUMINATED CURB SIGN; BRONZE NAME PLATE; REINFORCED-CONCRETE SIGNS

The sewers in these systems were thoroughly inspected while undergoing the cleaning process, and minor repairs were made where required, so that no serious cave-ins of the sewers have been reported in these two districts this year. This unquestionably demonstrates the value of what might be termed "preventive work in the maintenance of sewers."

The cleaning in itself is not only necessary to insure the proper operation of the sewers and thus prevent the backing up of sewage into cellars and the overflowing of streets, but it provides for a patrol system of inspection that catches the many minor defects of natural deterioration before serious breaks can occur.

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Bond and Shear in Reinforced Footing Offsets

By Clifford Older*

Reinforced concrete is now so generally used that designers are sometimes found using the formulas for this material under certain conditions which lead to rather peculiar results. A case in point is that of such footing offsets as prove desirable in the design of many thousands of highway bridges.

As an example, consider the footing outlined in Fig. 1. The soil reaction under the offset *O* may be represented by the area *ABCD*. Let *V* equal the resultant of this reaction, *y* its moment arm, *F* the thickness of the footing and *EC* the critical section to be considered.

Assume a footing thickness *F* of 18 in., a moment arm *y* of 9 in. and a reaction *V* of 6,000 lb. Assume also that the t-bars used to reinforce the offset are located 6 in. above the bottom of the footing, because of convenience in placing in wet foundation pits. These are assumptions frequently approximated in highway-bridge design.

Ordinary Formula Shows Excessive Bond Stress

The bending moment at the critical section would be 54,000 in.-lb. Neglecting tension in concrete and applying the usual reinforced-concrete formulas, with $d = 12$ in., $f_s = 16{,}000$, and $n = 15$, it is found that 0.32 sq.in. of steel per lin.ft. of footing would be sufficient. The compression in the concrete would be about 300 lb. per sq.in.; the maximum shear ($d = 12$ in.) 45 lb. per sq.in.; average shear ($d = 12$ in.) 41.5 lb. per sq.in., or average shear ($d = 18$ in.) 28 lb. per sq.in. All of these stresses seem reasonable. The bond stress to be developed per lineal foot of footing, however, would be

$$\frac{jd}{V} = \frac{6{,}000}{0.92 \times 12} = 511 \text{ lb.}$$

Using $\frac{5}{8}$-in. round bars 12 in. on centers would provide an area of steel of about 0.31 sq.in., but the maximum bond stress would theoretically be about 277 lb. per sq.in. surface. To keep the bond stress down to 80 lb. per sq.in. without using a great excess of steel, $\frac{1}{4}$-in. round rods spaced about 1.4 in. on centers would satisfy the requirement as to bond and provide an excess tension area of about 0.10 sq.in. Such a selection of reinforcing steel to satisfy requirements of bond only seems rather absurd, considering the fact that, if the steel is entirely neglected and the offset figured as a homogeneous cantilever beam 18 in. deep, the tension in the concrete would be only about 83 lb. per sq.in., or not more than about one-third of the modulus of rupture that might be expected.

Probable Influence of Concrete Tension

It is evident that when the offset is small as compared with the thickness of the footing, and the steel ratio is low, the concrete stress at *C*, considering the offset as a plain concrete cantilever, may be well within a safe working stress for concrete in tension, the steel stress only *n* times the stress in the concrete at the same elevation, and the bond stress very small. As the bending moment increases, the required steel ratio increases also, and the concrete at *C* will eventually crack. It does not appear, however, that the bond stress increases suddenly from practically zero to the full theoretical amount when the modulus of rupture of plain concrete is exceeded, nor does it appear that the maximum diagonal tension is as great as the total shear at the face of the wall would indicate.

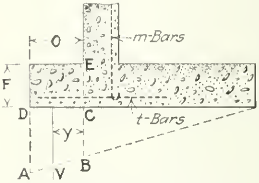

FIG. 1. SKETCH OF REINFORCED FOOTING OFFSET

Diagrams showing the position of the neutral axis, as determined by tests, indicate that for small loads the distance from the compressive face to the neutral axis is practically one-half the total depth of the beam, and this distance does not decrease materially, particularly when the steel ratio is small, until the loads are increased to at least one-eighth of the ultimate. The rise of the neutral axis is not abrupt at any stage of the loading. (See "Principles of Reinforced Concrete," by Turneaure and Maurer, 2nd ed., Art. 101.) These diagrams seem to indicate that, particularly when small steel ratios are sufficient, tension in concrete is an important function; it follows that bond and probably diagonal tension are materially less than figured by the usual formulas, at least for loads which would produce a concrete stress less than the ultimate.

Tests of wall footings by Professor Talbot (See University of Illinois Bulletin No. 67) indicate very high theoretical bond stresses at maximum loads and but few bond failures. Only four bond failures were reported when the steel ratio was less than 0.0098. In each of these cases the steel stress exceeded 41,000 lb. per sq.in. at failure. In considering diagonal tension, Professor Talbot recommends that the critical section be taken at a distance out from the face of the wall equal to the depth of the footing.

New Illinois Highway Rule on Offsets

In view of these considerations, the Bridge Bureau of the Illinois Highway Department has adopted the following rules governing the design of footing offsets:

> Shear, as a measure of diagonal tension, and bond stresses are neglected when the tensile stress in the concrete (fc′) figures less than 75 lb. per sq.in. considering the offset as a nonreinforced cantilever beam.
>
> Shear and bond stresses are considered to increase uniformly from zero at fc′ = 75 lb. to the full theoretical shear $\left(v = \frac{V}{bjd}\right)$ and bond $\left(u = \frac{V}{\Sigma o jd}\right)$ at fc′ = 200.
>
> For values of fc′ greater than 200, the usual formulas for shear and bond are used.

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*Bridge Engineer, Illinois Highway Department, Springfield, Ill.

Tension in concrete is neglected in figuring the area of steel required for tensile stresses as some steel is desirable in any case to aid in anchoring the M-bars of the vertical wall.

In order to facilitate the application of these rules, curves have been plotted for footings of various thicknesses, of which Fig. 2 is an example.

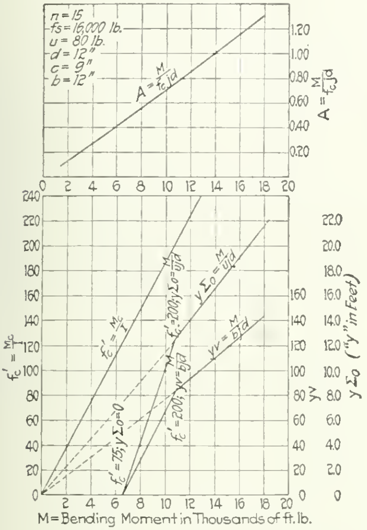

FIG. 2. DIAGRAM FOR SHEAR AND BOND IN 18-IN. FOOTING OFFSET 12 IN. DEEP

The derivation of the formulas used in plotting these curves is as follows. The notation is the same as that in common use except as noted. Let

y = Moment arm (see Fig. 1);
V = Reaction on offset = total shear;
I = Moment of inertia of critical section, neglecting reinforcing steel;
d = Gross depth F of footing (see Fig. 1);
c = One-half depth of footing = $\frac{1}{2}F$;
fc' = Tension in concrete, neglecting reinforcing steel.

Then

$$fc' = \frac{Mc}{I} \tag{1}$$

$$M = Vy; \quad V = \frac{M}{y}$$

$$u = \frac{V}{\Sigma ojd} = \frac{M}{\Sigma ojdy}$$

$$y\Sigma o = \frac{M}{ujd} \tag{2}$$

$$v = \frac{V}{bjd} = \frac{M}{bjdy}$$

$$yv = \frac{M}{bjd} \tag{3}$$

Also from (2) and (3) $bvy = uy\Sigma o$ and $yv = \frac{u}{b}(y\Sigma o)$

$$M = f_spjbd^2 = (pbd)f_sjd$$

$$pbd = A$$

$$M = Af_sjd$$

$$A = \frac{M}{f_sjd} \tag{4}$$

It will be noted that when the bending moment on the offset has been computed, the area of tension steel (neglecting tension in concrete) and the tension in the concrete (neglecting steel) may be read direct from the diagram. The readings for bond and shear must be divided by y in order to obtain the true value of these quantities. For convenience, the bending moment is given in foot-pounds and y in feet. The curves for $y\Sigma o = \frac{M}{ujd}$ and $yv = \frac{M}{bjd}$ are dotted from the $fc' = 200$ point to zero in order that the reduction relation may be seen.

In computing the tables from which the curves were plotted, large-scale curves giving values of j and R_s ($= f_spj$) for various percentages of steel were used.

Duty of Water for Irrigation Under Idaho Conditions*

By Don H. Bark†

The investigations have determined the factors which must be taken into consideration in determining the proper duty for an entire irrigation project. The first factor is the proper duty of water at the land. The results of the investigation indicate that under conditions similar to those obtaining in Idaho a normal project with medium clay loam should furnish sufficient water so that 2 acre-feet can be retained upon each and every irrigated acre during the season; that this quantity should be delivered under a rotation system in heads of such sizes that economical use can be secured; and that where a project is devoted one half to grain and the other half to alfalfa or other crops requiring a similar volume of water, 18.7% of this 2 acre-feet should be delivered during May, 28.3% during June, 32.8% during July, 17.2% during August, and 2% during the first half of September, there being but little need for irrigation during the month of April and practically none after the middle of September, provided stock water or that used for domestic purposes is not taken into consideration. It has been shown that the farmer must receive approximately $2\frac{1}{4}$ ft. of water per acre at the farm in order for him to retain 2 ft. per acre upon the land. Where projects consist in whole or in part of porous soils or of soils with porous subsoils lying closer to the surface than 6 ft., more than $2\frac{1}{4}$ ft. per acre should be delivered to the consumers, the quantity required being largely dependent upon the porosity of the soil.

A conservative estimate of the transmission losses should be made in advance for each project, in either cubic feet per square foot of wetted area or per cent. per mile, from the quantity required of canals to furnish sufficient water to all parts of a project. A normal project will be found to lose from 20 to 40% of all water diverted before the water can be delivered to the farmer.

After the duty of water at the land, the size of the project, and the probable transmission losses have been determined, the net area which may be irrigated may be readily found. It then becomes necessary to calculate the extent of waste or nonirrigated land from all causes which will finally be contained in the project. This, added to the net area which can be irrigated, will give the gross area of the project. The extensive survey that was made for the determination of this factor seems to indicate that 90% of a normal project will be irrigated every year after the project is fully developed.

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*Conclusions of Bulletin No. 339, United States Department of Agriculture, "Experiments on the Economical Use of Irrigation Water in Idaho." Copies of the Bulletin may be obtained for 10c. from the Superintendent of Documents, Washington, D. C.

†Irrigation Engineer, Division of Irrigation Investigations, United States Department of Agriculture.

The investigation has demonstrated the adequacy of 2 ft. per acre for diversified crops on the better class of soils, but it requires careful husbandry to render this quantity adequate, and it seems evident that but few projects will ever exist, with conditions similar to those in south Idaho, where an allotment of less than this supply will be justified. It is believed, however, that the volume of water which will produce the maximum yield of crop on any certain variety of soil is in but few cases the proper and economic duty. It is very evident that the cost of the land, of water, the value of the crops produced, and the cost of producing them, as well as the volume of water which will produce the largest yield, must all be taken into consideration when determining the duty for any project. In many places the largest crop has been produced where the most water has been applied, but the yield has been in but few cases proportional to the quantity of water used, and in view of this there is no doubt that, broadly speaking, one would be justified in opening up a project with a higher duty of water where water is very valuable and land comparatively cheap than where land is high and water comparatively inexpensive.

The determination of the proper supply of water for an irrigation project is a very serious problem and one that must be given the most careful consideration, for it is fully as serious to err on the side of too little water as it is on the side of too much. If too little water is allotted, the farmers never can produce profitable crops and the lands never will reach their highest possible value, while if too much is allotted the ultimate irrigated area is not only cut down, but the excess supply is almost invariably used, resulting in the rapid water-logging and deterioration of the irrigated lands.

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Excess Condemnation and City Planning

By Charles K. Mohler*

SYNOPSIS—The principles and advantages of excess condemnation, or the taking of more land than is needed for the immediate purposes of a public improvement, and the subsequent readjustment of lot lines and resale of the excess property are set forth. A number of the arguments are illustrated by examples from a Pacific Coast city.

A serious obstacle to city planning in most states is the lack of adequate methods for acquiring the necessary lands for public use. Excess condemnation has been employed in Europe for over 60 years. In the United States, Connecticut, Massachusetts, Maryland, New York, Ohio, Pennsylvania and Virginia have established the right of "excess condemnation," or the right to take by condemnation land outside the exact bounds of a proposed improvement. The objects in acquiring excess land which may be resold or leased by the governing agency are:

1. To place it under necessary or desirable restrictions.
2. To secure remnants or fractions of subdivisions outside the improvement boundaries.
3. To secure enough additional property outside the boundaries to include, where necessary, in resubdivision.
4. To secure for future use land which may not be needed at the present.

The reasons for these objects should be briefly discussed.

1. Restrictions—In laying out streets, boulevards, parks, playgrounds, etc., the very object of the improvement may be defeated if proper restrictions are not placed on the adjoining property. While the necessary restrictions may be secured in some cases by means of easements, it may prove more advantageous in others to condemn the property and resell under such restrictions as it may be wise to impose. It may be desirable or necessary to exercise the right to abate nuisances.

2. Remnants—Securing remnants (the value of which may and probably has been awarded to the owner from whom the main portion was secured) is a right of the greatest importance. This feature can best be shown and illustrated by a street opening recently undertaken in a Pacific Coast city.

In Fig. 1 the "Proposed Broadway 'Opening' " is shown, made up of the hatched portions *B* and *D* and the portion of an alley marked *C*. Notice the small fractions or remnants left from lots 4, 5, 34, 32 and 30. Lots 6, 7, 8, 21, 22 and 24 are left facing unimportant cross-streets. Lot 22 is left too narrow for proper development, and the alley east of lot 21 will prevent joining to the lots on the east, to secure the best use. With the opening completed, the old portion *EE* of Broadway would be rendered practically useless and as a result should be vacated and thrown into the resubdivision. Lots 6, 7, 8 and 21, while assessed for benefits, are not in such position as to derive the full amount that should be possible through resubdivision. Under the present status the municipality is powerless to effect any change from such conditions as described, and as shown in Fig. 1.

The most successful method of handling remnants appears to be that worked out and used in France. Where remnants are too small for proper development, they are acquired by the municipality. The parcels are then carefully and impartially appraised and the owner of the adjoining property given the opportunity to purchase at the appraised value. If the owner of the adjoining property does not purchase within a specified time, the municipality may then proceed to take over his property, combine it with the remnant and resell the whole.

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*Consulting Engineer, 150 Hill St., Los Angeles, Calif.

The futility and evil effects of leaving wedges or remnants in the hands of private owners without any power of control by the governing agency is well illustrated by Figs. 3 and 4. In Fig. 3 the "old" street is shown on the left and the "opened" street on the right with the remnant in between occupied by a brick wall that serves the purpose of an advertising billboard. The pleasing billboard effect is seen in Fig. 4. At the extreme left of Fig. 4 is the end elevation shown in Fig. 3. Fig. 5 shows the general layout of the old and "opened" streets and the remnant left between the two public thoroughfares.

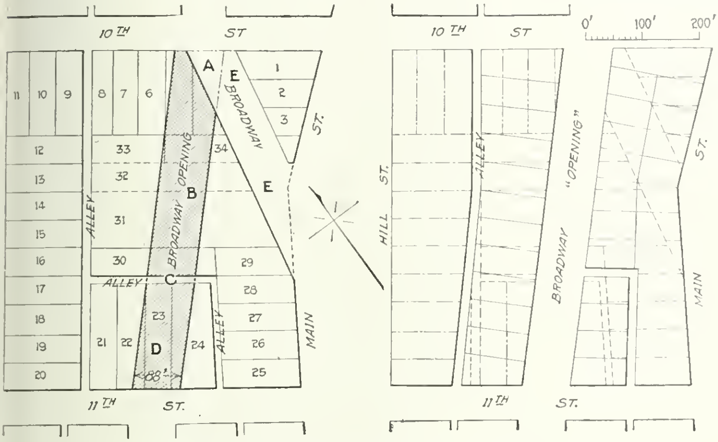


Fig. 1 Fig. 2

FIGS. 1 AND 2. EFFECT OF STREET OPENING ON LOTS, LOS ANGELES, CALIF., AND POSSIBLE SUBSTITUTE

Fig. 1—Ordinary method as carried out. Fig. 2—Excess condemnation possibilities

Again referring to Fig. 1, observe the long wedge-shaped remnant left from lot 5, facing on 10th St. The award for the portion of lot 5 taken was fully equivalent to, if not greater than, the fair value of the entire lot; but still the remnant is left in possession of the original owner. In addition to the possibilities of billboard development, such as just illustrated, it may stand as an effective barrier to the proper development to secure the best results from the "opening" improvement.

The valuable frontage in the case under consideration is on Broadway. That would call for the merging of lots 6, 7 and 8 and the remnant remaining from lot 5. Lots 6, 7 and 8 have been assessed benefits, and naturally should be given the opportunity of getting the best returns. If the owner of the remnant does not choose to come to some reasonable agreement with the other owners, nothing can be done unless the others submit to a "hold-up." As the remnant has already been paid for, why should it not be taken by the municipality and devoted to the good of all concerned? The only use the wedge can serve by itself is for the location of an advertising fence and a possible "stand" of some sort.

3. Resubdivision—Under remnants, just considered, one feature of resubdivision was touched upon. The question is one of far-reaching importance. Again referring to Fig. 1, a glance will show how far the "improvement" will fall short of the possibilities, if the entire situation is left as shown. The desirable, if not necessary, changes to make are the following:

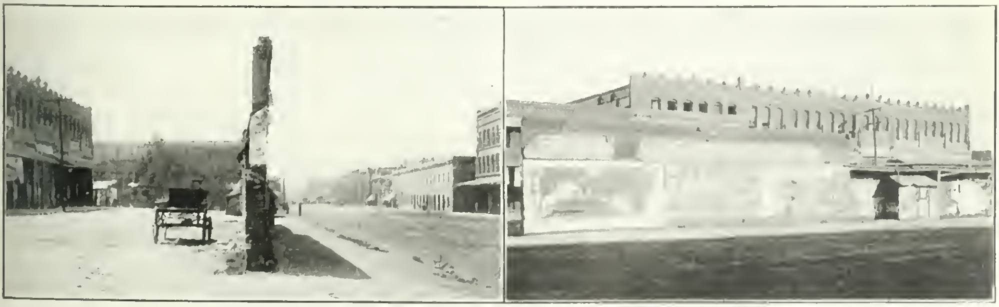
A. To throw lots 6, 7 and 8 and the remnants of lot 5 together and replot so as to get the valuable Broadway frontage.

B. To vacate the portion of Broadway marked *EE*, to combine with lots or portions of lots 1, 2, 3, 4, 34, 32, 31, 29 and 28, for an entire rearrangement in subdivision.

C. From the south line of lots 13 and 32, to change the location of the alley west of Broadway to bring the south end out opposite the alley south of 11th St.; to close the portion of the east and west alley lying between Broadway and the north and south alley just mentioned and use it for resubdivision. This will give the twofold advantage of Broadway frontage for lots 21 and 22 and equalize the depth of lots lying between Broadway and Hill St.

D. To relocate the alley between Broadway and Main, midway between the two, to secure depth for the Broadway frontage of lot 24 and equalize the lot depth between Broadway and Main.

Fig. 2 shows a possible resubdivision in accordance with the foregoing requirements. Old subdivision lines are shown with a dash and dot, and old street lines in short



FIGS. 3 AND 4. REMNANT AND WALL LEFT IN LOS ANGELES STREET WIDENING AND STRAIGHTENING (SEE FIG. 5)

End view of wall, new and old streets, looking south. Side view of wall and use to which it was put

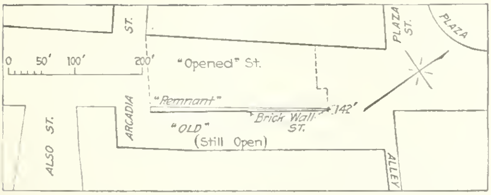


FIG. 5. PLAN OF STREET WIDENING AND STRAIGHTENING SHOWN IN FIGS. 3 AND 4

dashes. New subdivision and unchanged lines of streets are solid. The advantages gained are briefly:

A. The valuable Broadway frontage is secured throughout.

B. The old and useless portion of Broadway is vacated and made available for use, so that instead of being left with five small remnants, ten large well-shaped lots are secured.

C. West of Broadway all lot lines are at right angles to the street line. East of Broadway the deviation from right angles of the lot lines is equally divided between Broadway and Main. This gives better intersection angles on both streets than the old subdivision lines.

D. As before stated, the change in the location of the alleys on each side of Broadway gives equal depths of lots between Broadway and Main and Broadway and Hill. The alleys are also brought out opposite the alleys south of 11th St.

E. All long, narrow, thin, wedge-shaped and fractional portions of lots are eliminated and lots of usable size and shape are obtained instead. This is a very important object to accomplish.

F. The amount of land added and made available for sale by the vacation of that portion of Broadway and the alley rendered useless, together with the replotting of the entire tract effected, should increase values for resale enough to pay for the improvement, if not actually return a profit.

4. Land for Future Use—Where only such land can be acquired by condemnation as is required for immediate use, it may prove a serious handicap where future developments need more land than can be used at the time the improvement is first undertaken. Generally when public improvements are made, the surrounding property at once increases in value. Occupancy and speculation may so increase values that, when additional development is undertaken, the necessary land may cost many times what it would have cost if acquired under the first proceeding, if in fact it can be obtained at all. Sites for parks, playgrounds, schools, public buildings, etc., are cases in point. Some advocate the purchase of the major portion of the surrounding property, which would benefit by the improvement, by the municipality for resale or lease, in order to realize on the increment in value. Under proper safeguards this would be advisable in some cases.

It is needless to state that much of the property, if left as shown in Fig. 1 on the old subdivision lines, will be of little if any value.

It may be pertinent to call attention to several misconceptions about excess condemnation.

1. In Favor—(a) Some believe it will afford a means of paying for an improvement, or even return a profit, by the resale of land taken. This may or may not be the result and should be considered as merely incidental in most cases. Returns from resale should not be counted in any sense as the "object" in undertaking an improvement.

2. Against—(b) The fear is entertained by some that the right to take excess land will result in the municipality undertaking improvements for the purpose of exploitation or speculation.

(c) Others seem to fear that the governing agency might undertake improvements and acquire so much land as to go bankrupt.

These two negative misconceptions are founded largely on the affirmative one, where "returns" from resale are "expected." When an improvement is undertaken because of its need or inherent merits and excess land is acquired for any of the objects—restriction, securing remnants, resubdivision, land for future use as above specified—there should be little danger of either speculation or bankruptcy.

The fear is also expressed that the person whose property is taken outside of an improvement may be injured or exploited. The process for acquiring property outside the improvement boundary will be the same as for that inside and a party affected should suffer no more injury in one case than in the other.

Cities have so increased in size, population and importance that every reasonable facility should be made available to correct past mistakes and to provide for future needs. Working methods for this purpose have been too long neglected.

Influence of Viscosity in Pumping Crude Oil

By Arthur L. Collins*

It is the intention here to emphasize the importance of the viscosity factor in the design and operation of pipe lines rather than the gravity of the oil. The article by C. P. Bowie, on "Pumping California Crude Oils," in *Engineering News*, Dec. 2, 1915, treats of the oils registering 16° Bé. and over. Pipe lines that transport oil with a viscosity practically the same as that of water for all temperatures offer no particular difficulties. The data obtained on lines where the viscosity of the oil is greater than that of water have always been of little importance to the designing and operating engineer, because there has been no reliable way to measure this so-called viscosity. It can be shown that without this factor, better termed "friction characteristic of the oil" rather than viscosity, there can be no accurate basis for design and operation.

For two years the writer has devoted his time almost exclusively to the study of oil friction in pipe lines. The object has been to establish a scientific method for locating pumping stations for new lines, a method which will also insure the making of repairs and improvements intelligently. Lines now operating can then be made to operate more economically and satisfactorily by knowing in advance how the oil will act under different climatic conditions.

In July 1914, E. I. Dyer, of the Union Oil Co., prepared a paper for the American Society of Mechanical Engineers, in which he said:

> Unless the loss of head by friction can be predetermined with reasonable accuracy, every element entering into both

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*1651 Waller St., San Francisco, Calif.

> the first cost and the operating costs of the installation is uncertain; and should the design be undertaken in an era of keen competition and small margins of profit, a losing venture might easily result. . . .
>
> The most economical pipe line for a given service cannot be determined in advance without a working knowledge of the laws governing the flow of oil in pipe lines in general. The determination of these laws offers the most important single problem in pipe-line work.

In considering what is meant by the word viscosity the writer wishes to dispel a general impression that the specific gravity or relative weights of the different oils is a measure of the respective viscosities. The lighter products of the crude oils run to gasoline and the heavier products to asphaltum or the base. The former may be said at times to be more thin, or viscous, even than water. The latter may be of all degrees of consistency and are known as heavy oils. It may be said to be a coincidence that the light crude oils have a thin consistency and the heavy crude oils are thick.

It is possible to select certain lubricating oils as the product of the crudes and have the general rule as mentioned reversed. Thus a 25° Bé. (specific gravity, 0.9032) may have a greater, or rather thicker, consistency than, say, an 18° Bé. (specific gravity, 0.9459).

Generally, when a California crude oil measures around 15° Bé. its consistency becomes not unlike that of molasses at the normal temperature. At 25° Bé. the oils may not be dissimilar to water with reference to their friction characteristics. It is, however, very important to bear in mind that two oils, say of 15° Bé. or lower, may vary almost any amount in their friction values at the same temperatures and within the limits of the temperatures as determined by climatic conditions. By mixing a small percentage of the lighter oils with the heavy oils the viscosity of the latter may be changed to a remarkable degree. Then, in order to handle any given oil, the formula that takes into consideration the gravity of the oil when a viscosity, or, better termed, friction factor, is the one required, cannot be considered very seriously in oil pipe-line work.

The formula developed by Mr. Bowie (*Engineering News*, Dec. 2, 1915) barely reaches the class of oils for which more scientific knowledge must be obtained in order that pipe lines may be constructed and operated to the best possible advantage. The lowest value of C as given in his formula is for a 16° Bé. oil. It would not be considered advisable to attempt a formula such as is given where the gravity of the oil appears as the friction factor.

The oil pipe line as it exists today is the result of cut-and-try methods with what may be termed a wide variation in the safety factor. The meaning of factor of safety as used here by the writer is the reserved pressure in excess of that required for the pumping of water for any given capacity. Economical pipe-line design means the saving of as much as possible of this required excess equipment. Economical operation requires not only a saving in fuel and wear and tear on the machinery, but a maximum quantity of oil pumped.

The absence of an easily operated "oil machine" that will determine the friction characteristics of an oil will account in part for the absence of data on friction flow. The ordinary types of viscosimeters in which the oils must pass through an efflux tube of capillary size are useless for this purpose. Attempts to connect the results of laboratory work with the field work when using California oils have never been satisfactory. To this factor can be traced the lack of sympathy for research work along these lines by the oil companies.

In the article by Mr. Bowie reference was made to the first pipe line constructed in California for the transportation of the crude oil, testing 14° Bé., as obtained in the Kern River fields. As it is the intention to give here also data on the "safety factor" of oil lines, the following is noted regarding this "rifled pipe line" (from *Engineering News*, June 7, 1906, and *Journal of Electricity, Power and Gas*, Oct. 3, 1908):

Cost, about $5,000,000.
Length, 282 mi. Diameter of pipe, 8 in.
Pumping stations, 24 mi. apart.
Capacity, 17,000 to 20,000 bbl. per 24 hr. of net oil.
Pressure on pumps, 750 lb. per sq.in.

In the line is inserted 10% of water to form the water film around the oil. The formula that applies to the capacity and pressure of the line is $p = \frac{Kv^2}{d}$, where

p = Fall in pressure for 100 ft.;
d = Diameter of pipe;
v = Velocity;
K = Constant.

K changes as follows: For 8-in.-pipe not rifled (with oil)—straight pipe—oil—no water, average, $K = 7$; 90% oil and 10% water, best value of $K = 4.1$. For 8-in. pipe, rifled (with oil)—90% oil and 10% water, average, $K = 0.49$; 90% oil and 10% water, best value, $K = 0.37$. For 8-in. pipe, rifled (straight water)—average, $K = 0.18$. With these data at hand it is desirable now to obtain the pressure as given by these values for the comparison.

Assume the capacity as 24,000 bbl. (1,008,000 gal.) per day. The velocity in the pipe is about 4.45 ft. per sec. When $K = 0.18$, the pressure is 23.5 lb. per sq.in. When $K = 0.37$, the pressure is 48.3 lb. per sq.in. When $K = 0.49$, the pressure is 64 lb. per sq.in. per mi.

This formula gives a value of 23.5 lb. per sq.in. per mi. for water, but for convenience the writer wishes to use the value of 25 lb. per sq.in.—which can be justified by the formula for ordinary plain pipe.

The 64 lb. can be provided in the spiraled line only by making the stations 12 mi. apart rather than the 24 mi. as planned. If the stations are 12 mi. apart and it is desired to discharge 24,000 bbl. per day, there will be required a safety factor of $\frac{64}{25}$, or 2.56, as determined by the formula. It is quite evident from the factors where K is from 4 to 7 that some treatment of the oil is absolutely necessary; otherwise the pressure would be several times greater than is permissible.

It may be noted here that the other oil lines have not been duplicates of the rifled system. Another point worth mentioning is the fact that the first lines with the "hot system" have the pumping station 12 mi. apart. The reason may be more than a coincidence, since they have all been constructed by empirical methods.

The data given by Mr. Bowie on p. 1070, *Engineering News*, Dec. 2, 1915, no doubt have reference to the "hot method," in which the viscosity of the oil is changed by heating.

As has been mentioned before, the value 16° Bé. is a variable quantity when given as a measure of viscosity, but Mr. Bowie's indicated value of C will be used for the second comparative example.

$$Q = C\sqrt{\frac{P}{Le}}$$

where

Q = Quantity of oil in barrels per hour;
C = Constant;
P = Initial pump pressure in pounds per square inch;
L = Length of line;
e = Factor dependent upon the size of the pipe used (for 8-in. pipe is 1).

For 16° Bé., C is 160. P is then 39 lb. per sq.in. per mi.

It should be remembered that this value is the pressure on the pumps. In the first mile out from the station the pressure of the oil may not be more than that of water, but the last mile may be several times that of water, due to the cooling of the oil. The formula gives an integrated value of 39 lb. per sq.in. per mi. for a line 13.1 mi. long. In practice it may be necessary to space the stations all the way from, say, 5 mi. to 25 mi. apart, depending upon the character of the country. The viscosity of the oils testing 17° Bé. and lower is very erratic; and it has been impossible, as far as the writer knows, to obtain an assignable measure of the friction characteristics on any laboratory instrument. The permissible average pressure on a station of 13.1 mi. is 800 lb. divided by 13.1, or 61 lb. The line would have a safety factor of $\frac{61}{25}$, or 2.44. Using the derived value of 39 lb., there would be required a factor of safety of $\frac{39}{25}$, or 1.56.

By the experiments of the writer it had been concluded that the 25° Bé. oil gives a value practically the same as water, which is borne out by comparing the value of C as given by the formula of Mr. Bowie.

The following data are from the Valley pipe line (Shell Co.), recently constructed (*Journal of Electricity, Power and Gas*, September, 1915):

Cost, about $4,000,000.
Length, 170 mi.
Two-thirds of the pipe is of 8-in. diameter.
One-third of the pipe is of 10-in. diameter.
Capacity is 25,000 bbl. per 24 hr. of 16° Bé. oil.
Stations, 15½ mi. apart.

Let it be assumed that the water pressure for 24,000 bbl. per day is 25 lb. per sq.in. per mi. for 8-in. pipe and the pressure for the 10-in. is one-third of that value, or 8⅓ lb. per sq.in. The average pressure then is 19.5 lb. per sq.in. instead of 25 lb. The permissible pressure is 800 lb. at the pumps. The pressure is 51.6 lb. per sq.in. per mi. The factor of safety is $\frac{51.6}{19.5}$, or 2.65.

The important feature as pointed out in this recently constructed line is that, as custom had established the distance between stations as about 13 mi., an improvement had been made by increasing the distance to 15½ mi., offsetting the increased pressure due to the added cooling of the oil and resulting increase in pressure due to viscosity, and saving one pumping station. The saving is estimated at $250,000 in the first cost, as the difference between the $300,000 station and $50,000—the latter being the difference in cost between the 8-in. and 10-in. pipe. This factor of safety can be estimated in dollars. In the foregoing example, to pump water only would require five stations. Then it has required, to take care of the safety factor, six stations aggregating $1,800,000. There is then $1,800,000 out of the total of $4,000,000 which is left to the judgment of the engineer for distribution and expenditure with indefinite data as a basis for the designs, granting that there is no reliable way by which the friction characteristics of the oil to be handled can be accurately measured.

For the summary we have:

Rifled Line:	
Capacity, 24,000 bbl., including 10% water, stations 12 mi. apart.	
Safety factor, by allowable station pressure	2.50
Safety factor by formula, as necessary	2.56
Associated Line (by Mr. Bowie):	
Capacity, 24,000 bbl.	
Safety factor by allowable station pressure	2.44
Safety factor by formula, as necessary	1.56
Difference	0.88
Shell Line:	
Capacity, 24,000 bbl.	
Safety factor of construction	2.60

After considering the improved method of the Shell Co. with reference to the combination of the 8- and 10-in. pipe the engineer no doubt will ask: If it may be considered good practice to increase the length between stations from 14.17 mi. to 15.45 mi. in a line 170 mi. long and in so doing save $250,000, why not increase this distance another 1½ mi. and save a like amount or thereabouts?

The question is likely to remain unanswered until the friction characteristics of the oil that is to be handled are better understood by those to whom the work of constructing and operating the line is intrusted.

Pipe lines, and particularly those which are heated, deteriorate very rapidly. It has been said that the life of the pipe line should be considered as 10 yr. These lines sooner or later, and some of them in the near future, must be completely or in part reconstructed. Again, the demand for capacity on the pipe lines is going to increase rather than decrease.

The oil industry has been allowed to develop with those in charge of the operations little appreciating the value of using the friction characteristics of the oil rather than the gravity, in the solution of their transportation problems, for no other reason than the absence of a better system of grading the oils. Inasmuch as it has been stated that the capacity of a line is determined by its weakest point, the proper grading of the oils for minimum friction qualities will eliminate the peaks of high pressure and cannot help but improve operating conditions.

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Electric Traction a Success on C., M. & St. P. Ry.*

The first electric locomotives of the Chicago, Milwaukee & St. Paul Ry. were placed in service on the Three Forks-Deer Lodge division in the Rocky Mountains, Dec. 9, 1915, and electric operation has been maintained since then. Complete success of the new system is reported by the railway officials. In April of this year service was extended to Harlowton, making a total of 220 mi. of electrically operated line. By November, 1916, it is expected that steam traction will be abandoned over the entire proposed stretch of 440 mi. between Avery, Idaho, and Harlowton, Mont. (four engine divisions). The general engineering features in connection with this project have been described in *Engineering News* (Jan 7, 1915).

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*From information furnished by the General Electric Co., Schenectady, N. Y., maker of the electrical equipment noted herein.

This section is now the longest stretch of trunk line under electric traction in the world. It is the only line where electric locomotives are operating over more than one engine division. The main continental divide is crossed, giving the severest service conditions possible on the entire system of the railroad. In crossing the three mountain ranges included in the electric zone there are several grades of 1% or more, the most difficult of which is the 21-mi. 2% grade between Piedmont and Donald. The longest grade is the 49-mi. 1% grade on the west slope of the Belt Mountains. The curvature is heavy, the maximum being 10°. There are in all 36 tunnels, the longest of which (1½ mi.) is under St. Paul Pass, through the Bitter Root Mountains.

PASSENGER AND FREIGHT SERVICE

The passenger service is comparatively light, consisting of two all-steel transcontinental and one local train in each direction daily. It has been found that on the 21-mi. 2% grade between Piedmont and Donald the electric locomotive can reduce the running time from 1 hr. 5 min. to 10 min. The run from Deer Lodge to Butte has been cut from 1 hr. 20 min. to 50 min. The four through passenger trains (the "Olympian" and the "Columbian") are taken across the two mountain ranges by a single passenger locomotive. These trains consist of eight vestibuled steel coaches weighing 660 tons. Instead of changing locomotives at Three Forks as before, the same locomotive is run through the 220 mi. from Deer Lodge to Harlowton, changing crews midway. The entire electrified division will be covered by passenger trains in approximately 15 hr., including all stops, increasing the attractions of the line for tourists. The local passenger train in the electric zone is handled by a half-unit locomotive.

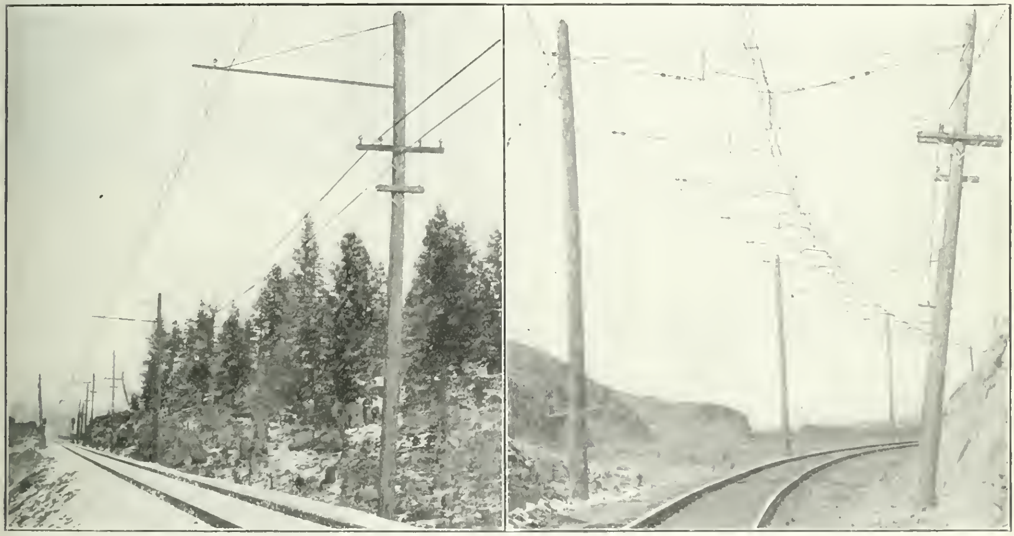

FIGS. 1 AND 2. OVERHEAD 3,000-VOLT LINE CONSTRUCTION, ELECTRIC-TRACTION ZONE, C., M. & ST. P. RY.

Fig. 1—Tangent bracket construction. Fig. 2—Cross-span, pull-off and feeder-tap construction on a 10° curve

A large part of the freight traffic consists of through trains made up of an assortment of foreign cars weighing from 11 to 25 tons empty and 70 tons loaded. These are equipped with air brakes variously adjusted for different conditions of service, making the problem of holding long trains on heavy downgrades difficult with air alone. But with the electric locomotives regenerative braking has been resorted to with general success—the locomotive motors become generators and return power to the line, the air brakes being released and held in reserve.

In the freight service on the first division, where steam locomotives require 10 to 12 hr. to make 115 mi., the electric locomotives need a schedule of only 7 to 8 hr. for the same distance. The heavy grades and curves have always offered a serious obstacle to steam-locomotive operation even in summer time, and in winter serious delays have occurred owing to engine failures. In December, 1915, several Mallets were frozen up at different points on the system, and the new electric equipment was rapidly pressed into service to replace them. On several occasions the electric locomotives hauled in disabled steam engines and trains that would have otherwise tied up the line and interrupted the service.

POWER-SUPPLY SYSTEM

Trains of 3,000 tons trailing load have been hauled east and 2,800 tons west, using a helper on the heavy grades. All passing tracks are being lengthened to take advantage of longer trains, which are now possible with electric traction. On some runs, where the grades are less than 1%, trains of up to 130 cars and as heavy as 4,000 tons have been hauled by a single unit.

It should be mentioned in passing that the scheme of electrification includes the generation of power at several hydro-electric stations of the Montana Power Co., its transmission by 100,000-volt three-phase 60-cycle current, its conversion in substations to 3,000-volt direct current and its distribution over catenary overhead construction to the electric locomotives. The power company's transmission lines are carried on steel-tower and wooden-pole lines and tap into the railway system at seven different points. The railway company has a transmission line extending the entire length of the system on wooden poles. Each substation may be fed from either direction and also at the tie-in points from a third source of power. There are 14 substations distributed along the route at average intervals of about 32 mi. Each station contains stepdown transformers, motor-generator sets, switchboard and necessary equipment. The 100,000-volt current is first stepped down to 2,300 volts for the synchronous motors, each of which drives two 1,500-volt direct-current generators connected permanently in series.

The overhead construction is comparatively simple. There are two No. 0000 copper wires, flexibly suspended side by side from the same steel messenger cable by independent hangers alternately connected to each wire. Bracket supports are used where the track alignment will permit; cross-span construction is used on passing tracks, switching yards and sharp curves. All the overhead work is supported on 40-ft. wooden poles suitably guyed. A 500,000-circ.mil feeder runs the entire length of the electric zone, and on heavy grades there is a supplementary feeder. The feeders are tapped to the trolley wire at every seventh pole, or approximately each 1,000 ft. On the top of the poles is carried a supplementary No. 0000 negative feeder, which is tapped to the middle point of every second reactance bond (coils placed in the track 5,000 to 6,000 ft. apart, bridging insulated joints in the rails and permitting direct current to pass, but impeding 60-cycle signal currents). Each track is bonded with a 250,000-circ.mil bond at each joint and double bonded on heavier grades to prevent excessive drop in voltage.

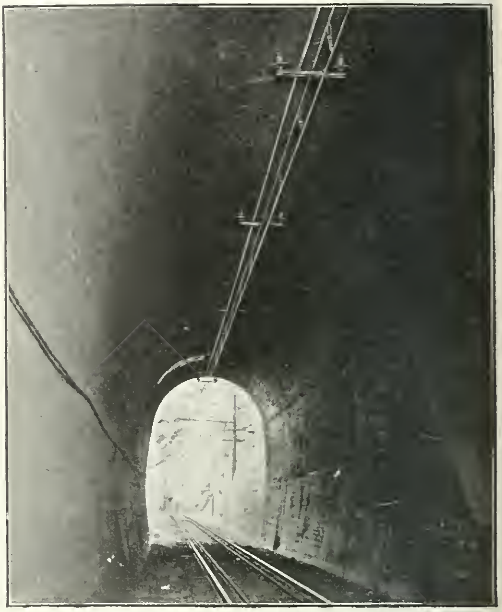


FIG. 3. OVERHEAD CONSTRUCTION IN TUNNELS
Collapsing hangers give flexibility

Two types of locomotives have been developed—main-line and switching. The main-line locomotives are constructed in two half-units intended to be permanently coupled together; but the halves are duplicates and each is capable of independent operation. The only difference between passenger and freight units lies in their gear ratios and minor auxiliaries. The freight locomotive

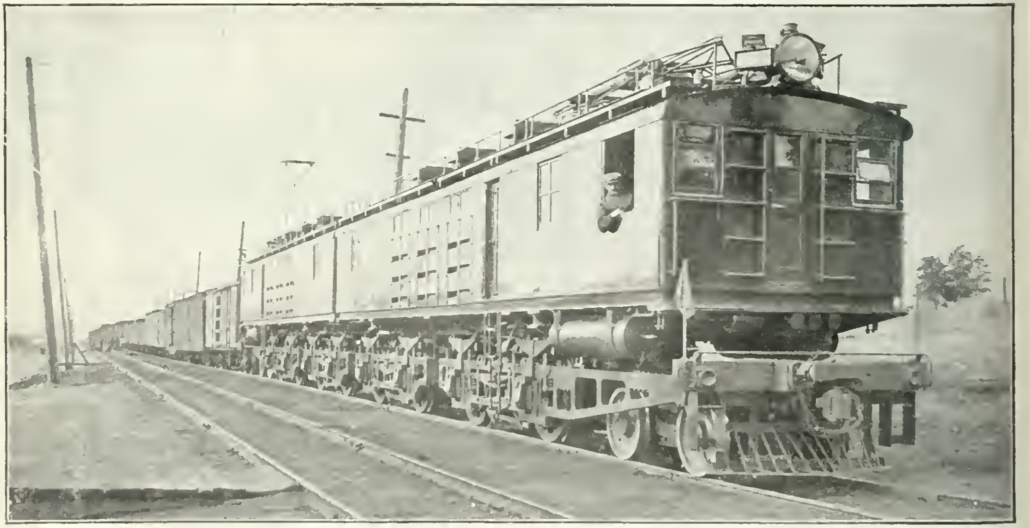


FIG. 4. ONE OF THE 3,000-HP. ELECTRIC LOCOMOTIVES OF THE C., M. & ST. P. RY.

DATA ON C., M. & ST. P. RY. 3,000-VOLT ELECTRIC LOCOMOTIVES

Main-Line Freight Locomotives

Length overall	112 ft.
Total wheel base	102 ft. 8 in.
Rigid wheel base	10 ft. 6 in.
Total weight	564,000 lb.
Weight on drivers	448,000 lb.
Weight per driving axle	56,000 lb.
Weight per guiding axle	29,000 lb.
Diameter of driving wheel	52 in.
Diameter of guiding wheel	36 in.
Number of driving motors	8
Total output (continuous rating)	3,000 hp.
Total output (1-hr. rating)	3,440 hp.
Tractive effort (continuous rating, 15.75 mi. per hr.)	71,000 lb.
Per cent. of weight on drivers (trac. coef.)	15.83
Tractive effort (1-hr. rating, 15.25 mi. per hr.)	85,000 lb.
Per cent. of weight upon drivers (trac. coef.)	19
Tractive effort starting (30% coef.)	136,000 lb.

Switching Locomotives

Length inside knuckles	40 ft.
Height over cab	13 ft. 10 in.
Height—trolley down	16 ft. 8 in.
Width overall	10 ft.
Total wheel base	29 ft. 4 in.
Rigid wheel base	8 ft.
Diameter of wheels	40 in.
Weight—locomotive complete	140,000 lb.
Weight per driving axle	35,000 lb.
1-hr. rating of locomotive	542 hp.
Tractive effort (1-hr. rating, 12 mi. per hr.)	18,400 lb.
Tractive effort (continuous, 13.2 mi. per hr.)	13,480 lb.
Tractive effort, starting (30% coef.)	42,000 lb.

weighs 282 tons, has a starting tractive effort of 136,000 lb. and 85,000 lb. running at normal speed. These figures are to be compared. with a weight of 278 tons for the Mallet steam locomotives, which have been relieved and which had a tractive effort of 76,200 lb. At this time 42 main-line units are in service—30 freight and 12 passenger. Each is equipped with eight 1,500-volt motors insulated for 3,000 volts to ground. The motors' normal 1-hr. rating is 430 hp.; the continuous rating is 375 hp. Each motor is twin-geared to its driving axle. The motor has commutating poles and provision for forced ventilation from a blower in the cab. The pantograph shoes are of copper.

The control equipment is of the familiar multiple-unit type; the main control switches are mounted in steel compartments inside the cab with inspection and repair aisles. In each half of the locomotive are a motor-driven air compressor and a motor-generator set furnishing low-voltage current for control circuits, headlights, cab lighting and for charging storage batteries on passenger coaches. (Under steam operation the charging current for these batteries was furnished by a steam-turbine generator set on the locomotive.) This same motor-generator set drives the blower for ventilating the traction motors. On the passenger locomotives are oil-fired steam boilers for heating the cars.

The electric regenerative-braking apparatus automatically controls the speed by regulating the amount of energy put back into the line. The usual speed of a freight train electrically hauled is 15 mi. per hr. ascending, and 17 mi. per hr. descending maximum grades, but with half these speeds the braking can be maintained if required. In case there are no other trains between substations to absorb the power returned to the line by a descending train, this power passes through the substation machinery, is converted from direct to alternating current and fed into the distribution system of the power company. Credit is given for all energy thus returned. The power returned by a 2,500-ton train, running at 17 mi. per hr. down a 2% grade, is about 4,700 hp. In addition to the elimination of difficulties due to the use of air brakes and the prevention of brake-shoe and wheel wear there has been a saving of about 15% in power.

This change from steam to electric traction will cost about $12,000,000. The investment is expected to be self-supporting, through savings in operating expense. C. S. Goodnow, Assistant to the President of the Chicago, Milwaukee & St. Paul Ry., is engineer in charge of the work.

* * *

Inspecting Bituminous Road Materials at Refineries

The Bureau of Highways of Philadelphia, Penn., of which William H. Connell is chief, has for over a year been extending its inspection service to the plants and refineries where the materials to be used in bituminous roadwork are manufactured. In his recent annual report on the work of the bureau Mr. Connell states that while it has been customary with many organizations dealing with highway work to inspect or test batches of completed materials at refineries to determine in advance of shipment that they conform satisfactorily to the requirements of specifications, the work of this bureau has made an important step in advance of this by specifying that an inspector should be present during the entire process of producing and combining the materials used, thus making it possible to secure samples of the ingredients as well as of the completed mixture and to determine the method and proportions of combination.

These inspectors made such tests at the plant or refinery as were necessary to control the general character and the consistency of the products, while complete tests on both the ingredients and mixtures were made in the municipal laboratories. It is possible by this means for the city to make complete studies of the desirable properties of such materials and of the variations that should be made in the finished product to suit local conditions rather than to leave these points almost entirely in the hands of the manufacturer, as has largely been the case in the past.

* * *

A Ten-Story Building as a Bridge Approach is to be erected by the City of New York on Blackwell's Island, adjoining the Queensboro Bridge. A number of the city institutions are located on the island, approach to which has hitherto been only by boat, although the large bridge crosses the island some 140 ft. in the air. The new building will house some of the necessary institutional services and will contain freight elevators capable of carrying a 5-ton motor truck from the island to the bridge level. Boat service to the island will then be discontinued.

Powdered Coal as Fuel for Locomotives was first tried as long ago as 1901-02, on an engine of the Manhattan elevated railway in New York. The merit of this system of combustion was demonstrated, but its use was not extended, as the means of pulverizing and handling the fuel and controlling the fire were unsatisfactory. In 1914 the New York Central R.R. equipped an engine of the 4 : 6 : 0 class for experimental work. In 1915 the Chicago & Northwestern Ry. equipped a passenger engine of the 4 : 6 : 2 class, which is now in regular service between Chicago and Milwaukee. Early in 1916 the Delaware & Hudson Ry. adopted pulverized fuel for a 145-ton freight engine of the 2 : 8 : 0 class, and installed a plant for drying, pulverizing, storing and supplying the fuel both for locomotives and for stationary boilers, using the waste tailings from anthracite culm banks. The Missouri, Kansas & Texas Ry. is installing a similar plant to supply pulverized coal for both locomotives and stationary boilers. A number of other railways are considering the matter, and the Central Railway of Brazil has decided to adopt the method, after extensive investigation of the work and experience in the United States. This information is taken from a report presented at the annual meeting of the International Railway Fuel Association, held at Chicago, May 15-18. The committee is of opinion that the efficiency of the system has been demonstrated and that there will be marked progress in its use with bituminous and anthracite coals and lignite for locomotives and stationary power plants.

Field and Office

Earth Handled Cheaply in Grading Utah Roads

Graders handled by gasoline tractors moved earth at a cost of 7.5c. per cu.yd., in Utah road work. This is the average cost, the best record being 3.8c.

Grading on Western prairies is not heavy work. The roads follow approximately the contour of the ground, and except for cutting down low humps and filling slight depressions the grading consists merely in opening ditches and crowning the roadway. The earth to be moved in the average highway can be taken to comprise the two triangular ditch cross-sections (Fig. 1) each 4 ft. wide by 1 ft. deep. Thus, the total excavation per mile is 782 cu.yd., or about 1.000 cu.yd. in 1¼ mi. The last named distance was that covered each day by the machine outfit illustrated in the views; the cost per day being $75.

The best record was 2½ mi. per day. This is not for resurfacing an old road, but for grading a new road across comparatively level ground.

The construction of the Midland trail in Box Elder County during the last two years is a good example of this tractor-grader method of construction. Long stretches of a 100-mi. highway were graded for from $30 to $60 a mile. The territory passed through was practically all virgin soil, much of it covered with a heavy growth of sage brush.

Scheme of Shallow Grading

The first step is to mark plainly the outside lines of the ditches. This is done by placing flags at intervals so that the tractor operator can follow the proper line by ranging in the flags with one or two markers on his machine. The tractors used vary, since most of them are hired (with the crews) by the day. A 50-hp. gasoline tractor has given the best service.

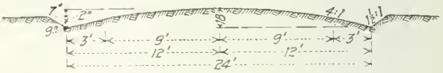
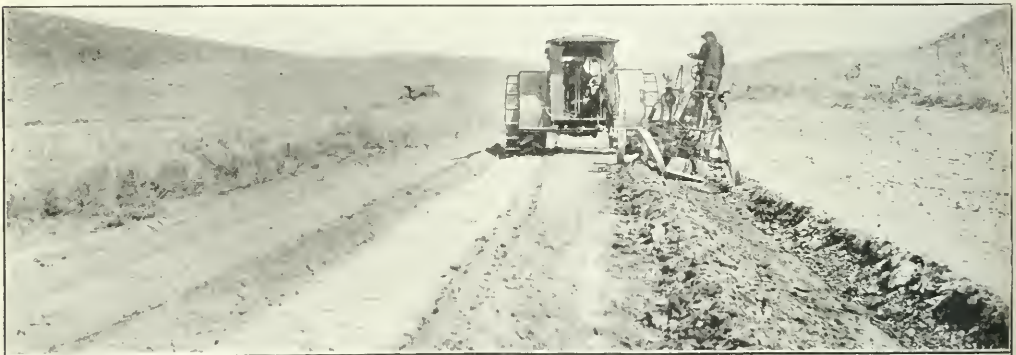


FIG. 1. CROSS-SECTION OF STANDARD EARTH ROAD, UTAH STATE HIGHWAY DEPARTMENT

Coupled to the tractor is a standard 10- or 12-ft. road grader of extra-heavy construction. The first cut is made



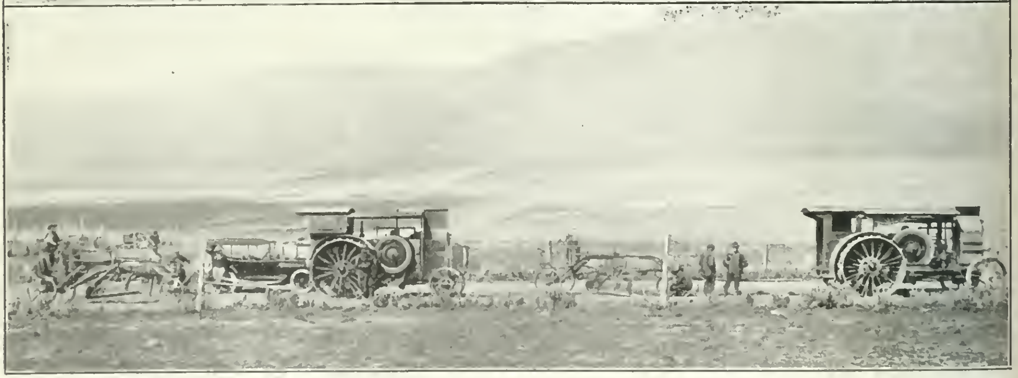


FIG. 2 (UPPER) MAKING FIRST CUT IN RIGHT-HAND DITCH FIG. 3 (LOWER) GASOLINE TRACTOR-GRADER OUTFIT BUILDING MIDLAND TRAIL, BOX ELDER COUNTY, UTAH

along the line of the flags and is designed to give one-half the necessary depth to the ditch. At some convenient point the outfit is turned about and a similar cut made on the opposite side of the road. The second trip crowds the material excavated in the first trip to the crown of the road. The third cut excavates the ditch to grade and the fourth places this material on the crown.

Where ordinary sage brush is encountered the grader is first run over the roadbed with the blade set level a little above the surface. This cuts off the brush, after which a rooter and rake are used to clear the roadbed. Where the sage brush is extra heavy, a grubber has to be employed before the graders can be utilized.

The crew with the grading machines consists of only five men. Each unit requires a tractor operator and a grader operator, and there are a teamster and a four-horse team for hauling water, oil and supplies. It is sometimes convenient to grade over the culvert sites and place the culverts afterward by cutting the roadbed.

Where the state or county does not own the equipment the best results have been attained by leasing the tractor and grader operators and teams from a single contractor. This insures harmony and efficiency in operation. The two tractors and crews illustrated in Fig. 3 were leased for $7.50 per hr.

Similar work using teams and fresnos is done in some of the counties of the same state and the cost ranges from $300 to $600 per mi.

Six of the Utah counties are now using tractor-grader outfits similar to those illustrated. The tractors are proving so economical and efficient that it is planned to use them with wagon trains or trailers for placing the surfacing material. An experimental plant will be tried out this season, and it is hoped to reduce the cost of gravel-surfaced roads. The cost of graveling (6 to 8 in.) now runs from $500 to $1,500 a mi., depending on the proximity of the material.

The principal difficulties in operating the tractor-grader units have been in getting materials and supplies. So far as possible extra castings of all tractor parts liable to break are kept with the outfit.

The state highway department of Utah consists essentially of a State Road Commission of five members under which is the State Road Engineer and his staff. The state is divided into five groups of counties, and the general administration of the road work in each group is allotted to one of the commissioners, who is concerned chiefly with the financial problems. All road construction is under the State Road Engineer, although the State Engineer is a member of the commission. E. R. Morgan is the State Road Engineer.

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Pile Formula Modified for Double-Acting Hammer

On a contract now under way the specification requires pile penetration for given loading to be determined by the well-known *Engineering News* pile formula. The contractor is using a double-acting steam pile-hammer, and the engineer inquires what form the formula ought to have under the conditions.

The *Engineering News* formula, devised by the late A. M. Wellington in 1888, is based on the equation between the energy stored in the hammer and the work done in overcoming the resistance to penetration. Two factors modify the equation—an allowance for dissipation of energy and a factor of safety. A factor of 6 is used. The dissipation of energy, by brooming, spring of the pile, etc., is supposed to be such as to reduce the penetrating effect by 1 in., in the case of a drop hammer, giving the formula

$$P = \frac{2Wh}{s + 1}$$

in which W = weight of hammer, pounds or tons; h = height of fall, feet; s = penetration, inches; P = pile capacity, pounds or tons.

For steam hammers the reduction is assumed to be only 0.1 in. (which represents less dissipation of energy on account of the decreased destructive effects of the hammer, due to the low fall and the more rapid blows), resulting in the formula

$$P = \frac{2Wh}{s + 0.1}$$

Recently several comparisons of steam-hammer driving with results derived from the formula have led various engineers to the conclusion that the steam-hammer loss of penetration is greater than 0.1 in. and should be taken at 0.3 in., giving the formula

$$P = \frac{2Wh}{s + 0.3}$$

The question now arises, What influence will the driving action of the steam exert? Its effect on brooming, rebound and similar dissipative actions is probably slight, and negligible in comparison with the conditions existing before the addition of the steam pressure. All factors of the formula are unchanged except the energy of the hammer, which is increased by the added velocity due to the steam action. At the same time a slightly increased penetration is secured. If the increased penetration is used in the formula without making allowance in the numerator for the increased energy of the hammer, the formula would appear to show lower load capacity in the case of piles driven by double-acting hammers than for piles driven with a free-falling steam hammer. This obviously would be incorrect. The following rule may be taken as a general guide:

> Ascertain as nearly as possible the foot-pounds represented by the blow delivered by the hammer. This can be done by adding to the foot-pounds represented by the free fall of the hammer the foot-pounds obtained by multiplying the mean effective pressure by the area of the piston and the length of stroke in feet. The result is the numerator of the formula.

In the absence of specific data on mean effective pressure for the particular hammer assume that it amounts to 25 lb. per sq.in. Multiply this by the effective piston area and add the product to the weight of the hammer. This means using the formula in the shape,

$$P = \frac{(W + Ap)h}{s + 0.3}$$

in which, of course, P and W must be in pounds if the steam pressure is taken in pounds.

⁂

A Drilling Contest between a single-jacker and a jackhamer arranged by Louis A. Rehfuss, West Point, Calaveras County, Calif., resulted in the jackhamer, with air at 60 lb., drilling 81 in., while the hammersman drilled 9 in. The cost per jackhamer shift figured out 1.75 times that of the hand-drilling shift, but the cost per foot of hole drilled by the jackhamer figured only 19½% of the cost of hand-drilled hole.—"Engineering and Mining Journal," June 21.

Weak Retaining Wall Saved by Anchored Buttresses

A corner of one of the finest residences in Denver, Colo., was built over made ground, and the architect here erected a retaining wall that incloses both a corner of the house and an open veranda or children's play-yard backfilled to the level of the first floor, or some 6 or 7 ft. above the grading level.

Not much precaution was taken in placing foundations for this wall, and as a result it soon commenced to settle both downward and outward, opening large diagonal cracks, which were unsightly and threatened the safety of that corner of the house. The architect was at a loss for a remedy, so he "put it up to" a local contractor, C. S. Lambie, president of the C. S. Lambie Co.

The method adopted by Mr. Lambie was to drive sections of 8-in. cast-iron pipe along the footing of the wall and as close to it as possible. Fig. 2 shows a sketch. This pipe was driven to firm bearing in the original ground surface and partly filled with concrete. Then a 6-in. I-beam, bent to lie close to the wall, was inserted in each of the pipes and the pipes were filled with concrete to the top, making them essentially concrete piles.

Holes were drilled in the wall and the I-beams thoroughly tied into it by U-shaped rods. On the back face of the wall near its top a channel was placed and secured to the I-beams on the other side of the wall by two yokes, or U-shaped rods, at each pile, as shown in Fig. 2. From the ends of this short piece of channel, iron rods were inserted, the other ends of which were anchored to a block of concrete in the concrete pavement of the play-yard.

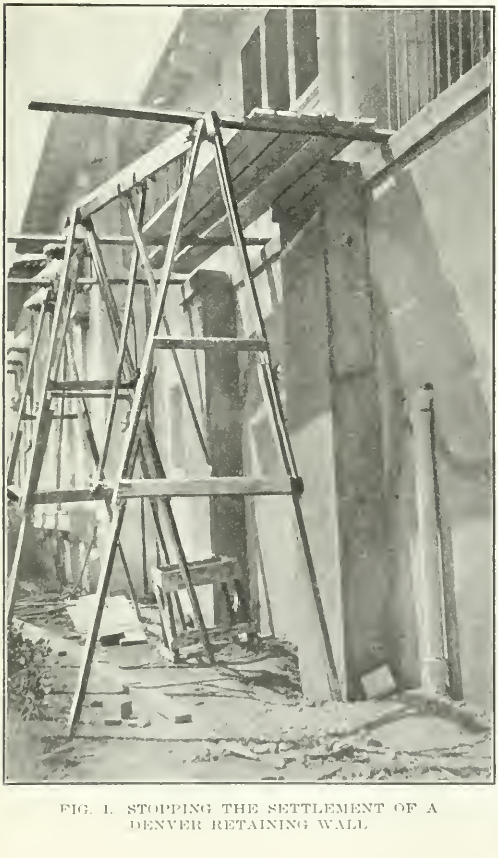

FIG. 1. STOPPING THE SETTLEMENT OF A DENVER RETAINING WALL

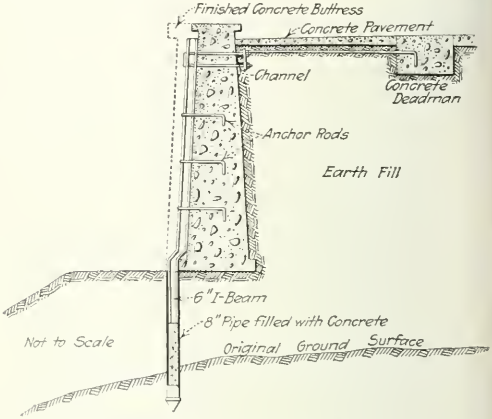

FIG. 2. CROSS-SECTION OF WALL AND REINFORCING BUTTRESS

The I-beams and ties were then inclosed in forms and filled around with concrete, giving the buttressed or pilastered wall shown in Fig. 1. When the whole had been finished to correspond to the rest of the residence, the architectural appearance had been improved rather than injured.

⁂

Manholes Built in Quicksand with Open Caisson

Building manholes by a modified open-caisson method was reported by the Underground Construction Committee of the National Electric Light Association at the recent Chicago convention, a member company having found the scheme advantageous.

The excavation to the quicksand is made in the ordinary manner. Then a wooden frame is built, having the same horizontal section as the manhole walls. This framework is built up of 2-in. planks to a total thickness of 6 in., the corners being well fastened so as to eliminate diagonal bracing and leave the center of the framework free for the excavation. The framework is then placed in a level position on the quicksand, and the manhole is built of brick to the required height, the walls being well plastered on the outside.

After setting for three or four days, the excavation of the manhole proceeds. By digging along the walls inside of the manhole and under the wooden framework the structure will usually settle to the required depth. During the excavation only sufficient water should be removed to allow the men to work to advantage, as otherwise the sand becomes quite hard. The settlement, if slow, can be accelerated by placing bags of sand or other weights on top of the manhole walls. Ordinarily the excavation and the settlement of the structure to the required depth will not require more than 8 or 10 hr. unless obstructions are encountered. After the manhole has reached the proper depth the settlement is stopped by backfilling the excava tion and tamping around the outside of the manhole walls.

Upon completion of the settlement the water is removed from the manhole, the sand excavated to the level of the bottom of the wooden framework, and a heavy concrete bottom is placed in the manhole. The openings for the conduit are cut in the manhole walls after it is entirely completed and settled to the proper depth.

In building such manholes the cost of labor is about double that of the ordinary manhole. The wooden framework is the only other item of expense.

⁂

Temporary Bascule Bridge for Construction Purposes

By H. Da Camara[*]

During the construction of the piers for the new Burlington Bridge across the Missouri River at Kansas City, Mo., it became necessary to find a method of carrying material over the channel without stopping navigation.

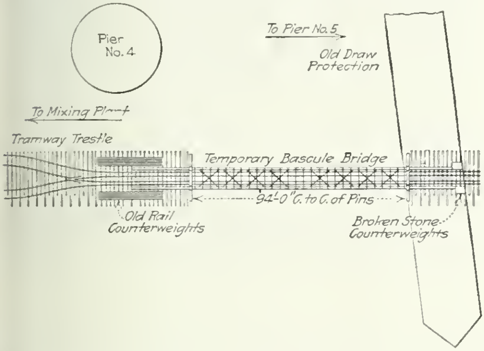

FIG. 1. GENERAL PLAN OF BASCULE BRIDGE SHOWING TRACK ARRANGEMENT

From the north shore out to Pier 4 a timber tramway, supported on pile bents spaced 15 ft. c. to c., had been used very successfully. This trestle was designed to carry a live load of 50 tons applied by a locomotive crane.

The original plan was to continue the tramway on to Pier 5, cutting through the upstream end of the draw protection of the old Hannibal Bridge. Interference with some of the government boats was the immediate cause of a change in this plan, although navigation was afterward (December) stopped by ice.

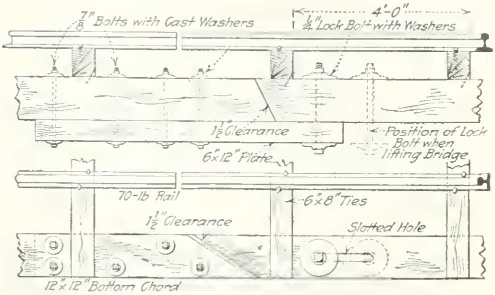
7/8" Bolts with Cast Washers
4'-0"
1/4" Lock Bolt with Washers
1½" Clearance
Position of Lock Bolt when lifting Bridge
6"x12" Plate
70-lb Rail
6"x8" Ties
1½" Clearance
Slotted Hole
12"x12" Bottom Chord

FIG. 4. DETAIL OF LEAF

The engineers for the contractor decided to span the channel from the new Pier 4 to the old draw protection, a distance of about 100 ft., with a light wooden bascule bridge. The trunnion for the north half of the span was supported by a double bent of 12 cypress piles capped and braced as shown in Fig. 3. This bent came in line with the south side of the dock for Pier 4, so did not decrease the available channel width. The south half was carried entirely by the draw protection, except that one set of backstay cables was made fast to the cap of the first bent of the continued tram trestle. The towers were of 12x12-in. timbers fitted with ordinary timber-derrick mast shoes. The bracing consisted of 3x10s and 6x8s as shown in Fig. 1. The cable backstays were old $\frac{5}{8}$-in. steel cable, four strands in the short sets and six strands in the long. The 12x12-in. stiff-legs served to make the whole more rigid.

The leaves of the bridge were constructed as shown in Fig. 4. Timber 47 ft. long carried the ties and rails. The lateral bracing was of 3x10s bolted to the under side of the 12x12s. The supporting cables were two strands of $\frac{5}{8}$-in. steel wire fastened at each end by means of a

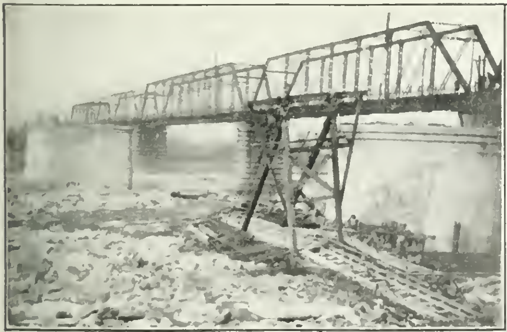

FIG. 2. SHOWING THE NEW BURLINGTON BRIDGE AT KANSAS CITY, AND THE TEMPORARY BASCULE BRIDGE CARRIED OUT BY ICE

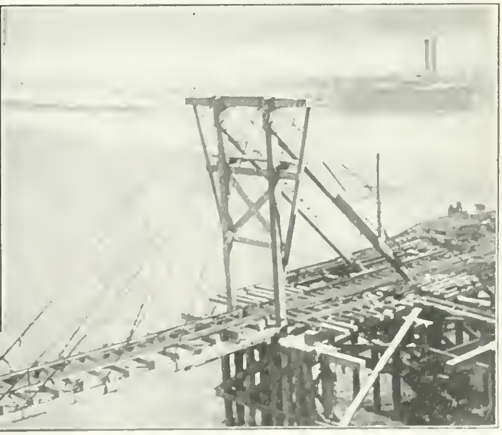

FIG. 3. NORTH LEAF

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[*] 4126 Virginia Ave., Kansas City, Mo.

clevis to wire-cable lashings. The timbers were protected under these lashings by rail splice plates spiked on at the edges. Each of the supporting cables was made adjustable by the insertion of a turnbuckle or steamboat ratchet at the lower end.

The center connection, detailed in Fig. 4, was fitted with a lock bolt so arranged that the load of a car in passing was transmitted to both leaves of the bridge, making the deflection of the rail ends at this point the same. The bridge was designed to carry a live load of 5,000 lb. at the center of the span, produced by one yard of concrete, bucket and car. The concrete was transported by two cars running on parallel tracks. The cars were hauled by ½-in. cable from a two-drum hoisting engine, from the mixing plant to the derrick at the pier.

In order to continue this system to Pier 5 an ordinary rail frog was introduced at the north approach to the bridge as indicated in Fig. 1, thus in effect double-tracking the bridge. The passing point of the cars was 200 ft. north of the frog. In raising the leaves of the bridge, the lock bolts were moved as shown by the dotted position in Fig. 4. The north leaf could then be raised by the load line from either the derrick at Pier 4 or from the locomotive crane if it happened to be available. The south leaf was operated by a line run through snatch blocks from the third drum of the derrick engine to Pier 5.

The air pipes which were also carried by the bridge were fitted with rubber-hose expansion joints and united at the center of the span and at the hinges.

The bridge was used until the ice broke up and swept the north half, along with about 400 ft. of tramway, down the river (Fig. 2). As this did not damage the caisson for Pier 5 the remainder of the concrete was placed from a mixing plant on the south bank.

The Union Bridge and Construction Co. of Kansas City, Mo., was the contractor for the caisson work.

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Half-Hour Performance of 4-Wheel Scrapers

Last season on a county-road contract in Summit County, Ohio, Windsor Brothers employed two sets of Maney 4-wheel scrapers, consisting of six machines each. Two hills, fairly close together, were cut through, the yardage amounting to 48,000 and the average haul to 500 ft. The deepest cut was over 20 ft. The soil was clay. Steep grades were encountered.

The performance of seven of these scrapers over a short period was watched by J. C. Gorman, Jr., District Manager of the Ransome Concrete Machinery Co., Columbus, and the following figures were compiled:

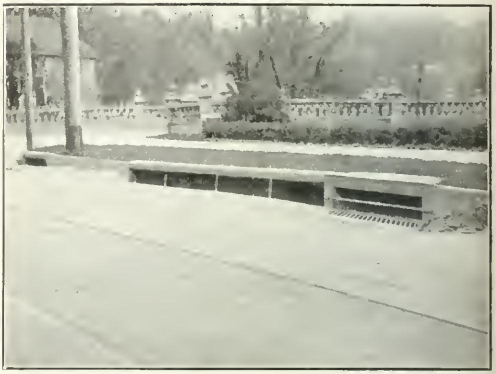
Length of haul	500 ft.
Time required to move 31 yd.	30 min.
7 scraper teams at 50c.	$3.50
Two 2-horse plow teams, each with drivers at 50c	1.00
1 extra plowman	.20
1 snatch-hook man and horse	.30
2 dumpmen	.10
2 slopemen	.10
1 extra snatch-hook man	.20
1 engineer on hoist	.35
1 foreman	.50
1 hoistman	.50
Total	$7.35

At the rate of 31 yd. in 30 min., or 62 yd. per hr., the cost per yard moved is 12c. Unfortunately, data covering the entire job are not available.

The weight of a 1-yd. Maney scraper (2,200 lb.) makes tractor haulage almost a necessity. The Baker Manufacturing Co., which makes this scraper, also builds a ½-yd. 4-wheel scraper weighing 1,500 lb., which is more adapted to team haulage.

NOTES

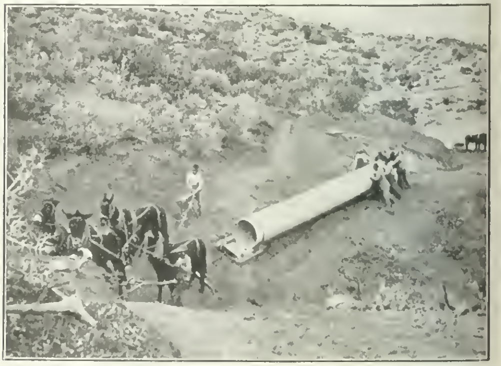
A Record Size Catchbasin Inlet is believed to be one 20 ft. long on a sidehill street in Council Bluffs, Iowa, shown in the accompanying illustration. The runoff demonstrated the need of such a large opening; the water comes in such volume and such rapidity as to flow by the original opening (to the right). The inlet is a series of compartments with a 24-in. outlet from each to a very large storm sewer under the street.



A 20-FT. CATCHBASIN INLET, COUNCIL BLUFFS, IOWA

It was installed several years ago by S. L. Etnyre, then city engineer, now superintendent of the water-works. Including the corner inlet, which is for all practical purposes part of the same sewer connection, the opening is 26 ft. from end to end.

Sledding Large Steel Culvert Pipe Cross-Country—Transporting large corrugated-steel pipe culverts over mountain trails ahead of the grading is often quite a problem. In one of the state highway divisions in northern Arizona, F. R. Goodman, division engineer, used the method of transportation shown by the view herewith, in which a 36-in. culvert 24 ft. long is being moved. The pipe is carried by two sleds made of scrap ends of 4x4's and shod with strap iron. The sleds are made high, to keep the pipe from rubbing against the ground, which would damage the zinc coating. As the view shows, a team of mules can take the culvert over fairly rough ground. Similar methods are used for transporting the flat corrugated plates used for headwalls.



SLEDDING A CORRUGATED STEEL CULVERT OVER THE ARIZONA HILLS

Editorials

Materials an Active Field

Useful information on the relative attracting power of an all-work and of a half-play convention is given by the attendance figures for the meetings of the American Society of Civil Engineers and the American Society for Testing Materials, both held last week. The facts appear to prove that engineers will go where their time will be put to the best practical use.

Formerly junket conventions were much the fashion, and most organizations believed that entertainment features were a vital element, however undesirable on general principles, of a convention. Such fashions and beliefs are getting to be obsolete, at least among engineers. Even the time-honored picnic style of the official railway conventions has in recent years been transformed. The great success of this year's Testing Materials meeting settles the matter conclusively.

Incidentally, there is no chance to doubt of the vitality of an organization that can draw a record-breaking increase of membership in the very year when it raises its dues by 50%. The American Society for Testing Materials has accomplished this, and now, with 2,071 members and a phenomenally broad and intense range of work, it stands strong among the most prominent technical organizations of the world.

While achieving this lofty position, the society has also stepped beyond the confines of earlier conservatism by electing as its president a manufacturer, or, as the society classes it, a producer—engineers in private practice being called nonproducers or consumers. The personality of the new executive, A. A. Stevenson of Philadelphia, makes it certain that the society will have no cause to repent of its iconoclasm. An efficient and energetic administration is needed more this year than at any time in the recent past. Expansion of work means new problems.

There are delicate problems in drawing specifications. A mortgage can not be more precise and binding in its terms than the right kind of specification for a technical material. The enthusiasm of the youthful investigator must be combined with the wise fairness of the grayheaded judge in writing the clauses. Many tendencies exist in drawing a new specification that run counter to this spirit of balance. There is often a natural desire, for example, to improve the state of the art by introducing cunning provisions which shall prevent the outside parties who will use the specification—seller and buyer—from entering into the particular kind of agreement that they wish and intend to make. Insofar as this may give rise to contradictions in the terms of the agreement actually made it is a harmful artifice. It makes the specification a poor legal document, one apt to create disputes and lawsuits rather than avoid them.

The work of a large subdivided body which creates specifications needs constant and careful supervision, in this regard and in others. To provide such supervision is a duty that becomes more urgent as well as more difficult as the work broadens out. There are present problems before the authorities of the American Society for Testing Materials, and more are likely to arise. But at the same time the situation justifies the hope that the problems will be successfully solved.

Broader Water-Works Vision

The trend of discussion on electrolysis and fire protection at the recent convention of the American Water-Works Association in New York City, noted in *Engineering News*, June 15, p. 1151, has raised questions in the minds of some as to the willingness of water-works men to coöperate with other utilities and agencies rendering public service. Do the water-works men need a broader vision?

Whatever their real intent may have been, a number of the water-works men at the convention gave the impression that they wished the Association to stand aloof from the present national coöperative study of the mitigation of electrolysis on underground structures.

It is a matter of great moment to the entire public if water and gas pipes or telephone and electric-supply cables are damaged by stray electric-railway currents so as to impair the quality or increase the cost of those utility services. It is of equally serious consequence if the absolute elimination of electrolysis is so costly that it would put the local transportation system out of business or dangerously increase the hazards of operation. In the face of such a situation the public interest demands that all the utilities in conflict coöperate in finding out precisely what the danger and damage are to the pipe and cable companies and what degree of minimization can be secured and supported by the transportation agency.

The courts have specifically laid that duty upon all the interests involved, on the one hand, just as they have recognized, on the other hand, the liability of the invading railway to meet the costs of such a suppression of stray currents as is practical, and to meet the damages to the prior occupant of the street.

This need of coöperation is a feature of utility regulation that all the existing commissions are bound to take up as they are given jurisdiction over water utilities. A few have such jurisdiction and have already begun to insist on coöperation.

A great advance has been made in the knowledge of electrolytic damage and in the practical suppression of stray railway currents since the national joint committee on electrolysis was formed to secure the coöperation of the water, gas, electric-light, telephone and street-railway interests. The water-works representatives were slow to join in the committee's deliberations and at the convention a few weeks ago strong opposition to representation on the joint committee was expressed, though no action against it was taken.

The argument is that the three water-works representatives sitting with six gas men, three telephone men, three electric-light men, three steam railway men, three electric railway men, three professional electrical engineers and one United States Bureau of Standards representative will be outvoted—though the representatives of interests adversely affected by stray currents number 15, the railway men 6 and the neutrals 4. The water-works men urge that the other representatives have a community of private-corporation interests. The water-works men fear that the conclusions of a joint committee of such a character may be prejudicial to cities and to water companies engaged in hard fights to get compensation for electrolytic damages.

Alongside the electrolysis controversy, but differing from it in many respects, has been the wordy conflict between the water-works and the fire-insurance men over whether water supplied through private connections for the protection of factories should be paid for by the factory owner or by the city and whether such connections should be metered. There can be no charge of lack of coöperation in the consideration of this question heretofore, for the two leading water-works associations have yielded the floor for hours during one convention after another to insurance men. Each side has contended vigorously for what it has considered to be its own interests and for what it has also held to be the interest of the public. At the New York convention the water-works men, nettled somewhat by the fact that the discussion on this one subject was consuming practically all of "Superintendents' Day," finally withdrew the privilege of the floor from the insurance men.

The questions involved in the private fire service controversy include some far-reaching matters of public policy. It may be that they will never be settled until the public utility commissions are made legal arbitrators—which has seldom if ever been done as yet.

In both the electrolysis and private fire-service matters the water-works men are fighting for the integrity of their property and of the service which it is called upon to render. No one who has followed these controversies for a score or so of years can doubt the good intentions and the zeal of the water-works men. Like all who are fighting for principles and property, they might well cultivate greater breadth of vision and more of a spirit of toleration and coöperation.

Fortunately, when we come to measure the actual results at the recent meeting of the American Water-Works Association, it is seen that the acrimonious discussion did not wholly govern the resultant action. Committees will continue to work with other interests engaged in the study of electrolysis and fire protection.

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Railway Car-Wheel Flanges and Frog Clearances

The late A. M. Wellington once remarked that it would be difficult to find anywhere in engineering a small amount of metal performing such an important service with such marvelous reliability as that rendered by the flange of a railway car wheel. This little projecting lip on the rim of a car wheel, only about an inch in thickness and in height when the wheel is new, is the sole means of protecting from derailment every wheel of every railway train in the world. As is well known, the great bulk of the car wheels in service in the United States are made of cast iron, and the engineer as a rule hesitates to trust cast iron where it is to be subjected to transverse stress and to shocks; but the casting of car wheels has been so perfected that their record of safety and reliability in service leaves little to be desired.

When Mr. Wellington made the remark quoted, the average railway freight car had a capacity of 30,000 to 40,000 lb. Freight cars of the present day are built to carry a load of 100,000 lb., and many of higher capacities are in service. In addition to this there has been a notable increase in freight-train speeds with a corresponding increase in shocks to the wheels and axles.

There has been a general feeling that because of the increase in stresses to which car wheels are subjected some additional thickness should be given to the wheel flange so that it might better withstand the severe and incomputable stresses which it receives.

As every engineer connected with railway work knows, however, the present standard practice as to width of openings through frogs, switches and guard rails is based upon the use of car wheels with flanges of the present standard thickness, and any material increase in the flange thickness would necessitate an alteration in these track standards. The difficulty of altering these standards is apparent. A railway freight car in its wanderings may run over the tracks of any railway in the United States and Canada. It is impossible, therefore, for any single railway company to change the thickness of its car-wheel flanges without endangering the operation of these cars on every railway that did not alter its track standards to correspond. Moreover, if a thicker wheel flange were adopted by the railways of the United States for new cars, there would be fully a dozen years while the car wheels already in service were wearing out during which there would be a variation in flange thicknesses. It would be unwise, of course, to begin the changing of track standards until at least a large majority of the cars in service had the thicker flanges, and during all this transition period there would be increased danger of derailments at switches and frogs.

Nevertheless, the Association of Manufacturers of Chilled Railway Car Wheels recommended some time ago that car-wheel flanges should be increased in thickness about $^1/_4$ in. As a result of this recommendation, the matter has been under investigation by committees of the Master Car Builders Association and the American Railway Engineering Association. At the recent meeting of the former association held at Atlantic City, its committee submitted a report in which it said that "nothing will be gained in the interest of safety or economy by adding metal to any portion of the flange of cast-iron car wheels in such locations as will in any way affect track clearances."

The investigation which led to this conclusion included a detailed study of car-wheel fractures and showed that the wheel fractures which caused derailments were almost invariably of a character that would not have been prevented by any increased thickness of the flange. Further than this, the committee reports that a certain railway had special wheels cast for use under its tenders having a flange $^1/_8$ in. thicker than the standard. The average age of 203 of these wheels when condemned was 11 months, whereas of the same number of wheels with M. C. B. standard flanges in the same service the average age when condemned was 11.1 months. Further, of these thick-flanged wheels condemned, 28% were thrown out of service on account of worn flanges, while of the wheels condemned having M. C. B. standard flanges but 15.2% were condemned on account of worn flanges. From this showing it would appear that the thickening of the wheel flange tends to increase the rate of flange wear. Two other railways reported to the committee that they had experimented with car wheels having thicker flanges and had found that the back of the flange in almost every case was grooved by contact with guard rails and frogs.

No better proof could be asked for that the present standard car-wheel flange is as thick as it can safely be made without a readjustment of track standards. The very great difficulty of maintaining safe operating conditions during the long transition period which would be necessary if a change in flange thickness were decided on has just been pointed out. It is exceedingly fortunate, therefore, that this small projection on the car wheel's rim, which seemed barely large enough for its work 25 years ago, is now proved to be still entirely reliable, notwithstanding the great increase in weights and speeds of rolling stock.

Once More One Accepted Cement Specification

The adoption last week by the annual meeting of the American Society for Testing Materials of the revised cement specification submitted by its committee on cement is a definite step forward toward that most desirable end—a nationally accepted cement standard. If, as seems probable, the last minute revisions are accepted by the government and by the civil engineers this specification will in fact, at least, warrant the name "American" quite rightly denied it in the title by the meeting.

Ten years ago the labeling of the universal acceptance of a cement specification as an important step forward would have sounded anachronistic, for following the promulgation of the 1904 standard specification the purchase of cement throughout the country was gradually being brought under the provisions of that standard. Individual or freaky specifications were growing rarer and rarer and hope was held out that in a year or two only a small percentage of the cement sold would have to answer other than the tests laid down by the American Society for Testing Materials.

But the knowledge of cement is in a state of flux. Old as are the fundamentals of this knowledge, the wonderful increase in the use of concrete has necessarily multiplied investigation and experience so that the facts of yesterday become the faults of today. Of all of the ingredients of concrete, cement suffered least in this increasing knowledge, but it did suffer somewhat and demands grew that the standards of purchase be changed to meet the new knowledge.

Unfortunately certain elements in the cement committee—elements made up not wholly though largely of the manufacturing interests—adopted an uncompromising Bourbonism. They resented change; they maintained through several years that not only had 50,000 or 60,000 or at last 100,000 copies of the old specification been distributed—of course an unanswerable argument for the specification—but that the standards set by that specification were the best conceivable for this or all time. With only minor retreats from this uncompromising position the cement committee stood for eight years until it was forced into a revisionary attitude by the promulgation of a separate government standard and the loss of the prestige not only of government sanction but of universal acceptance. The revision of last week is but tardy recognition of long standing constructive criticism.

The lessons of the past ten years should not be lost on the cement committee of the American Society for Testing Materials. Nothing could be further from the desirable than a constant annual shifting to meet the local winds of research and opinion, but a due respect for the developments of the art is incumbent. Science and engineering have no place for the precept "Whatever is, is right."

Boston Engineers Triumph

The order for reinstatement in city employ of three of the Boston engineers removed for political reasons last winter is a triumph for the cause of good government, the members of the engineering profession in Boston who aided in the fight for reinstatement and the engineers themselves.

Under the guise of the abolition of positions for the sake of efficiency and economy, 17 men in the Department of Works, mostly engineers, were summarily removed from office. Many had served Boston for years. The testimony in the lawsuit that has just terminated favorably indicated that the real causes of the removal were lack of political activity in favor of Mayor Curley, as shown by failure to attend political meetings and to contribute to party campaign funds. The attorney for the city objected naively to this line of testimony that there was nothing new in expecting political activity and soliciting campaign contributions. The testimony also appeared to show that appointments to offices new in title, the incumbents of which are to perform the same general duties as fell to those abolished, and increases in salaries added to instead of taking from the expenses of the Department.

It was also alleged that notwithstanding a charter provision requiring the appointing officer to certify that each appointee is qualified by training and experience for the duties of the position to be filled, at least one of the appointees to replace the politically decapitated men lacked experience in some of the new duties beyond having once run an instrument on that class of work. Some of these allegations may or may not be trivial in themselves, according to one's viewpoint, but taken together and with other factors, the Judge decided that the men had been removed or displaced in bad faith and ordered them reinstated.

In commenting on the wholesale decapitation last winter, we asked what the Boston engineers as a whole were going to do about it. They have answered nobly during the past few months by strongly backing the three employees who demanded reinstatement. This backing, we understand, included contributions to conduct the fight, as well as testimony in court—as noted elsewhere in this issue. The outcome does credit to the engineers of Boston and will be a help to the engineering profession and to better government throughout the whole country.

Letters to the Editor

Using Engineers in Present Military Emergency

Sir—I have been in receipt of numerous inquiries from engineers as to how their services could best be utilized in the present emergency along our southern border, and I have generally answered that the best service engineers can render at the present time is to join one of the engineer regiments of the National Guard, of which a large number must be raised to complete the engineer quota of the twelve infantry divisions of the National Guard.

I send this information to you thinking that it may be of interest to your readers. WILLIAM M. BLACK,
Chief of Engineers, U. S. Army

Washington, D. C., June 30, 1916.

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Railroad Valuation Surveys May Be Made Useful

Sir—The railroads of the United States are spending large amounts of money on the work of evaluating their physical plants in accordance with the LaFollette Act, and judging from the comments in the engineering and economic press, the resulting figures and data will not be of great value to the railroads. I wish to draw attention to one way by which very useful and real benefits, which will be increasingly felt as the years go by, may be derived by the railroads from the re-surveys which are being made for use in the valuation work.

On any railroad of respectable age, how many detached surveys for special purposes have been made by the maintenance and other departments, each referred to some mile post, bridge backwall or other presumably permanent landmark? In a great many instances, especially as regards land and right-of-way information, new surveys are made when the notes of previous and much more valuable surveys are on file in the office, but cannot be used because they are referred to a mile post which has been destroyed and carelessly replaced by the road forces at a different place, or to the former position of the backwall of a bridge which has since been partly filled in. How useful would all those old surveys be in the present valuation if they were referred to some common datum of levels and alignment?

The present valuation surveys would serve admirably as a reference basis for future surveys and could be made available for that purpose at small expense. Two permanent monuments set at random on the company's property out of the way of future improvements and possibly 20 to 30 ft. from the track, would give a line to which two stations of the track survey might be referred. These pairs of monuments might be placed at intervals of about a mile or less, and would be used as the initial or closing point of all future surveys.

A piece of scrap rail 4 ft. long, pointed at the forge and driven with a sledge until nearly flush with the surface of the ground and marked on the top with a center punch would make a good and permanent monument. Situation sketches giving the elevation and notes needed to find the monuments would be necessary and these should be made on transparent sheets of standard field-book size so that they could be blueprinted and thus made conveniently available for use by the field parties. It is, of course, also necessary that some proper system of indexing and filing the field notes be used.

Unless this or some more suitable method of rendering the present surveys permanently available as a common basis for future surveys is soon taken, the opportunity will have passed and the expense of obtaining equally good results as those now available will be greatly increased. WALTER H. DUNLAP.

Washington, D. C., June 21, 1916

[It may be possible that some of the railways are doing the very thing suggested by the writer, and if so it would be worth while for the facts to go on record. *Engineering News* will be pleased to make note of such instances.—Editor.]

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Government and Student Free Engineering Service

Sir—The editorial in your issue of June 1 entitled "Government and Student Free Engineering Service," leads the writer to present a phase of the subject that has not, so far as he knows, been discussed. Putting aside the question of relative quality of the work turned out by senior students under the guidance of their professor and which is donated to the individual client at the expense of the taxpayers of the state—a most unequal distribution of burden—there is yet to be considered a more vicious result where the practice extends over a term of years.

Consider this. The senior class that today furnishes free engineering service will become the practicing engineers in ten years time and will in turn be subjected to the competition of the then existing senior class and its free engineering service. This competition cuts down the earnings of the practicing engineer and consequently lessens the value of his investment and the state's investment in his education, and it may readily become severe enough to cause him to abandon his engineering activities entirely and seek other means of livelihood. One of the purposes of the institution being to train young men in the fundamentals of engineering science so that there will grow up in the state a body of efficient men skilled in developing the various resources of the state, and thereby react in many ways to the advantage of the general public, any act or system that reduces or destroys the effectiveness of that body defeats to the same extent the purpose of the institution and prevents it from fully justifying its existence. There is nothing gained by training young men in engineering science if later on in life they must abandon their chosen field because the institution which nourished them takes away their means of livelihood. The practice of tearing down with one hand while trying to build up with the other is puerile and can produce nothing lasting nor worth while.

The engineering student has about one year to be a senior and perhaps 35 to 40 years to be a practicing engineer. Why establish a system of free service that may be of some slight benefit to the senior student for one scholastic year and then be a constant menace and a greater detriment to him during the subsequent period of his professional life? The effectiveness of the practicing engineer is reduced and his influence curtailed in proportion to the reduction in his income; for he cannot employ as many of the younger graduates, he cannot so well serve as a man of affairs in his community, he cannot so effectively influence investors to back legitimate projects for the development of the state, nor can he so materially increase the standing of the engineering profession with the public. The net result of the free-service system extending over a term of years is to reduce the income of the practicing engineer, to cause him to abandon his profession, to reduce his effectiveness as a citizen and a man of affairs, to nullify the purpose of the institution, and to waste the taxpayers' money in an educational investment that does not bring the returns that it should. ROBERT C. BARNETT.

Kansas City, Mo., June 12, 1916.

Sir—The attention of the United States Public Health Service has been called to the editorial appearing in your issue of June 1, 1916, and especially to the paragraph reading as follows:

> A far more serious question than the effect on the profession is the character of the service likely to be rendered under conditions of either Federal aid or free assistance by engineering students. In saying this, we are not questioning the advice given by the United States Public Health Service in the particular case in hand. As a general proposition, however, the various branches of the Federal government are not sufficiently well manned either in numbers or professional competence of the majority of such staff as exists to make proper studies of local questions, determine all the various facts based upon local conditions, and then give advice—much less prepare plans and specifications—that will meet the needs of the case.

As the editorial refers to engineering service, and as the Public Health Service is the only branch of the Federal government mentioned in the previous discussion or likely to be called upon for advice of the kind mentioned, this reference must be construed as a criticism of the professional competency of the Public Health Service to give advice in matters involving engineering projects.

In view of the varied activities of the Public Health Service it would seem neither necessary nor desirable that a majority, or any considerable proportion, of its corps be particularly skilled in the relatively small phase of the Service work requiring a technical knowledge of sanitary engineering or familiarity with its principles. The comparatively small number of the local investigations undertaken requiring such knowledge are invariably assigned to members of the corps especially fitted by education and training for such work; and these officers are always allowed sufficient time and facilities to investigate the facts thoroughly. Such local investigations have to do almost always with questions of the efficiency of engineering structures such as water-purification or sewage-disposal plants, or with the necessity for new structures. The advice given refers only to the general principles to be followed, not with the design of structures, always recommending that the advice of competent engineers be followed in the selection of detailed plans. Conclusions and advice having to do with such questions are invariably reviewed by engineers of the Service of high standing and ample experience.

The character of the work done by this portion of the Public Health Service corps in their broader investigations constitutes a sufficient answer to the implication that such men are not professionally competent to render advice on the principles to be followed in solving local public health problems. A review of reports rendered by the Public Health Service on local conditions will show, moreover, that the conclusions reached are based ordinarily either upon thorough investigations by the Service or upon the consideration of sufficiently reliable data previously collected by competent engineers.

It is therefore apparent that the editorial in your journal has been based on a misconception of the work undertaken by this Service and the qualifications of its engineering staff. A. H. GLENNAN,

Acting Surgeon-General.

Public Health Service, Washington, D. C.,
June 10, 1916.

[As to the second of the two foregoing letters, the paragraph quoted in it from our editorial of June 1, was carefully phrased (1) to disclaim criticism of the advice given by the Public Health Service in the Lexington sewage-treatment case, and (2) to include "the various branches of the Federal government" that from time to time render engineering assistance on local as distinct from Federal questions.—Editor.]

Notepaper Defended

Gentlemen:—

In the June 8th *Engineering News* is an article "The Applicant's Difficulty' by R. Fleming.

Finding fault with an application, because it is written on notepaper, is silly.

What difference does the paper make? What it reads would interest most people.

I use notepaper in my personal business, exclusively, and so do many others.

There never will be a standard letter sheet. Too many people and firms have a liking for "the different."

In my office I receive letters in all, sizes, shades, and odd printing. Everyone gets personal attention and there is no trouble in filing them.

I wonder, if he ever tried to buy business paper on a Sunday or in the evening. If he did, he tried at the local drug store, and its dollars to doughnuts that what he got was notepaper.

I'd consider a letter, carefully, if it was written on a tomatoe can cover. What's in it is what interests me.

Yours very truly,

. . . .

[We print the above letter exactly as it was written, omitting the signature. Any comment upon it would be superfluous.—Editor.]

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Activated-Sludge Experiments on London Sewage are being conducted by the County Council of London, England, according to the latest annual report of the council. During the year reviewed by the report more than 20,000 long tons of lime and 5,000 long tons of protosulphate of iron were used at the two chemical precipitation plants maintained by the council

Important Committee Work in Materials Testing Society

SYNOPSIS—Report of annual meeting of American Society for Testing Materials, Atlantic City, N. J., June 27-30, 1916.

Replacing the existing standard specification for portland cement by a radically new one, revising nearly all the steel specifications except those for rails, and establishing a dozen or two other new specifications were the technical achievements of the annual meeting of the American Society for Testing Materials, held last week in the customary congeniality of Atlantic City, N. J. Apart from this, however, the meeting had a new and distinct tone due to the strong growth of committee activities. One or two knotty problems springing out of this growth presented themselves, and they are likely to keep the society's officers busy during the coming year.

There was a slump in the number and range of technical papers, for which the large amount of committee work is at least partly responsible. However, some papers of first importance were read. The cracking disease of brass and bronze was partly cleared up, new light was thrown on heat-treatment changes in high-carbon steel, endurance testing and the elastic-limit problem were usefully discussed, etc.

That the society has outstripped some of the older and larger engineering organizations in point of technical importance was demonstrated pretty well by the attendance at the meeting. It happened that the American Society of Civil Engineers held its summer convention at the same time, in Pittsburgh, but many of its members cut the convention in favor of the Atlantic City meeting. The latter broke its own record of attendance, in spite of the counter-attraction. No less than 513 men were registered, against 489 last year, and even by Wednesday evening, June 28, when the Pittsburgh convention was in full blast, the attendance had reached 455.

A. S. T. M. Specifications Will Stimulate South American Trade

Two unusual events emphasized the importance of the specifying and standardizing work to which the society is chiefly devoted. An agreement was reached between the Department of Commerce and Labor of the U. S. Government and the society's executive committee under which the department will translate the A. S. T. M. specifications into Spanish and will circulate them free through the South American consular offices. Already over 30 of them have been translated.

Alongside this government recognition stands an equally significant recognition by the architectural profession, which has hitherto held aloof from the testing engineers. The American Institute of Architects was represented by Prof. Thomas Nolan (University of Pennsylvania), who made the following statement to the meeting:

> The American Institute of Architects has just appointed a new Standing Committee on Materials and Methods, to collect, record and publish for the architectural profession, in a more efficient manner than heretofore, the most important results of investigations of the materials and methods of construction, carried on by the American Society for Testing Materials, the engineering societies and similar organizations.

The address of the president, Mansfield Merriman, under the title "The Work of Committees," happened to touch on some of the very conditions that featured the meeting. Describing the origin of the society's system of working out results by standing technical committees, Mr. Merriman defined the principles on which the success of the system depends. Among them he included the coöperation of the society at large in the final stage of the work by its letter ballot on the adoption of standards—a proceeding subjected to considerable criticism in recent years.

About one-third of the entire membership is engaged in the committee work, yet its cost to the society is only $1,200 per year for 37 committees. Mr. Merriman suggested that larger expenditures in this direction are in order, now that the society is no longer hampered by annual deficits. Increase of the membership dues on Jan. 1, 1916, is producing an additional income which will in the first year wipe out the accumulated deficits.

Specifying Engineering Design and Methods

The society is confronted by serious unsolved problems in the desire of certain committees to prescribe not only the material but also how that material may be used. Thus, one committee in specifying the qualities of gypsum plasters wished to limit the framing of the building to a minimum spacing of 16 in., and proceeded still farther to tell what lath must be used and how they must be nailed on, not to speak of detailed rules for applying the scratch coat, the brown coat and the finishing coat. Fortunately the committee reconsidered, and withdrew the whole proposed specification before actually coming into the meeting.

The difficulty was brought on two years ago by the Drain-Tile Committee (chairman, Prof. A. Marston, Ames, Iowa), followed by the Sewer-Pipe Committee (chairman, Rudolph Hering, New York). The former insisted that the quality of drain tile cannot be specified successfully unless the pressure of earth on pipe in trenches and the right way to lay the pipe be specified at the same time. It drew up a specification covering all three matters, and this specification was adopted by the society in 1914. The Sewer-Pipe Committee, followed suit with a document entitled "Recommended Practice in Laying Sewer Pipe," which in 1915 was accepted by the society as tentative, though not accompanied by a specification for quality of sewer pipe.

Thereupon the Executive Committee, believing that the society should stick to its own work on quality of materials and keep clear of the engineering questions involved in the use of materials, established the principle that in general the committees should not include matters of engineering design or construction in their specifications, but that they might do so if necessary. This declaration has had but little effect up to the present, and the question involved appears to be still unsettled.

The Drain-Tile Committee this year reported a radically new specification, restricted mainly to specifying quality of tile, but retaining some essential reference to earth pressure or to methods of laying. The Sewer-Pipe Committee adhered to its intention to specify recommended practice in laying pipe sewers, and indeed revised the specification. The Gypsum Committee, already mentioned, made the widest divergence from the principle declared, but by later withdrawing its specification kept the question from coming up for direct discussion.

THE SOCIETY RESUMES CONTROL OF COMMITTEES

Action was taken in two or three matters to place restraint on the tendency of committees to assume absolute control of their fields. This tendency, appearing with the growth in weight of the committees and their work, had the result that in recent years proposed specifications went through the society meetings in routine fashion, and lively discussion was rare. This year several committees undertook to put their specifications through without a one-year trial as provided by the rules. But if any expectations were based on the tame attitude of prior meetings they experienced a partial disappointment. A fight developed when the Road Materials Committee made its proposal for immediate adoption without revealing adequate reasons for the request, and the committee was overruled as to an entire group of specifications.

Another squabble, this time on definitions of special technical terms, led to preliminary steps toward appointment of a Nomenclature Committee. Definitions have up to now been prepared by the technical committees for their several subjects, and frequent overlap developed, with controversy over who had jurisdiction. When the Gypsum Committee presented definitions including one for concrete, and it appeared that a rather novel and academic meaning was to be formally tacked on to this well-fixed term, objection was raised, and in consequence the committee received a mild rebuke: It was instructed next year to justify its endeavors to deal with terms that apparently are not in the immediate field of the committee.

The Cement Committee took the very large view that its new cement specification will monopolize the field so thoroughly that it should be called "American Standard Specification," and that this name should be given it by the American Society for Testing Materials. The tone of the society meeting was more modest, and the committee's proposal was turned down gracefully. The title "A. S. T. M. Standard Specification" was considered good enough.

An unusual decision affecting the clearness of specifications was reached by the Executive Committee during the past year. The question was raised at last year's meeting whether it would not be best to prohibit discrimination between two or more materials unless the same specification contained a method of distinguishing the materials. By the decision now reached it is "inexpedient to approve this proposal because in some cases there are no known methods of distinguishing different materials without direct knowledge of their origin." The case of acid and basic openhearth steel has been cited in support of this decision.

MICROGRAPHY AND STRUCTURE STUDIES IN THE FOREGROUND

In the independent papers, and to some extent in committee reports, micrographic and other study of internal structure was very much to the fore. This is true not only as to amount of use of structure study, but also as to definiteness and convincing character of the proof furnished. A leading case in the latter regard was a paper on improving brass condenser tubes, by A. E. White, in which the entire argument on limits of annealing temperature was set forth and proven in remarkably clear manner by a series of accurately comparable microsections.

The importance of microstructure studies stood out so much, in fact, that when the suggestion was made that magnifications ought to be standardized there was prompt general approval of the idea, and committee work on the subject will doubtless be initiated shortly.

COÖPERATION WITH OTHER ORGANIZATIONS

Notable among coöperative efforts was the work of the Joint Committee on Concrete and Reinforced Concrete, and this, unfortunately, seems to have reached a point where either the committee or its coöperation or both are in a bad way. Similarly in the co-called Joint Conference on the cement specification the coöperation partly failed, inasmuch as the agreement reached in conference was upset when the society's Cement Committee met by itself. In general, however, the extent of coöperation is growing steadily, and even the failures are such only in superficial appearance. The two new cases of coöperation—real or prospective—with the Department of Commerce and with the architects, represent a weighty addition to the prior list.

REMAKING THE PORTLAND CEMENT SPECIFICATION

After four years of labor, the committee on Cement presented a revision of the requirements for portland cement in the present Standard Specifications for Cement, adopted in 1904 and slightly revised in 1908 and 1909. This latest revision consists in an entire rewriting of the specifications, a number of changes in the requirements, and the incorporation in the specifications of the method of making the tests, which has hitherto been an appendix of the specifications in the form of the recommendations of a special committee of the American Society of Civil Engineers. The requirements for natural cement have not as yet been revised, although the new methods of making tests will apply to natural as well as portland cement (see page 13 of this issue).

It may be worth while here to set down briefly a history of the specification.

The first standard specification for cement was adopted by the American Society for Testing Materials in 1904 and soon received extended recognition as a laudable attempt to standardize what had up to that time been variable practice. In a few years, however, the constantly changing views on concrete and on cement led to a number of complaints mainly by engineers, as to the requirements of the specifications and repeated efforts were made to get the committee to revise the standards. A certain conservatism, inspired by a desire for a reasonable permanence in standards even at the expense of minor error, managed to prevent any changes in the specifications until 1908 (and again 1909) when some changes, mostly in the tensile requirements, were made.

In 1912, however, the Federal departments by executive order were compelled to adopt for use in all of their work a government specification for cement which had been prepared by a special committee of government en gineers. This was a severe blow to the prestige of the A. S. T. M. Standard specifications. So in March, 1912, the society's cement committee recommended that a conference committee of the American Society of Civil Engineers, the Government Departmental Committee and the American Society for Testing Materials be organized "to confer for the purpose of reconciling differences" in the specifications. In pursuance of this recommendation on Oct. 24, 1912, the Joint Conference on Uniform Methods of Test and Standard Specifications for Cement was organized.

This conference reached practical agreement on Apr. 28, 1915, but its report, an extensive volume, was considered by the Cement Committee to be more elaborate than its instructions permitted and the recommendations contained therein were not made public but were, at the annual meeting of 1915, made the subject of consideration of subcommittees for the ensuing year. During the past year the Conference and the Committee agreed on a specification which was sent out for information some months ago and which, as revised by the Committee (the Conference not being present) in meeting at Atlantic City on June 28, 1916, was submitted to the meeting of the society on June 29.

The specification was subjected to little criticism on the floor, but about an hour was used up in a spirited discussion on the title for the specification submitted by the Committee. To quote the report:

> The committee recommends that the proposed revised specifications for portland cement be given the title "American Specifications and Methods of Tests for Portland Cement." In the judgment of the committee, they are entitled to this distinction because they are the result of several years' work of the special committees representing the Board of Direction of the American Society of Civil Engineers, the United States Government Departmental Committee, and Committee C-1. It is highly desirable to convey not only to those who use cement in this country, but also to our export trade, that there is a single uniform American specification for this important product.

This recommendation was referred to the Board of Direction, which returned it for the consideration of the meeting, with the statement that in the Board's opinion such action would be insidious since there are numerous other specifications of the society to which the same arguments as to title apply. The discussion resolved itself into two sides one of which argued for the "American" in the title because of the impressive effect on South American trade and as a recognition of the three interests involved in the producing of the specifications. The opposition upheld the Board of Direction and further disputed the right of any body to usurp the word "American." The opposition won out and the title has been referred to the Board of Direction.

Finally it should be said that up to now neither the American Society of Civil Engineers nor the Government Committee has accepted the specifications as revised on June 28, so that those specifications so far are only the tentative Standards of the American Society for Testing Materials, to become effective as such Jan. 1, 1917, subject to the approval of the letter ballot of the society.

The Cement Committee further submitted proposed tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar, which may later be made a part of the Cement Specifications. The compression test recommended is on 2x4-in. cylinders instead of on the 2x2-in. cubes which have been mentioned in previous compression recommendations, and for that reason was objected to on the floor. The specification, however, was adopted as tentative.

The personnel of the committee is to be changed. George F. Swain, chairman, George S. Webster, vice-chairman and Richard L. Humphrey, secretary, have resigned and their places are to be filled by Russell S. Greenman, of the State Engineer's office of New York, as chairman, H. B. MacFarland, Testing Engineer of the Atchison, Topeka & Santa Fe Ry., vice-chairman, and P. H. Bates, of the United States Bureau of Standards, secretary.

New Metal Specifications

The Steel Committee recommended changes in a large number of its specifications, showing that its activity during the year was well up to normal. Most of the changes are of minor character, for example, the whole group of structural steel specifications is revised only by change of the table of permissible variation of plates to accord better with experience.

Boiler and firebox steel is affected by making the bend test much less severe, the specimen however to be taken from the top of the plate to give a check on the uniformity of the metal. The old specification, with this change, was retained for locomotive use, over the objections of C. L. Huston, who questioned the new bend-test clauses. A wholly new specification was drafted for stationary boilers, in order to get into closest possible agreement with the Boiler Code of the American Society of Mechanical Engineers. It differs from the Boiler Code in respect to the bend test and also in allowing a slightly greater range of tensile strength.

A noteworthy little innovation was made in the standard 2-in. tension test specimen, which for years has had ½-in. diameter and threaded ends to screw into the grips. Shouldered ends, for use with socket grips, were made permissive, to agree with the adoption of socket grips in some leading laboratories during the year. In regard to diameter the committee showed remarkable agility of mind. In its preprinted report it recommended changing from ½-in. to 0.505 in., which would give a cross-section of ⅕ sq.in. Before coming into the meeting, however, it changed its mind back to ½ in., and the meeting accepted the recommendation without asking an explanation.

New specifications drafted by this committee cover track spikes, screw spikes, tie plates, spring bars with special silicon requirements, and automobile springs, besides boiler steel as noted above.

Several laboratory researches were carried out for the committee. One of them, by J. R. Cain and H. S. Rawdon, of the Bureau of Standards, aimed to determine how reliable is the ladle test of steel. Ladle-test ingots were found to be segregated and unsound, and various analyses of them differed accordingly. Further work is planned to develop a method of getting good ladle-test ingots.

All the revisions and new specifications proposed by the committee were accepted by the society in the form proposed (standard or tentative).

The Wrought Iron Committee on the contrary was practically inactive. A corrected table of minimum weights was inserted in the boiler-tube specification, however.

The committee on Nonferrous Metals took up during the year the subject of copper and brass for firebox and tube service. Four specifications were formulated as a result, and all of them were accepted by the meeting as tentative: Copper Plates for Locomotive Fireboxes, Copper Bars for Locomotive Staybolts, Seamless Copper Boiler Tubes, and Seamless Brass Boiler Tubes. Other work by this committee was extensive revision of the specification for spelter, and a new specification for railway bearing alloys, but the latter was referred back to the committee after criticism.

Copper wire is in the hands of another committee. Two specifications were approved as standard, after being tentative for the past year and then being revised slightly: For bare concentric-lay copper cable, and for high-strength bronze trolley wire. A specification for insulated wire was approved as tentative.

OTHER NEW SPECIFICATIONS

Paint materials are affected by a revised specification for purity of raw tung oil (the new name for Chinese wood oil), tests for shellac, tests for distillation of paint thinners other than turpentine, and methods for routine analysis of white pigments. The three latter are tentative only.

In fuels, specifications for coke and for sampling and analysis of coal were (after revision) advanced to the rank of standards, having been proposed as tentative last year. Methods for laboratory sampling and analysis of coke were accepted as tentative.

Road materials gave rise to a sharp controversy between the committee and the meeting, which resulted in accepting many of the specifications as tentative only, while the committee wished nine-tenths consent to advance them at once to the rank of standards. The new specifications are for certain grades of broken stone, determining specific gravity of homogeneous coarse aggregates, mechanical analysis of aggregates (concrete aggregates excepted), penetration test of bituminous materials, test for loss on heating of oil and asphaltic compounds, method of distillation of bituminous materials suitable for road treatment, and determination of softening point of bituminous materials other than tar products.

The density grading recently applied to Southern yellow pine has been extended to Douglas fir, under substantially the same wording. The Timber Committee reported a specification for bridge and trestle timbers of this wood, under which only the "dense" grade is acceptable. This was adopted as tentative. A revised specification for sampling and analysis of creosote oil was also accepted as tentative.

A tentative specification for fire hose for public department use, reported by the Rubber Products Committee, was accepted. The same was done with a group of specifications for cotton fabrics for automobile tires and for hose and belting, wherein different tests are established for the two classes of fabric. Commercial considerations appear to have controlled in formulating the latter specifications. There was an interesting set of five papers reporting results on comparative tests of the two test methods specified, which established the superiority of one method.

A curious situation arose as to elastic limit in tension testing. The society's standard methods of mechanical testing were slightly supplemented and revised, chiefly as regards "elastic limit," now defined as beginning of set. Coincident with this change, however, the Steel Committee put into use a very different definition. An improvement was introduced in specifications for steel forgings providing for a new way of determining the elastic limit, but without any reference to permanent set: An extensometer reading to 0.0002 in. shall be used, and while the load on the specimen is increased at a uniform rate the observer shall watch for the point at which the rate of elongation shows a sudden increase, this point to be recorded as the elastic limit.

The ancient question of what is elastic limit, involved in the above, was illuminated by an excellent topical discussion joined in by J. E. Howard, T. D. Lynch, H. F. Moore and F. B. Seeley. This discussion tended to establish the view that proportional limit and set limit are identical.

The standard tests for magnetic properties of iron and steel were revised extensively by detailing tests suitable for permanent magnets.

NOTES OF PROGRESS

Interesting progress is being made in some phases of the committee work not represented in the above. On the subject of shipping containers, a test apparatus of the foundry-rattler type for boxes, etc., is being shaped up to serviceable form. On concrete aggregates work is being done that may lead to some definite knowledge of what to put into concrete mixtures. The most vital work seems to be an elaborate study of impurities in sands, being carried on by D. A. Abrams and O. E. Harder at Lewis Institute, Chicago.

The Sewer-Pipe Committee has formulated a full and valuable discussion of the service of sewer pipes and means of coördinating quality with service. Every engineer concerned even remotely with sewers ought to read this monograph.

The Paint Committee has started tests on the efficiency of different methods of cleaning the surface of steel before painting—a subject on which practically no knowledge exists. Similarly the Corrosion Committee, now also in charge of metallic coatings, is starting two important comparative tests, one on relative corrosion of 100 or more sheets of different irons, the other on galvanizing.

The Rubber Products Committee is working successfully on specifications for rubber insulating tape, the Copper Wire Committee on tinned copper wire. The Gypsum Committee has already made great progress in its work on gypsum and plasters and methods of test for them, and is likely to bring this work to full success in the next year.

In numerous other subjects, as heat treatment, waterproofing, and cast-iron soil pipe, little or no progress can be recorded.

NEW OFFICERS AND REGULATIONS

A. A. Stevenson, of the Standard Steel Works, Philadelphia, Penn., was elected president for the coming year, and S. S. Voorhees, of the Bureau of Standards, Washington, D. C., vice-president. The new members of the executive committee are W. H. Bassett, John Brunner, G. W. Thompson and F. E. Turneaure.

A change was made in the manner of selecting the nominating committee (now chosen by referendum), by making elected members of the committee ineligible for service the following year. A new regulation allowing proxy voting in the technical committees was adopted.

New Chief Engineer of the Baltimore & Ohio

Francis Lee Stuart has resigned as chief engineer of the Baltimore & Ohio R.R., effective July 10, to engage in private practice with offices in New York City. He will be succeeded as chief engineer of the Baltimore & Ohio by Ralph Norman Begien, now General Superintendent of the Baltimore & Ohio Southwestern at Cincinnati.

Mr. Stuart has been chief engineer since Jan. 1, 1911, previous to which he was for five years chief engineer of the Erie R.R. Under his direction a very extensive program of improvements has been carried out on the Baltimore & Ohio, including the construction of three- and four-track lines in mountainous country, grade reductions and curve eliminations, etc. The Magnolia cutoff, on the eastern end of the Cumberland division in West Virginia, described in *Engineering News*, June 29, is among the many important projects carried through by Mr. Stuart. The double-track tunnels on the main line through the Allegheny Mountains at Sand Patch, Penn., and Kingwood, W. Va., are other notable engineering achievements during this period.

R. N. Begien, the new chief engineer of the Baltimore & Ohio system is a native of Boston and an engineering graduate of Harvard University, class of 1897. For three years he was engaged in survey work in Central America for the Nicaraguan Canal Commission, after which he spent a year in railway work in Ecuador. Returning to this country he was for a short time with the Engineering Department of the District of Columbia at Washington. In 1902 he joined the engineering staff of the Baltimore & Ohio R.R. as an assistant engineer on surveys and construction of trunk line and branch line improvements, and later was on special work under the chief engineer at Baltimore. From 1908 to 1909 he was division engineer at Philadelphia, then acting engineer of maintenance-of-way of the main line system, assistant to chief engineer, assistant to general manager, assistant to third vice-president, assistant general superintendent and recently general superintendent of the B. & O. Southwestern.

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Water for a Million People Proposed at Seattle

A water-supply program to provide ultimately for a population of 1,000,000 at a cost of $8,182,000 was outlined in a report to the city council of Seattle, Wash., made on June 15 by A. J. Dimock, City Engineer, and L. B. Youngs, Superintendent of Water. The Cedar River source of supply would be retained, but the present wood-stave conduits would be supplemented and eventually displaced by a concrete aqueduct to a point below Swan Lake and by two steel conduits below that point. Swan Lake, well down the conduit line toward the city, would be converted into a large storage reservoir and the storage within the city would be materially increased. The distributing system would be reinforced by trunk lines. This work would be carried out in sections, according to need rather than natural order. The scheme provides for an ultimate capacity of 150,000,000 gal. a day, which at 150 gal. per capita would serve 1,000,000 people, or the population in 1950 suggested by the Seattle expectancy curve.

The present supply is conveyed to Seattle through two wood-stave pipe lines, completed in 1901 and in 1909. No. 1 is 28 mi. long, and has diameters as follows: 54 in. to screening chamber, ½ mi.; 44 in. to a point 1 mi. west of Swan Lake, 10 mi.; 42 in. to Volunteer Park reservoir, 17½ mi. At three stream crossings, the 42-in. wood pipe gives way to steel. No. 2 is 34¼ mi. long, parallel with No. 1 as far as Volunteer Park, and only 10 ft. from it most of that distance. The diameters of No. 1 are: 54 in. to the screen chamber ½ mi.: 60 in. for 10 mi., to a point near Swan Lake; 51½ in. for 14 mi. to Beacon Hill reservoir; 48 in. for 4¾ mi. to Volunteer Park reservoir; 42 in. for 5 mi. to Maple Leaf reservoir.

Governing twin factors in the program for carrying out the improvements are the present wood-stave pipe lines and the need for storage, both nearer and within the city. (See *Engineering News*, Jan. 20 and 27, Feb. 3, Mar. 30, Apr. 6, 1915, pp. 140, 184, 197, 233, 585, 647.)

No. 1 wood-stave pipe line is now being reconstructed and No. 2 will soon need to be. The report states that if the city had the courage to rebuild the wood pipe lines every 12 years "we could probably obtain as satisfactory results as to safety of operation with wood pipe as with steel, and at very much reduced cost." But in view of the "tendency of human nature to put off reconstruction" as long as the old lines hold out steel rather than wood is recommended for the lower portion of the new conduit.

Water storage for Seattle, with a present estimated population of 300,000, and a maximum water consumption of 42,000,000 gal. a day, is limited to 183,000,000 gal. for the low service, 83,000,000 for the intermediate service, and practically nothing for the high service. The demand on the low service is greater than that on the high service but not in proportion to the storage. The two conduits together have a capacity of 63,000,000 gal. a day.

The two wood-stave pipe conduits pass close by Swan Lake, at a point about one third the distance from the intake to the city. This lake has a drainage area of perhaps 3,000 acres, and a water area of 535 acres. The city owns 23,000 of the 32,000 lin.ft. of shore line and 288 sq.mi. of the drainage area of the lake. A dam 16 ft. high would give 4,410,000,000 gal. available storage in the lake, or 100 days' summer and 200 days' winter consumption at the present rate. Such storage would reduce the pipe line hazard by a third, postpone the necessity for a more permanent pipe line between the intake and the lake, and give the supply the well known benefits due to storage.

If the two existing conduits were to discharge into Swan Lake their delivery capacity up to that point would be increased from 63,000,000 to 80,000,000 gal. a day. When still more capacity is needed, a 150,000,000-gal. concrete conduit should be built. Estimates show that for governing conditions plain concrete would be cheaper than reinforced concrete. This conduit would discharge into the east end of the lake. The outtake would be at the north end, and for about 2½ mi., or to Molasses Creek, local conditions favor a concrete conduit.

The capacities of the lower portion of the existing conduits would be reduced by the Swan Lake connection to 52,000,000 gal. a day, so when the connection is made a 50,000,000-gal. conduit should be built the remaining distance to the city.

The most imperative need today is more storage in the city. The report recommends that the city reservoir capacity be greatly increased and that some of this increase be made second to nothing but the completion of the rebuilding of Pipe Line No. 1, now in progress.

The estimated cost of the entire program recommended is as follows:

Concrete Conduit, Landsberg to Swan Lake, including rebuilding of intake	$573,000
Development of Swan Lake, including aqueduct to Molasses Creek	777,000
Replacing No. 1 Line with steel*	625,000
Replacing No. 2 Line with steel*	1,180,000
Steel Pipe Line No. 3, Molasses Creek to West Seattle	1,650,000
Steel Pipe Line No. 4, Molasses Creek to Volunteer Park	1,600,000
Enlarging Volunteer Park Reservoir	190,000
Enlarging Lincoln Park Reservoir	70,000
Reservoirs at West Seattle	483,000
Distribution	1,034,000
Total	$8,182,000

*Evidently meaning from the end of the concrete conduit only; if rebuilt of wood instead of steel the cost for the two would be reduced about $1,000,000.

If in place of a concrete aqueduct, Conduits 1 and 2 were rebuilt of steel and new Conduits 3 and 4 were also built of steel, each when needed and for the entire distance from the intake of the city, and Swan Lake was cut out of the program, the total cost would be $10,127,000 or $7,727,000 if Nos. 1 and 2 were rebuilt of wood instead of steel.

The successive steps recommended in the report are as follows:

1. Complete the rebuilding of Pipe Line No. 1 in wood.
2. Increase the capacity of Volunteer Park Reservoir.
3. Acquire and develop Swan Lake, including necessary lands and rights-of-way.
4. Build Pipe Line No. 3 of steel, from Molasses Creek to West Seattle.
5. Acquire sites and construct the West Seattle reservoirs.
6. Construct new distribution mains.
7. Rebuild Pipe Line No. 2 in wood or steel, as experience may dictate.
8. Construct a single conduit from Landsberg to Swan Lake, when necessary because of the need of additional supply or because of failure of present pipe lines.
9. Construct Pipe Line No. 4 from Swan Lake to Volunteer Park.

This would give 150,000,000 gal. a day. Items 2 to 7 (No. 1 already in progress) call for an outlay of $4,205,000. This should be authorized at once, the report says, but would be distributed through three to five years.

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Portland Cement Specifications

As outlined in the report of the annual meeting of the American Society for Testing Materials on another page, a new specification for portland cement was adopted by that meeting with the prospect of similiar adoption by the letter ballot of the Society, the U. S. Government departmental cement committee, the American Society of Civil Engineers and many minor societies. This specification, then, will probably be as nearly as possible a nationally accepted standard. Below is given that part of the specifications relating to requirements; there are in addition 33 sections relating to the methods of testing. The new specification is entirely rewritten and rearranged and does not include the requirements for natural cement. The main differences between it and the old A. S. T. M. standard specifications are as follows:

Fineness has been increased from 75% to 78% through a 200-mesh screen, with no prescription for the 100-mesh screen in the new specification. The permissible SO$_3$ content has been increased from 1.75% to 2% and the MgO content from 4% to 5%. The time of initial set has been increased from 30 min. to 45 min. as read on the Vicat needle and an alternate permission to use the Gillmore needle has been included. The neat test for tensile strength has been omitted and the 28-day tensile requirement for 1:3 mortar briquettes has been increased from 275 lb. per sq.in. to 300 lb. per sq.in. The normal air and cold-water tests for soundness have been eliminated and only the steam test retained.

The first 15 clauses of the specifications follow:

1. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

I. CHEMICAL PROPERTIES

2. The following limits shall not be exceeded:

Loss on ignition, per cent	4.00
Insoluble residue, per cent	0.85
Sulphuric anhydride (SO$_3$), per cent	2.00
Magnesia (MgO), per cent	5.00

II. PHYSICAL PROPERTIES AND TESTS

3. The specific gravity of cement shall be not less than 3.10 (3.07 for white portland). Should the test of cement as received fall below this requirement, a second test may be made upon an ignited sample. The specific gravity test will not be made unless specifically ordered.

4. The residue on a standard No. 200 sieve shall not exceed 22% by weight.

5. A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking or disintegration in the steam test for soundness.

6. The cement shall not develop initial set in less than 45 min. when the Vicat needle is used or 60 min. when the Gillmore needle is used. Final set shall be attained within 10 hr.

7. The average tensile strength in pounds per square inch of not less than three standard mortar briquettes (see Par. 57), composed of one part cement to three parts standard sand, by weight, shall be equal to or higher than the following:

Age at Test, Days	Storage of Test Pieces	Tensile Strength, Lb. per Sq.In.
7	1 day in moist air, 6 days in water	200
28	1 day in moist air, 27 days in water	300

8. The tensile average strength of standard mortar at the age of 28 days shall be higher than the strength at 7 days.

III. PACKAGES, MARKING AND STORAGE

9. The cement shall be delivered in suitable bags or barrels with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. A bag shall contain 94 lb. net. A barrel shall contain 376 lb. net.

10. The cement shall be stored in such a manner as to permit easy access for proper inspection and indentification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

IV. INSPECTION

11. Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified. At least 10 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 31 days for the 28-day test. The cement shall be tested in accordance with the methods hereinafter prescribed. The 28-day test shall be waived only when specifically ordered.

V. REJECTION

12. The cement may be rejected if it fails to meet any of the requirements of these specifications.

13. Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

14. Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

15. Packages varying more than 5% from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected

News of the Engineering World

Thacher Bridge Patent Called Invalid by District Court

The well-known United States Patent No. 617,615 issued to Edwin Thacher, Jan. 10, 1899, for a "new and useful improvement in concrete arches" has been declared invalid by Judge Hale of the United States District Court, District of Maine, in a decision handed down June 27, 1916, in the case of Edwin Thacher vs. the Inhabitants of the Town of Falmouth. The judge based his decision mainly on the contention of counsel that the Monier arch, as shown in the celebrated 1895 arch experiments of the Austrian Society of Engineers and Architects, is a substantial anticipation of the Thacher claims. Other patents apparently did not enter into the defense of the case.

The bridge in question is a 160-ft. twin-rib reinforced-concrete arch, the ribs being reinforced with upper and lower rows of ¾-in. rods tied together every 3 ft. with so-called "hoops" of ½-in. rods and vertical so-called "binders" of ⅜-in. rods. In contradistinction to one Thacher suit, however, these vertical rods were not brought into the case to set up the dependence of the upper and lower longitudinal rods. The suit was for infringement of the first and third claims of the patent; it was brought by Mr. Thacher against the town but it was defended by the Maine State Highway Commission, with S. W. Bates, of Portland, Me., as attorney.

As stated, the main defense was the 75-ft. Monier bridge tested by the Austrian society and described in the *Zeitschrift des Oester. Ingenieur- und Architekten-Vereines*, under date of May 24 and May 31, 1895. The judge's comments on this bridge are as follows:

> It is in evidence that in 1895 the "Zeitschrift" of the Austrian Society of Engineers and Architects published in a supplement the results of a series of tests made on full-sized arch bridges of certain well-known types, for the purpose of getting data for calculations. Among other publications was the description of a bridge 75 ft. long, built on the Monier plan, with longitudinal wires about ½ in. in diameter and cross-wires about ½ in. in diameter. The proofs contain also cuts and descriptions of the bridge construction. This publication is shown to have been made some time before the application for this patent was filed.
>
> I think the "Zeitschrift" must be held to disclose a construction having in combination all the elements of the patent in suit. It contains the abutments, the concrete arch, the series of pairs of bars, one bar of each pair near the intrados, and the other pair near the extrados; it shows each bar extending well into the abutments, after the completion of the abutments. I think there can be no doubt that the concrete work, into which the arch extends, must be held to be a part of the abutment after the construction is complete. Each bar of the pair is clearly independent of the other bar of the pair. It appears that the wires in use, under the system disclosed in this publication, were ½ in. in diameter. A wire of this character may well be called a bar; the reinforcement used in the construction described in the publication was something more than a wire netting.
>
> We have before us the drawing of the Thacher patent; also of the defendant's construction. Having these two drawings in mind, if we examine the drawing described by the "Zeitschrift" publication, we shall see that this drawing appears to present the elements of the Thacher patent and of the defendant's construction, as I have just referred to them in detail.

The Court further ruled that the publication in the foreign periodical was legal anticipation and that the fact that the bridge was for test and not for practical use could not be used to eliminate it. The decision continues:

> The "Zeitschrift" device appears to belong to the German Monier system. It is not necessary, however, to decide to what system it belongs. In my opinion it discloses public knowledge of the improvement in question. In view of this disclosure, the proofs lead me to believe that the complainant did not discover anything new. He enlarged some of the longitudinal wires; he omitted some of the lateral wires; he made some other mechanical changes; by these means he thought he would be enabled to build a bridge more economically than it could be built under the Monier system. The result is shown in what the complainant has brought before the public.
>
> He testifies that he had read a paper produced by Frederick von Emperger before the American Society of Civil Engineers, giving a sketch of the Monier system. This was some time before von Emperger produced his patent No. 583,464 in 1897 to which reference has been made by the courts. The complainant testified that this paper started him upon the line of inventive thought which led up to this patent. The proofs do not induce the belief, however, that Mr. Thacher made any advance in the art.
>
> Variations of size of wires do not constitute invention; widening the spaces between the bars, to enable an engineer to use coarser concrete, is not invention; dispensing in whole or in part with unessential parts is not invention; producing economy in bridge building by consolidating numerous small bars into one large bar cannot be said to be invention. These things are mechanical; they relate to good engineering; they do not disclose inventive thought.

The judge then sought to show that had the Austrian bridge been submitted to the court in the two previous Thacher cases (Maryland: *Engineering News*, Mar. 4, 1915, p. 461; Feb. 10, 1916, p. 290. New York: *Engineering News*, Mar. 23, 1916, p. 580; June 15, 1916, p. 1157) it would have come under what the judges in these cases considered an anticipation.

The final decision is as follows:

> After a careful examination of the "Zeitschrift" publication I am constrained to hold that Mr. Thacher's alleged invention in the patent in suit was described in a printed publication previous to his application for a patent, and that such printed publication was made in this country and in a foreign country. By reason of this publication I find that the patent in suit does not disclose invention; it is therefore invalid.
>
> Having taken this view of the publication to which I have referred, it is not necessary to refer to other publications, although other publications are produced illustrating the German Monier system.
>
> In view of my conclusion as to the validity of the patent, it is not necessary to discuss the question of infringement. The bill of complaint is dismissed with costs.

◆

Boston Tunnel Face Blows Out

A statement concerning the Boston Edison tunnel blowout, June 21, 1916, indicates the remarkable fact that a tunnel face of practically semiliquid material blew out with such violence that nearly the full height of the shaft was filled with the inflowing mud and water. The tunnel is being built as a cable conduit under the Reserved Channel at what is known as the L Street Bridge on Summer St. Extension in South Boston. It is to be a 7-ft. circular tube 70 ft. below street surface and 981 ft. long between end shafts. The tunnel walls are 12 in. thick, the shaft walls 16 in. thick; the shafts are also 7 ft. in diameter inside.

Borings showed under the harbor silt coarse sand and gravel, silt and sand, stiff blue clay, and finally a hard stratum of sand, gravel and clay. In the latter the tunnel was located.

Work was begun at the west shaft, which was sunk to depth as a steel caisson under compressed air. Excavation for the tunnel away from the shaft had just started at the time of the accident. A pressure of 30 lb. was being carried, indicating that the face was not as good as the borings had indicated.

Four men had just entered the heading. They were carried out with the blowout, and their bodies have not been recovered. The inflow nearly filled the shaft.

The Boston Edison company declined to give information on the accident. Investigation by the public authorities may throw more light on the facts. The Hugh Nawn Contracting Co. is constructing the tunnel.

Tunnel Will Not Be Built

The Supreme Court of the State of Pennsylvania on July 1 declared unconstitutional the act under which the so-called Neeld or South Hills tunnel, Pittsburgh, was to be built by the county. The decision reversed the Common Pleas Court of Allegheny County and the Superior Court. It involves both a defective title and the general proposal to have the county construct works within the city. Contract for the tunnel was let last fall to Booth & Flinn. Work was started on a sewer diversion near the west end of the tunnel, this diversion itself being a piece of tunnel work in shale. About $50,000 worth of work has been done. The whole enterprise was to cost about $1,350,000. A section and profile with data were printed in *Engineering News* of Aug. 12, 1915, p. 300.

Boston Engineers Reinstated in City Service by Court

A legal decision of interest to all engineers and of special interest to engineers in Boston was filed in the Dorchester District Court on June 27 by Judge Joseph R. Churchill. This decision orders the reinstatement of Frank A. McInnes, division engineer in charge of the sewer and water service, Storrs L. Durkee, superintendent of the permit department of the paving division, and Bliss W. Robinson, superintendent of the main drainage system, who, of the 17 employees of the Public Works Department discharged last January, contested the action of the mayor in announcing that their positions were abolished.

A few days after their "discharge" a hearing was given to these three men by the Commissioner of Public Works, Edward F. Murphy, as provided under the civil service regulations. The commissioner maintained that he had no complaint as to their efficiency, but that the department had been reorganized and the positions abolished so that there was no further occasion for their services.

The attorney for these men, Arthur D. Hill, decided to carry the cases on. Much testimony was presented to show that the so-called reorganization of the Public Works Department had been made in bad faith and that the work of the city could not actually be carried on without filling the vacant places, even though under different titles. The city, through its law department, attempted to show that the service had not been injured and that the civil service regulations had not been violated because the positions had not been filled. The case attracted much attention, because it is the first that has ever been brought under this law. Among the witnesses who were introduced for the plaintiffs were L. K. Rourke, consulting engineer, formerly Commissioner of Public Works; Frederick H. Fay, consulting engineer, formerly division engineer of the bridge and ferry division of the Public Works Department; Guy C. Emerson, consulting engineer of the Boston Finance Commission and a former superintendent of streets; Frederic P. Stearns, consulting engineer and past president of the American Society of Civil Engineers, and others.

The evidence was well summed up in Mr. Hill's argument, in which he said:

> We are required to prove that the petitioners held positions under civil service rules. That is conceded. We are required to prove that the petitioners were removed from positions or reduced in rank or salary without proper cause, or in bad faith. If we show they were removed without proper cause, we have shown enough, without regard to the proposition of bad faith. But I think in this case the matter of bad faith is proved. The question is whether the abolition of the offices was a bona fide abolition. If Mr. Murphy removed these men for any other reason than to maintain the proper working of the department he did it in bad faith. It is on this issue that the whole matter hangs. Mr. Murphy was given wide liberty under the Boston city charter. All he had to do was to act in good faith. But, if we show he acted otherwise than in good faith in the fullest sense of the word, then we have proved our cases. These offices could not be abolished in the true sense of the word.
>
> There is no charge of inefficiency against any of the petitioners. . . . . But Mr. Murphy hit upon the term "lack of effective coördination" as a substitute for "inefficiency."
>
> I think the charts will show that there was no real reorganization. . . . . It was shown that the new plan could be devised only for an ulterior motive and that it is full of inefficiencies and conflict of authority as well as overloading.

Judge Churchill concluded his opinion ordering the men to be reinstated with the following words:

> It follows from my findings that the order of removal was made by the respondent without proper cause and in bad faith and the order must be reversed in each case and the three petitioners be reinstated to their offices.

North River Piers Completed Inside Huge Coffer-Dam

The great coffer-dam at West 46th St., New York City, built in connection with the construction of the new 1,000-ft. pier, was flooded on the afternoon of June 29. To witness the opening of the sluice gates by Mayor Mitchel, a large party of invited guests and engineers were taken to the work by R. A. C. Smith, Commissioner of Docks, and C. W. Staniford, Chief Engineer. The coffer-dam was described in *Engineering News* of July 23, 1914. It is much larger than any previous dam of this type ever built. The only two important dams of a similar type are those built at Black Rock, near Buffalo, and one at Troy. In these previous dams the piles were less than 50 ft. in length and were driven through hard river bottom. At the West 46th St. coffer-dam the river bottom is of solid rock overlain with a thick layer of very soft silt. To make the successive cylinders which made up the dam at West 46th St., Lackawanna steel sheetpiles 70 ft. in length were driven and the contact of the sheetpiling in the interlock was the main reliance for watertightness. The bursting pressure on the interior of the cylinders was relieved by dumping riprap on either side of them. The coffer-dam proper was water-tight and remained so during the fifteen months from its completion until water was again admitted. The only places where water entered were through springs on the land side and a single leak at the 44th St. corner of the dam, where two piles encountered a boulder and could not be driven to the bottom.

The water pressure against the dam was about 90 tons per lineal foot. The dam contains about 3,800 tons of steel piling and about 90,000 cu.yd. of riprap. The area inclosed by the dam was about $5\frac{1}{2}$ acres.

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Riensch-Wurl Screens and Activated-Sludge Tanks have been recommended to treat the sewage of Lima, Ohio, by Geo. W. Fuller, Consulting Engineer, New York City. The plan is to operate the screens the year round, but at the outset to run the activated-sludge tanks about seven months in the year, when the flow of the Ottawa River is relatively small.

An Iron-Removal and Water-Softening Plant will be added to the water-works of Lawrence, Kan., the distribution system extended and protection against floods provided at a cost of $200,000. This work was projected some time ago, but was delayed until a second election, to make good a technical defect in the first one, could be held on buying the privately-owned plant. A favorable vote was secured on June 22.

Comparative Registrations at the second day of the meetings of the American Society of Civil Engineers at Pittsburgh and the American Society for Testing Materials at Atlantic City, both from June 27 to 30, are as follows: Am. Soc. C. E., Pittsburgh men 130, out-of-town men 132 (total 262), ladies 156. Am. Soc. T. M.; men 502, ladies 130. The latter society registered about a dozen more in the later days of the meeting; records for these days at the Pittsburgh meeting are not available.

Cement Production in 1915, as now finally reported by E. F. Burchard, of the United States Geological Survey, was practically the same as predicted in the preliminary report ("Engineering News," Jan. 27, 1916, p. 193). The shipments of natural cement in 1915 were 750,863 bbl., valued at $358,627, a decrease in quantity of 422 bbl., and an increase in value of $7,257 compared with those of 1914. The shipments of puzzolan cement in 1915 were 42,678 bbl., valued at $39,801, a decrease in quantity of 25,633 bbl. and in value of $23,557 compared with the shipments of 1914. The shipments of portland cement in 1915 were 86,891,681 bbl., as against 86,437,956 bbl. in 1914. Portland cement production in 1915 was only 85,914,907 bbl. against 88,230,170 bbl. in 1914. The 1915 average price per bbl. at factory was $0.86 against $0.927 in 1914.

The Increase in City Debt is the subject of a bulletin issued by the Census Bureau on July 7. The statistics cover 204 American cities which have a population of over 30,000. In 156 of these cities the net increase in debt during the fiscal year 1915 was $147,000,000, or $5.48 per capita of population. In the remaining 48 cities the debts were reduced during the year, the revenue exceeding the expenditure. The total reduction, however, was only $7,700,000. The debt conditions of the smaller cities are nearly hidden, however, by the overwhelming preponderance of the three largest cities—New York, Chicago and Philadelphia. The net indebtedness of New York City alone ($921,754,000) is nearly two-thirds as much as the total debt of all other cities of over 30,000 population taken together. The net per capita indebtedness of New York City amounts to $172.82.

PERSONALS

Roy O. Walker has resigned as City Engineer of Tarpon Springs, Fla.

R. S. Sinclair has resigned as President of Alsen's American Portland Cement Works, New York City.

Wm. P. Corbett has been appointed First Vice-President of Alsen's American Portland Cement Works, New York City.

Charles P. Juegar, recently Deputy Commissioner of the Cleveland (Ohio) water-works department, has been appointed Commissioner.

J. W. Kittrell, M. Am. Soc. C. E., of Rochester, N. Y., has been appointed General Manager of Alsen's American Portland Cement Works, New York City.

J. A. Wade, formerly with the S. Morgan-Smith Co., York, Penn., is now with George F. Hardy, M. Am. Soc. C. E., Consulting Engineer, New York City.

George W. Fuller, M. Am. Soc. C. E., has been appointed Special Lecturer on Sanitary Engineering (sewage disposal) at Sheffield Scientific School, Yale University.

M. E. Ready, former Assistant Engineer of the United States Reclamation Service, is now with engineering department of the Chicago, Milwaukee & St. Paul Ry., at Chicago.

J. L. Parsons, drainage and civil engineer, has resigned his position with the Lehigh Sewer Pipe and Tile Co., and has again taken up private practice, with offices at Fort Dodge, Iowa.

Charles R. Gow, M. Am. Soc, C. E., a well known engineer and contractor of Boston, Mass., has resigned from the Boston Licensing Board, to which he was appointed by Governor Walsh.

H. R. Hershey, recently Chief of Construction, Pennsylvania State Highway Department at Allentown, has been promoted to be Road Superintendent of Lehigh and Northampton Counties.

George H. Graves, formerly Assistant Electrical Engineer of the Sanitary District of Chicago, is now head of the department, having succeeded Edward B. Ellicott, M. Am. Inst. E. E., resigned.

Jerome Newman, M. Am. Soc. C. E., Chief Engineer of the Board of State Harbor Commissioners, San Francisco, Calif., has resigned, owing to differences with the President of the Board, J. J. Dwyer.

Arthur H. Morrill has accepted a position with Morris Knowles, Civil Engineer, of Pittsburgh, Penn. Mr. Morrill was formerly employed at the sewage disposal plant of the Baltimore Sewerage Commission.

Herman Nieter, former Sales Manager of the Kennicott Co., at Chicago, and later Manager of the New York office of the Blaw Steel Construction Co., is now Sales Engineer of the American Spray Co., New York City.

C. A. Case, Assoc. M. Am. Soc. C. E., formerly with the St. Louis & San Francisco Ry., at Joplin, Mo., and later with Albert C. Moore, Consulting Engineer, Joplin, Mo., has been appointed City Engineer at Neodesha, Kan.

C. D. Emmons, General Manager of the Chicago, South Bend & Northern Indiana Railway Co., South Bend, Ind., has resigned to become Vice-President and General Manager of the Boston & Worcester Street Ry., Boston, Mass.

Charles W. Losk, Assoc, M. Am. Soc. C. E., for the last six years Designing Engineer with Burns & McDonnell, Consulting Engineers, Kansas City, Mo., has been appointed City Engineer of Arkansas City, Kan., succeeding J. K. Titus.

Louis N. McDonald, recently Superintendent of the open-hearth and bessemer departments of the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, has been promoted to be Assistant General Superintendent of the Youngstown district of the company.

Frank H. Black, of Garrett, Somerset County, a member of the Pennsylvania State Commission of Agriculture, was appointed State Highway Commissioner, July 1, by Governor Brumbaugh. He succeeds the late Robert J. Cunningham, who died at Sewickley, April 4.

Ernest Martin Hopkins, of the American Bell Telephone Co., Boston, Mass., has been elected President of Dartmouth College, to succeed Ernest Fox Nichols, resigned. Mr. Hopkins is a graduate of Dartmouth and was formerly private secretary to President Tucker of the college.

Walter D. Hines, Chairman of the Executive Committee of the Atchison, Topeka & Santa Fe Ry., has been elected to the newly created office of Chairman of the Board of Directors. Mr. Hines is also General Counsel of the railway and will hereafter devote his whole time to the company.

A. R. Murphy, Jun. Am. Soc. C. E., of Knoxville, Tenn., has become associated with the engineering staff of Wallace & Tiernan Co., manufacturers of chlorine control apparatus, New York City. Mr. Murphy is a graduate of the University of Tennessee and has had several years water-works experience.

C. L. Sturdevant, Captain, Corps of Engineers, U. S. A., has been transferred from the Pittsburgh Office to Montgomery, Ala., where he will take charge of the office there, relieving Maj. F. C. Boggs. Major Boggs, who was formerly General Purchasing Agent of the Isthmian Canal Commission, has gone to the border.

Edgar Jadwin, Lieutenant-Colonel, Corps of Engineers, U. S. A., took charge of the Pittsburgh office on July 1, relieving

Col. Francis R. Shunk. Col. Jadwin has just completed a trip over the rivers in the territory in charge of the Pittsburgh Engineer Office, inspecting the slackwater improvements completed and under way.

James F. Barker, Principal of the East Technical High School, Cleveland, Ohio, has resigned to become President of Mechanics Institute, Rochester, N. Y., at a salary of $4,500 per annum. He graduated from Cornell University in 1893 and for a time was with the designing department of the Allis-Chalmers Co. at Milwaukee, Wis.

Richardson & Hale, Civil Engineers, Boston, Mass., are temporarily out of business because of the sending of the Massachusetts militia to the Texas border. Maj. Richard K. Hale, Assoc. M. Am. Soc. C. E., commands the First Battalion of Field Artillery, and Capt. Edward B. Richardson is in command of Battery A of the same battalion.

William C. Bulmer, former Special Engineer of bessemer department of the Ohio Works of the Carnegie Steel Co., Youngstown, Ohio, and recently Assistant Superintendent of the openhearth and bessemer departments, has been promoted to be Superintendent of these departments, succeeding Louis N. McDonald, promoted as noted elsewhere. Mr. Bulmer is a graduate of the University of Michigan, class of 1909.

Edward E. Krauss, formerly Secretary of the American Concrete Institute, **S. D. Burrows,** and **Frederick Edinger,** formerly Engineer in charge of design and construction with Wayss & Freytag, of Dusseldorf, Germany, have formed the Integrity Construction Co., with offices at 612 Lincoln Bldg., Philadelphia, Penn. The firm will engage in general contracting and engineering work, specializing in reinforced concrete.

Samuel Hill, Past-President of the American Road Builders' Association, of Seattle, Wash., is reported to have gone to Vladivostok, Siberia, to take charge of the traffic department of the Trans-Siberian Ry. for the Russian Government. Mr. Hill is a lawyer by education. He is a son-in-law of the late J. J. Hill, of St. Paul, and his early experience was as counsel of the St. Paul & Northern Pacific Ry. and the Minneapolis & St. Louis Ry. He has also served as President of some of the Great Northern subsidiary lines.

J. H. Ambler, Assoc. Am. Inst. E. E., **O. W. Ott** and **L. J. Riter,** have formed the firm of Ambler, Ott & Riter, Consulting Engineers, Kearns Bldg., Salt Lake City, Utah. Mr. Ambler is a graduate of the University of Pennsylvania and was formerly connected with the engineering department of the General Electric Co. and was recently Sales Engineer of the Salt Lake district; Mr. Ott is a graduate of Cornell University and was recently a member of the firm of Wilson & Ott, Consulting Engineers, previous to which he was Mechanical Engineer of the Oregon Short Line R.R.; Mr. Riter is also a graduate of Cornell University and has been with the Utah Power and Light Co., the Nevada Consolidated Mining Co., and other railway and mining corporations.

OBITUARY

Joseph O. Osgood, M. Am. Soc. C. E., Chief Engineer of the Central R.R. of New Jersey, died June 28 from heart disease at the Broad St. station of the railway in Newark, N. J. A portrait and biography will be published in next week's issue.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION
Sept 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N Y

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS
Sept 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenberg, Myers Building, Bethlehem. Penn.

ILLUMINATING ENGINEERING SOCIETY
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

THE ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22 Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The Engineer's Society of Western Pennsylvania entertained the members of the American Society of Civil Engineers at the Pittsburgh Convention, at a successful smoker on June 30. About 500 members and guests were present on the floor, while the balconies were filled with ladies attending the convention.

The Illinois Association for Public Health and Welfare has been organized to promote this field of activity throughout the state. The honorary president is Dr. Robinson (President of the State Board of Health); president, Dr. G. T. Palmer; secretary Paul Hansen (Chief Engineer of the State Board of Health, Springfield, Ill.)

The Kansas State Drainage and Conservation Association was organized in Topeka, Kan. June 22, with the following officers: President, V. R. Parkhurst, secretary, C. B. Zarker, Topeka; vice-presidents, C. P. Humphreys, H E. Dean, D. L. Dawdy, R. T. Wright, M. W. Crum, O. O. Wolf, O. E. Noble, James Shimer, S. W. Knotts and George Plum. The association will request the legislature to increase the authority of drainage boards, to provide for surveys of new drainage districts and to give the drainage boards power to condemn property for flood protection.

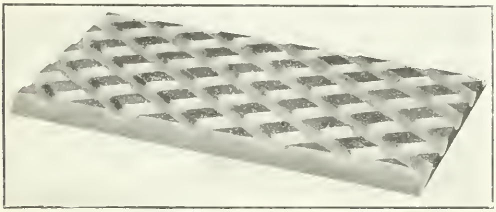
The National Exposition of Chemical Industries will take place for the second time in New York City in the week of Sept. 25, under the management of the International Exposition Co., at the Grand Central Palace. The American Electrochemical Society has arranged to hold its annual meeting Sept. 28 to 30. In this week the Technical Association of the American Pulp and Paper Industries expects to hold an annual meeting. The membership of this association comprises chemists, engineers, plant superintendents and foremen engaged in the manufacture of paper and its byproducts. The Bureau of Commercial Economics, Washington, D. C., is coöperating with the Exposition by arranging an elaborate program of motion pictures covering subjects dealing with the industries depending on chemistry.

The Roadmasters and Maintenance-of-Way Association will hold its annual convention Sept. 19 to 22, in New York City, at the Hotel McAlpin. The Entertainment Committee held a meeting on June 17, and at that time outlined the general program. The first day will be devoted to routine business and to discussion of committee reports, the latter being continued on Wednesday morning. On Wednesday afternoon, Sept. 20, there will be an inspection trip to the western end of the Long Island R.R., the party returning in time for a business session in the evening. The next afternoon a special train will conduct the members and guests over the main line of the New York, New Haven & Hartford R.R., between Grand Central Terminal and Stamford, Conn., while in the evening the Track Supply Association will give a banquet to the members and a theater party for the ladies. Friday morning will be devoted to business, and to an inspection of the exhibits of the supply association. In the afternoon the Central R.R. of New Jersey will carry a party down the Hudson River, through New York Harbor to Sandy Hook and Atlantic Highlands, thence by train to Asbury Park, and returning to New York. The secretary is L. C. Ryan, C. & N. W. Ry., Sterling, Ill.

Appliances and Materials

A New Safety Tread

A new type of safety tread was recently placed on the market by the American Mason Safety Tread Co., Lowell, Mass. The "Black Diamond" tread (the trade name of the new type), like the original Mason tread, meets the recognized requirements of a non-slip stair tread, including the deformed surface for receiving foreign substances, such as match stems, snow, ice, etc., and the necessary open-end grooves for drainage and easy cleaning.



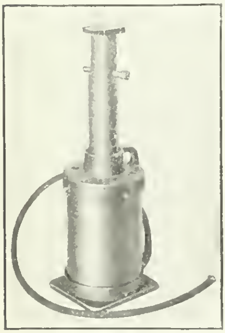
BITUMINOUS SAFETY TREAD

The abrasive material is carried entirely through the tread. The tread is made up of a skeleton metal frame, the surface of which presents a series of raised diamond-shaped openings. Each diamond unit is thus surrounded by a steel frame which takes the wear, the abrasive wearing down in proportion to the wear on the steel frame. The base of the tread consists of asphaltic compound.

Mason treads can be applied to all types of stairs, whether wood, marble, concrete or steel. When ordered for new concrete work the treads are shipped with anchors attached, ready to put in place.

* * *

Pneumatic Lifting Jack for General Service



PNEUMATIC LIFTING JACK

The small lifting jack shown is built by the Baird Pneumatic Tool Co., Topeka, Kan., for the various small jobs that occur around shop or yard. It has a minimum height of 10½ in. and with piston extended is 16 in. high. It may be operated by an ordinary automobile tire pump or from shop air connections. A central telescoping piece can be raised 2 in., making the total height 18 in. For the sake of additional safety holes are drilled crosswise through the piston and the telescoping piece, so that the latter may be locked with a pin when raised. The jack weighs 10½ lb.

* * *

Improved Tracing Cloth

A new and improved tracing cloth, bearing the trade name "Stirling," is being imported by the Defiance Manufacturing Co., 22 East 42nd St., New York City, the company being exclusive sales agents. After long research the makers developed for the fabric a coating that requires the use of no powder on the cloth before inking. The cloth is claimed to be 30% more transparent than the market standard, and tests have shown that up to six erasures may be made before re-inking is impossible. The price is about 10% under that of the standard cloths. It is reported that the British Indian Government has used 22,000 rolls in a year.

* * *

Ingersoll-Rand to Make Condensing Plants

The Ingersoll-Rand Co., 11 Broadway, New York City, is offering complete steam-condensing plants for all services. The equipment includes the "Beyer" barometric condenser, for which the company has secured the patent rights, "Imperial" duplex and "Ingersoll-Rogler" straight-line reciprocating dry vacuum pumps and, where required, "Cameron" simplex and centrifugal pumps.

The "Beyer" barometric condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air-removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle-plates. The noncondensable air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water and removed before it mixes with the steam.

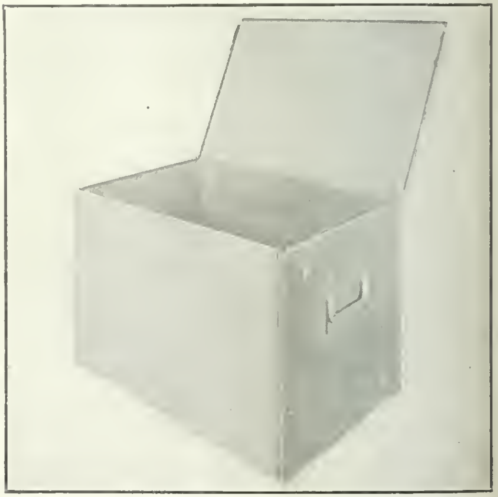
The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser. The vacuum and water pumps are independently operated and regulated to meet varying water temperatures.

* * *

Collapsible Steel Freight Container

A steel container for package freight has been placed on the market by the Pneumatic Steel Corporation of Norfolk Downs, Mass. The material of which the sides are made is formed of three thin steel sheets, with the two outside ones sweated on the middle sheet, which is corrugated. Protected hinges run the entire length of the ends and sides, enabling it to be knocked down to a thickness of ¾ in. There is a locking device and each shipper or owner can be provided with a private lock if desired. The handles are flush with the ends, and space is provided in the handle recesses for placing shipping instructions. The box can be manufactured in any desired size. Its first cost is high when compared with wooden boxes, but its strength and convenience make it worth considering in many instances.

The strength of this box was recently demonstrated in the testing laboratory of the Massachusetts Institute of Technology. For comparative purposes a standard wooden box used by the American Sugar Refining Co., made of ⅝-in. hemlock with ⅞-in. pine cleats 2 in. wide around the edges, was selected to be tested equally with a steel box of the same inside dimensions, 13⅞x19⅞x14⅜ in. The weight of the wooden box was 11.5 lb., and of the steel box 21.2 lb. The boxes were filled with 120 lb. of sugar in 60 two-pound cartons.



COLLAPSIBLE STEEL FREIGHT CONTAINER

When pressure was applied at the diagonally opposite corners, the steel box proved to be ten times as strong as the wooden box. When filled with sugar and dropped 3 ft. upon a concrete foundation two times, the wooden box was demolished and the contents badly damaged on the first test, while the steel box showed only slight injury at the corner and none of the pasteboard cartons was injured after the second test. Further tests still further proved the excellence of the steel container.

Engineering News

VOLUME 76 JULY 13, 1916 NUMBER 2

Tests of Large Bridge Struts Reveal New Facts

Important new facts about columns have been learned from the results of tests on eighteen very large bridge columns that were tested to failure on the 5,000-ton testing machine of the United States Bureau of Standards at Pittsburgh. Abnormal bridge steels were represented in the tests, ranging from hard or high-carbon steel to silicon steel, the most recent bridge material. The results stand out prominently as a further demonstration of the conclusion drawn from previous tests of large columns, namely, the failure point is at or very near the yield point of the metal. An absolute check on this fact is not obtainable because the Bureau investigated the metal only for its tensile yield point, and did not determine the compressive properties. The detail construction of the columns was found to have so marked an influence on the manner of failure that this feature dominated the tests. Only twelve out of the eighteen test columns showed integral bending; the other six failed by local crippling. Unsuspected weaknesses in pin jaws and latticing were revealed. A full report on the tests, prepared by J. H. Griffith and J. G. Bragg, has been submitted to the Director of the Bureau of Standards. The present notes are from a very brief summary of the report.

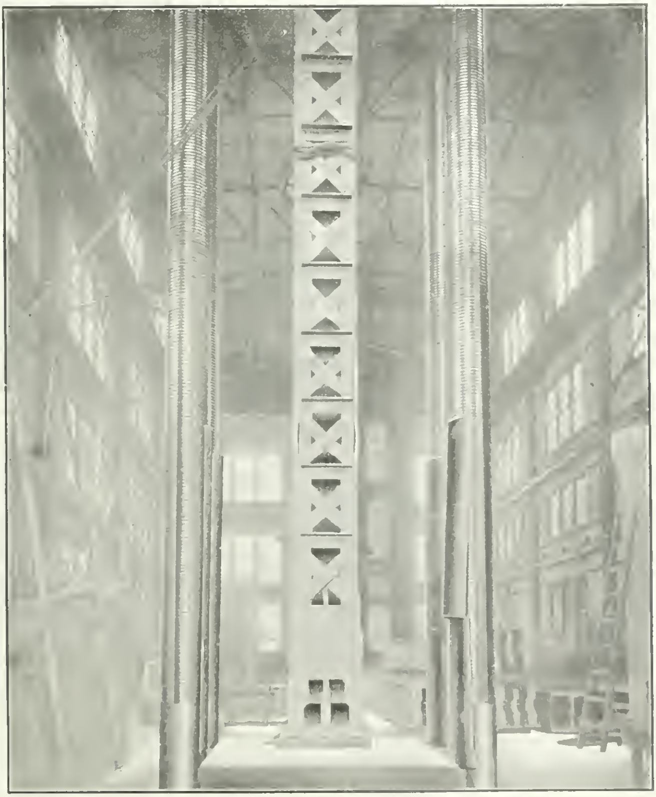
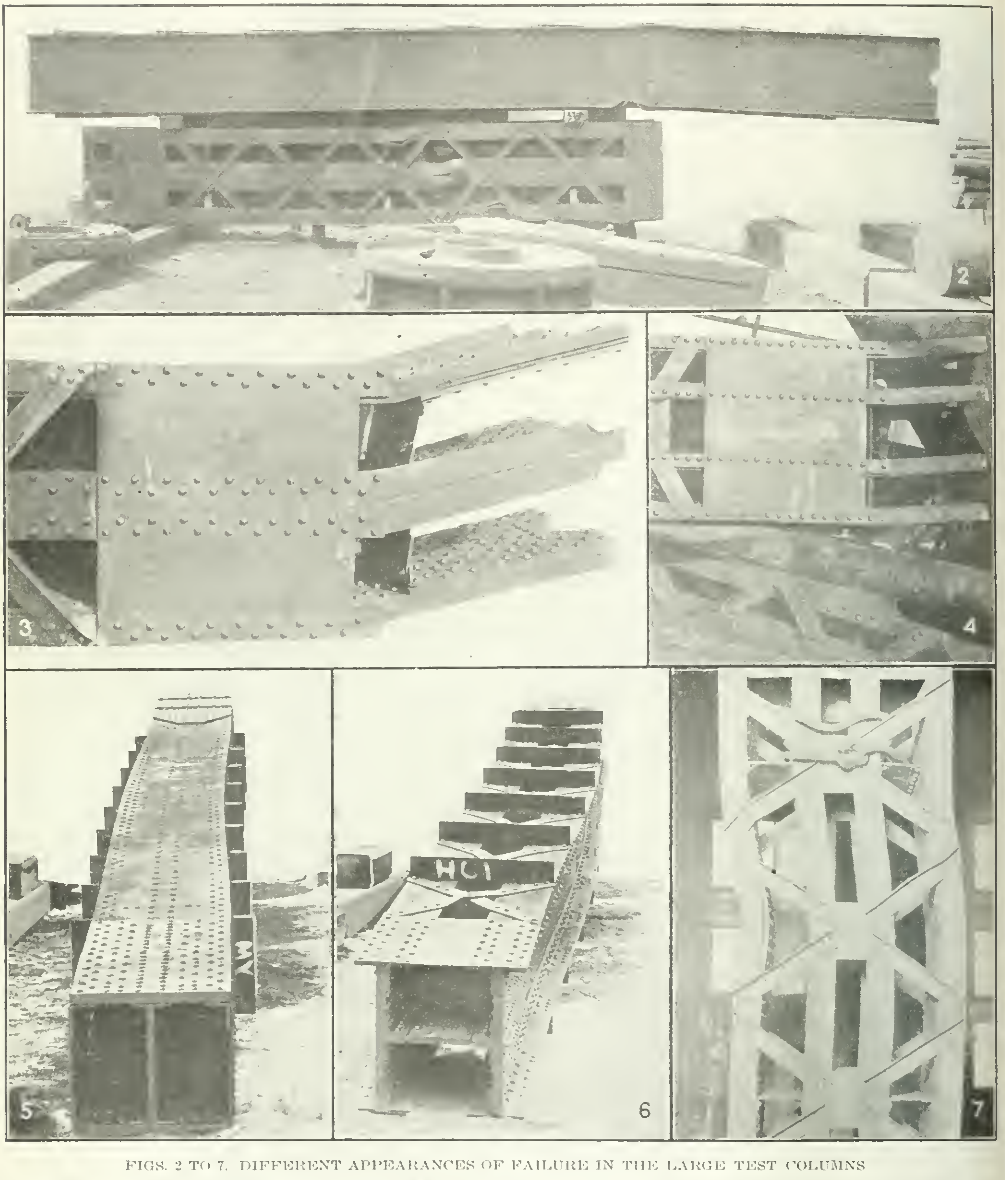


FIG. 1. THE BUREAU OF STANDARDS 5,000-TON TESTING MACHINE AT PITTSBURGH

A high-carbon steel column under test. Restrained lattice Buckling of diagonals has begun

The test objects were half-size models of compression members of three very large bridges—two now under construction, one recently completed. None of these models were made of ordinary "bridge" steel; they were built of nickel steel, Mayari steel, chrome steel, silicon steel and high-carbon steel. The chemical compositions are tabulated alongside the test results, Table 2. The columns ranged in length from 16 ft. to 24½ ft., in cross-section from 42 to 119 sq.in., and in slenderness-ratio from 15 to 44. Important details of construction differed in the several columns. Some had pin jaws at the ends, involving the usual absence of lateral bracing or staying of the thin end sections. Some columns had simple crossed lattice, while others, particularly those of the Metropolis Bridge, had transverse struts between successive sets of lattice bars. The columns were tested in vertical position. Deformation was measured by 80-in. extensometers clamped to the four corners at midlength. Numerous measurements were taken also on 8- and 16-in. gage lengths, on shaft, lattice bars, pin plates, diaphragms, etc.

Supplementary tests were made on small specimens, to obtain information on the qualities of the material and to study the effects of additional strain from fabrication



FIGS. 2 TO 7. DIFFERENT APPEARANCES OF FAILURE IN THE LARGE TEST COLUMNS

Fig. 2—Two typical body failures; local buckling of plates and angles with distortion of lattice. Figs 3 and 4 Buckling of pin jaws at end of laterally supported part. Figs. 5 and 6. Integral bending of column fitted with transverse stay members in the lattice. Contrast with Fig. 7. showing local buckling

Of the eighteen columns twelve failed as integral members, by bending in the body, as though they were of solid cross-section. The four columns with pin jaws failed by bending of the jaws. Two columns failed in the plane of greatest theoretical strength, distorting in the body.

No influence of column length was discernible in the results, as might be expected from the low values of slenderness-ratio and the small range under test. The bending at failure in the views is exaggerated; the load was increased to get enough distortion for a good picture.

Deflections first became visible at loads close to the maximum load, and increased to an inch or two as the loading progressed.

The average of the loads at failure is practically identical with the mean yield-point of the component steels (only $\frac{1}{2}$% deviation). More usefully stated: The curve of ultimate strength is practically confined to the zone between the curves of high and low extremes of the tensile yield-points for the specimens (each column, being composite, contains material of different yield-points.

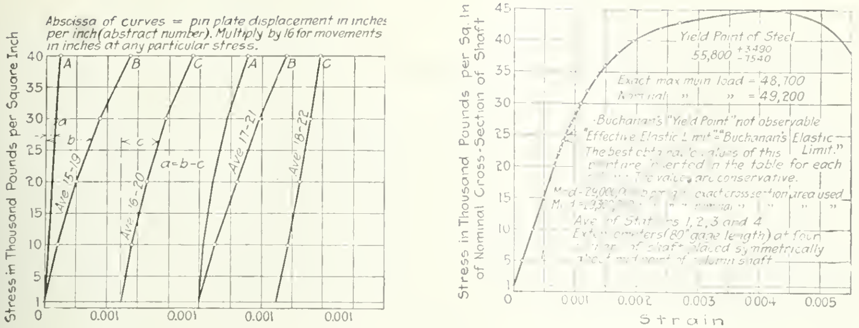


FIG. 8. TYPICAL CURVES OF TEST RESULTS

A typical load-deformation curve is given in Fig. 8. This shows a very straight lower portion and a gradually curving upper portion. The junction of the two portions is the elastic limit of the column. For the twelve columns that failed by integral bending the elastic limit averaged 48½% of the maximum load. The authors of the report believe, however, that the elastic limit was unfavorably influenced by initial strains from riveting and by

TABLE 1. DIMENSIONS AND MAKE-UP OF THE TEST COLUMNS

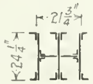
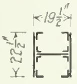
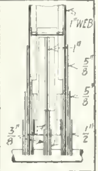
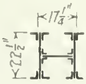
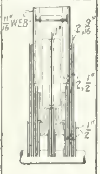
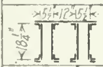
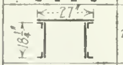
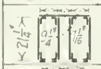
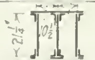
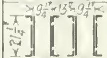
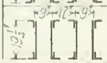
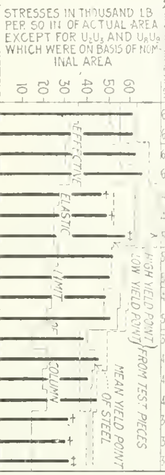
Bridge	Name of Column	Steel	Manuf.	"L" Length Pin. Cen. to End	Ends		Cross Section of Shaft	Material of Shaft	Material at Pin End	Bracing of Shaft			Area Sq In		Radius of Gyration R		Slenderness Ratio = L ÷ R	
					Low. Pin, In.	Upp.				Lattice, In	Transv Diaphgms, In.	Battens at Pin, In.	Nominal	Actual	⊥ to Pin	∥ to Pin	⊥ to Pin	∥ to Pin
Municipal, St. Louis	U_2U_3	Ni	American Bridge Co.	15 ft - 8½ in. End Top Chord	7½	Square		2 OUT WEBS, 24"x ¾" 4 OUT LS, 4"x4"x 7/16" 1 CENT WEB, 24"x 11/16" 4 CENT. LS, 4"x4"x 5/16" 2 DIA. PLS 9½"x 5/16" 8 DIA. LS, 2"x2"x ¼"	IN ORDER FROM OUTSIDE FOR U_2U_3 ONLY 6 PLS. 7/16" THICK 2 PLS. ½" THICK 2 PLS. 7/16" THICK 2 WEBS ¾" THICK OUT 2 PLS ½" THICK 8 PLS. ⅜" THICK 1 CEN WEB, 11/16" THICK	2½ Chan (¼ web)	3 ¼ thick	¼ pls	88.8	no data	7.55	8.57	25.0	33.6
	U_8U_9	Ni		24 ft.-0 in. Center Top Chord	Square Pin not used			2 OUT. WEBS, 24"x 3/32" 2 SIDE PLS. 16"x 7/16" 4 OUT. LS, 4"x4"x 7/16" 1 CEN. WEB, 24"x 11/16" 4 CEN. LS, 4"x4"x 5/16" 2 DIA. PLS. 9½"x 5/16" 8 DIA. LS, 2"x2"x ¼"			3 5/16 thick	¼ pls	110.3	no data	7.78	8.97	37.0	32.1
Metropolis	HC	C	Penna Steel Co.	All 24 ft.-4 in. Upper End Post	7	Square		2 SIDE PLS. 22½"x1" 4 LS, 4"x 4"x ½" 1 DIA. PL. 17¼"x 7/16" 4 DIA. LS, 3"x3"x ⅜"		Transv 4x3x5/16 in angles diag 4x¼ bars	3 ¼ thick	¼ pls	76.14	74.58				
	MY	My											76.14	74.90				
	31HC	C	American Bridge Co.										75.99	76.94	6.73	8.46 for all	43.5	34.5
	32S	Si											75.99	76.94				
	34CS	Cr											75.99	76.94				
	HC1	C	Penna Steel Co.	All 24 ft - 4 in. Upper End Post	7	Square		2 SIDE PLS. 22½"x 11/16" 8 LS, 4"x 4"x ½" 1 DIA. PL. 15¾"x 7/16" 4 LS, 3"x 3"x ⅜"		Transv 4x3x5/16 angles diag 3x¼ bars	3 ¼ thick	¼ pls	76.46	75.35				
	MY1	My											76.46	75.28				
	31HC1	C	American Bridge Co.										76.26	77.17	7.60	8.05 for all	38.5	36.4
	32S1	Si											76.26	77.17				
	34CS.	Cr											76.26	77.17				
Memphis	US_2MS_1	C	Penna Steel Co.	15 ft - 10 in. Upper End Post	7	Square		1 COV. PL. 27"x ¼" 4 WEB PLS. 18"x 7/16" 8 LS, 3"x 2"x ⅜" 4 FLATS, 2"x ⅜"	EACH COL. RIB 1 PL. ½" OUTSIDE 1 PL. ⅜" INSIDE 1 WEB, 7/16"	Transv tie pls ¼, see cuts Diag bar 3x¼	4 ¼ thick	5/16 pl	55.17	55.97	6.61	9.05	28.7	21.0
	US_2MS_1	MY		15 ft -10 in Upper End Post				1 COV. PL. 27"x 7/16" 2 WEB PLS. 18"x ½" 6 LS, 3"x 3"x ⅜"	EACH COL. RIB 2 PLS. 9/16" OUT. 2 PLS. ⅜" IN. 1 WEB PL. ½"	Diags. 3x1¾x¼ angles	None	⅜ pl	42.47	41.66	6.87	9.78	27.7	19.4
	U_1M_1	C		23 ft - 6 in. Upper End Post	8½			1 COV. PL. 25"x ¼" 4 WEB PLS. 21"x 11/16" 8 LS, 4"x 3"x ½" 4 FLATS, 3"x ½"	EACH COL RIB 1 PL. ¼" OUTSIDE 1 PL. ½" INSIDE 1 PL. ⅜" INSIDE 1 WEB, 11/16"	Diags 3x1¾x¼ angles	6 ¼ thick	5/16 pl	96.01	95.77	7.80	9.25	36.1	30.5
	U_1-M_1	My		23 ft.-6 in. Upper End Post				1 COV. PL. 27"x ¼" 2 OUT. WEBS, 21"x 7/32" 4 OUT. LS, 4"x 3"x ½" 2 FLATS, 3"x ⅜" 1 CEN. WEB, 21"x 15/32" 4 CEN. LS, 4"x3"x ⅜" 1 FLAT, 6½"x ⅜"	OUTSIDE RIBS(2) 2 PLS. ½" 2 PLS 5/8" 2 PLS. 9/16" 2 PLS. ⅜"} CEN RIB(1) 2 PLS. 9/16"}	Diags 3x1¾x¼ angles	5 ¼ thick	5/16 pl	66.55	66.02	8.17	8.17	34.5	33.8
	LC_0-LC_1	C		15 ft.-6 in., bot chord at pier				4 WEBS, 21"x ¾" 4 SIDE PLS. 13"x ½" 8 LS, 4"x 4"x ½"	EACH COL RIB 3 PLS. ⅜" 1 WEB. ¾" 1 SIDE PL. ½"	Tie pls ¼ diag 3x1¾x¼ / 8	4 ¼ thick	5/16 pls.	119.00	118.18	6.74	12.14	27.6	15.[illegible]
	LC_0-LC_1	My		15 ft., 6 in., bot chord at pier				4 WEBS, 19"x 19/32" 8 LS, 4"x4"x ½"	EACH COL. RIB 3 PLS ⅜" 1 PL ½" 1 WEB PL 19/32"	Tie pls. ¼ diag 3x1¾x¼ angle	4 ¼ thick	5/16 pls	75.12	76.47	6.87	11.59	27.1	16.0

TABLE 2. SUMMARY OF RESULTS OF COLUMN TESTS



NAME OF COLUMN POSITION IN BRIDGE GIVEN ON TABLE NO. 2	MAXIMUM LOAD LB PER SQ IN OF NOMINAL AREA	MAXIMUM LOAD LB PER SQ IN OF ACTUAL AREA	COLUMN MODULUS LB PER SQ IN OF NOMINAL AREA	COLUMN MODULUS LB PER SQ IN OF ACTUAL AREA	TYPE OF STEEL
U_2U_3	61,700[1]	*	28,600,000[1]	*	NICKEL
U_8U_9	61,400		[illegible]		
MY	[illegible]	[illegible]	[illegible]	29,000,[illegible]	MAYARI
MY1	64,700	65,[illegible]	[illegible],800,000	31,300,[illegible]	
US_2MS_1	[illegible]	[illegible]	[illegible]	[illegible]	
U_2M_1	[illegible]	49,700	[illegible]	[illegible]	
LC_0LC_1	[illegible]	57,900	30,800,[illegible]	30,300,[illegible]	
32S	52,800	[illegible]	[illegible]	[illegible],000,000	SILICON
32S1	[illegible]	[illegible]	[illegible]	29,50[illegible]	
34CS	[illegible]	48,700	[illegible]	[illegible]	CHROME
34CS1	51,[illegible]	51,200	29,900,000	29,600,[illegible]	
HC	38,400	39,200	§	§	HIGH CARBON
HC1	45,30	45,900	28,900,000	29,400,000	
31HC	41,700	[illegible]	29,100,000	[illegible]	
31HC1	46,500	46,000	29,100,000	28,800,000	
US_2MS_1	34,300	33,800	29,300,000	29,400,000	
U_2M_1	31,000	31,200	29,500,000	29,600,000	
LC_0LC_1	32,400	32,700	30,400,000	30,600,000	

	Name of Column	Chemical Tests Elements, % Ni	C	P	Mn	S	Si	Cr	Cu	Physical Tests Yield Point Mean	High	Low	Break Load Mean
Municipal Bridge, St. Louis	U_2U_3	3.51	0.29	0.014	0.59	0.031				55,500	63,100	50,500	93,300
	U_8U_9	3.59	0.32	0.015	0.59	0.033				55,200	63,100	52,040	93,060
Metropolis Bridge	HC		0.36	0.012	0.43	0.030				40,700	50,000	37,590	76,660
	HC1		0.36	0.012	0.40	0.030				44,100	50,000	37,650	75,930
	MY	1.12	0.34	0.010	0.68	0.037	0.10	0.53	0.10	59,900	68,380	55,890	100,610
	MY1	1.12	0.34	0.010	0.68	0.037	0.10	0.53	0.10	62,110	68,380	56,080	101,17
	31HC		0.28	0.017	0.64	0.031				42,900	45,440	37,280	73,400
	31HC1		0.28	0.017	0.64	0.031				42,700	45,440	37,280	74,400
	32S		0.35	0.017	0.83	0.039	0.38			57,200	58,840	51,940	87,700
	32S1		0.35	0.017	0.83	0.039	0.38			56,500	57,480	51,940	88,300
	34CS		0.31	0.017	0.49	0.028	0.13	0.66		55,800	59,290	48,260	82,700
	34CS1		0.31	0.017	0.49	0.028	0.13	0.66		54,200	58,010	48,260	83,600
Memphis Bridge	US_2MS_1 carbon		0.23	0.012	0.49	0.027				41,740	43,700	40,250	65,420
	US_2MS_1 Mayari		0.33	0.016	0.64	0.027		0.37		62,430	72,160	52,000	99,800
	U_2M_1 carbon		0.23	0.012	0.49	0.029				41,740	43,700	10,250	65,420
	U_2M_1 Mayari		0.33	0.016	0.64	0.027		0.37		62,830	72,160	52,000	99,800
	LC_0LC_1 Carbon		0.23	0.012	0.49	0.029				41,740	43,700	40,250	65,420
	LC_0LC_1 Mayari		0.33	0.016	0.64	0.027		0.37		62,430	72,160	52,000	99,800

* Scale weights not available for getting exact cross-sectional areas of shafts.
† Columns failed by local bending at end, as in Fig 2.
‡ Columns failed as indicated in Fig 3. Remaining members developed the strength as a unit.
§ Excluded in modulus determinations on account of the few observations taken within limits of proportionality. The 15 columns not marked (* §) were used for modulus calculations. Each stress and strain reading was treated as an observation.

crimping or local buckling of the shapes under increasing load.

In the ten columns of the Metropolis Bridge, all identical as to length and cross-sectional area, five of the specimens were built as H-sections in which each rib was a built channel with web and two flange angles, while the other five had in addition outer flange angles (and somewhat thinner web materials to keep the total-cross-section the same). Of the former set, four failed below the yield-point of the metal, while of the second set only two failed below the yield point. In other words, the columns with I-ribs were stronger than those with channel-ribs.

Transverse Members in Lattice

The Metropolis Bridge columns all had transverse bars at the panel-points of the lattice, and the lattice was double. More uniform bending of the columns was obtained and all sharp bends in the ribs eliminated. All these members failed with the smooth-integral-deflection curve exhibited in Figs. 5 and 6.

All the pin-plate observations indicate slight movement of one pin plate over the other. The intensity of the stress just over the pin probably accounts for this slip.

The modulus of elasticity of fifteen columns out of the eighteen averaged 29,600,000 lb. per sq.in., with a probable error of 120,000.

The coefficient of lateral expansion of the steel was found to be approximately the same as that of plain steel, the range being from 0.291 to 0.327, with a mean of 0.30.

⁂

Chicago Station Has 45,000-Hp. Steam Turbine

A 45,000-hp. (30,000-kw.) steam-turbine generating unit has recently been put into service in the Northwest station of the Commonwealth Edison Co., of Chicago. The following details of this huge unit are taken from an article in *Power*, June 20, 1916:

This machine is known as Unit No. 3 and has high- and low-pressure turbine elements on one horizontal shaft with the generator rotor (coupled sections).

Steam is carried in a 20-in. header from a battery of five boilers; in the high-pressure chest there are 14 admission valves all under control of the governor. There are also four overload valves discharging into the fourth stage. In passing through the high-pressure element the steam is expanded to 7 lb. below atmospheric pressure; it then enters the center of the low-pressure element and

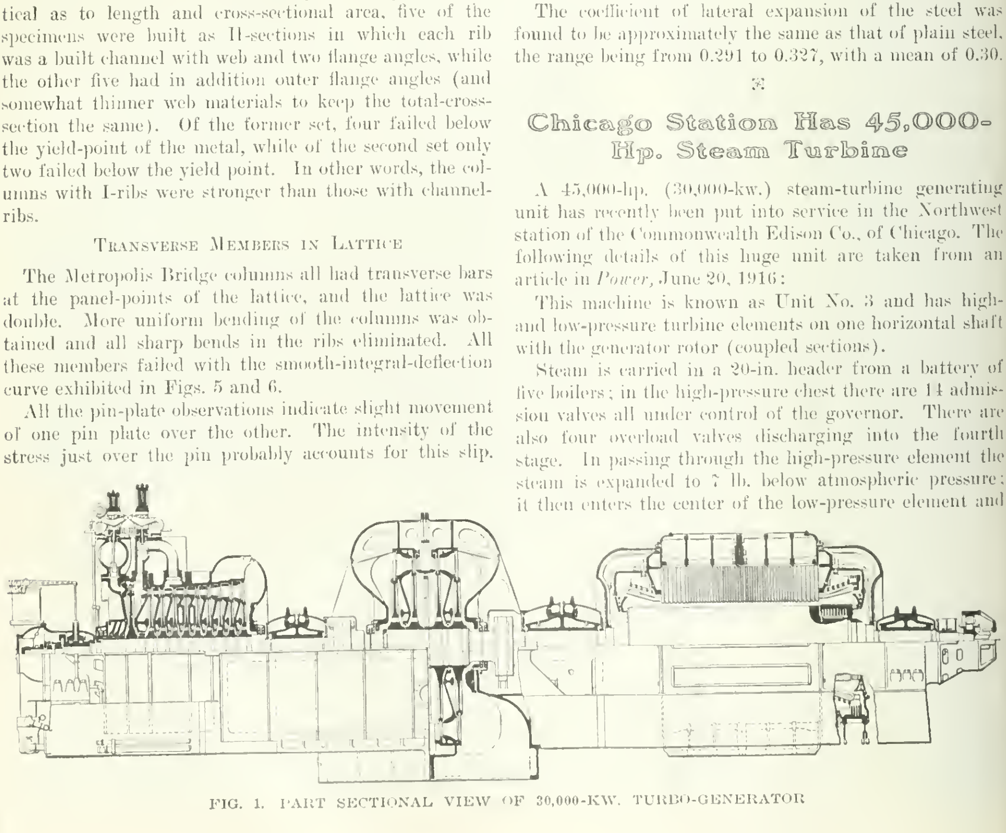


FIG. 1. PART SECTIONAL VIEW OF 30,000-KW. TURBO-GENERATOR

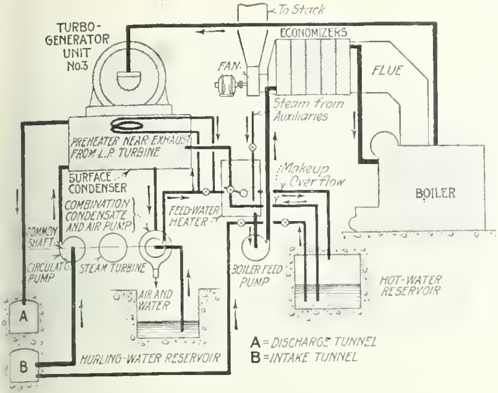


FIG. 2. DIAGRAMMATIC SKETCH OF STEAM AND WATER CIRCUITS

PRINCIPAL DATA ON EQUIPMENT OF UNIT NO. 3

Turbine

Maker	General Electric Co.
Type	Horizontal compound
Capacity, hp.	45,000
Number single stages, h.-p. element	10
Number of double stages, l.-p. element	2
Speed, r.p.m.	1,500

Condenser

Maker	Wheeler Condenser and Engineering Co.
Number of tubes	11,000
Size of tubes, in.	1
Surface in condenser, sq.ft.	50,000
Surface per kilowatt of generator rating, sq.ft.	1.67
Capacity, lb. of steam per hr.	360,000
Steam condensed per square foot of surface, lb.	7.2
Weight of condenser, empty, tons	176
Weight of cooling water in condenser, tons	66.5
Circulating-pump capacity, gal. per min.	52,000
Circulating-pump capacity, lb. per hr.	26,000,000
Cooling water per pound of steam, lb.	72
Condensate pump, gal. per min.	1,200

Generator

Maker	General Electric Co.
Capacity, rated	30,000
Voltage	9,000
Frequency, cycles	25
Speed, r.p.m.	1,500
Number field poles	2
Length complete unit, over-all ft.	59.5
Width, ft.	18.33
Floor area cover, sq.ft.	1,091
Area per kilowatt of generator rating, sq.ft.	0.036
Exciter voltage	220

Boilers

Maker	Babcock & Wilcox Co.
Type	Cross-drum, water-tube
Pressure, lb. per sq.in. gage	230
Superheat, deg. F.	200
Temperature of steam, deg. F.	600
Number of boilers in unit	5
Number of tubes per boiler	588
Diameter of tubes, in.	4
Length of tubes, ft.	18
Steam-making surface in boiler, sq.ft.	12,200
Stokers per boiler	2
Type of stoker	B. & W. chain-grate
Active area of two stokers, sq.ft.	273
Ratio grate area to boiler-heating surface	1 to 45
Per 1,000 sq.ft. of boiler-heating surface:	
Connected grate area, sq.ft.	22.3
Stack area, sq.ft.	4.17
Economizer surface, sq.ft.	538.2
Capacity of each boiler, lb. steam per hr.	85,000
Evaporation per sq.ft. of heating surface, lb.	7
Coal capacity of each boiler, lb. per hr.	12,600
Coal per square foot of grate, lb.	46
Size of steam main to turbine, in.	20
Boiler-feed pumps:	
Maker	Henry R. Worthington
Type	Turbine driven, three-stage, double-suction impeller
Capacity, lb. per hr.	450,000
Speed, r.p.m.	2,500
Water temperatures:	
In feed-water heater, deg. F.	100–120
Leaving economizer and entering boiler, deg. F.	270

Economizers

Maker	B. F. Sturtevant Co.
Type	High-pressure
Number of economizers	5
Number of tubes in each	456
Length of tubes, ft.	12
Heating surface in tubes	6,566
Maker	B. F. Sturtevant Co.
Type	Multivane
Capacity, cubic feet hot gases per min.	90,000
Horsepower of motor	100
Draft in boiler uptake, in. of water	2.4
Height of stack above boiler-room floor, ft.	250
Diameter of stack, inside, ft.	18

flows in opposite directions through double stages on either side and finally goes to the condensers. The steam and water circuits are shown diagrammatically in Fig. 2.

The shaft has a maximum diameter of 24 in. and is supported by four bearings. The latter are water cooled by pipes embedded in the babbitt; oil is supplied by forced circulation. The generator is a three-phase 25-cycle 9,000-volt machine rated for 30,000 kw. at 100% power factor (but it has carried 35,000 kw. with moderate temperature rise). A 220-volt exciter is mounted on the end of the main shaft.

The condenser is a two-pass surface type maintaining vacuum within ½ lb. of absolute. It will take 360,000 lb. of steam per hour, or 7.2 lb. per sq.ft. normally; the maximum steam-condensing capacity is 400,000 lb. The circulating water is drawn from an intake tunnel by a 48-in. double-suction tri-rotor pump driven by a 650-hp. noncondensing turbine. The normal hourly quantity of circulating water is 3,120,000 gal. On first entering the condenser the steam comes in contact with the preheating feed-water tubes. Air and condensate are taken from the condenser through a single outlet by a turbo air pump on the shaft with the circulating pump. In a separating chamber the air turns off into a separate compartment and is discharged by separate impellers. From Fig. 2 it is seen that the condensate passes from the heater to two turbine-driven boiler-feed pumps, thence to the economizers above the boiler and to the boilers. The accompanying table shows the principal data of turbines, condenser, generator and boilers for Unit No. 3.

⁂

Inaccurate Estimate Vitiates Time-Penalty Clause

The firm of Winston & Co., contractors, built a dam and reservoir for the City of Pittsfield, Mass. In the preliminary estimate of quantities placed in the sheet sent out for the information of bidders the quantity of earth excavation in stripping was estimated at 37,000 cu.yd. In actual construction the stripping amounted to 95,877 cu.yd. This increase developed gradually during the working season and could not be estimated in advance, as the engineer designated from time to time the depth to which the stripping was to be carried.

The contractors failed to complete the work on the specified date, and the city deducted liquidated damages of $75 per day for the time in which the contractors were delinquent. The latter brought suit for this amount, holding that the great discrepancy between the estimated quantity and the actual quantity of earth and other materials was the cause of the delay and that they should be relieved from the time requirement, which was based on the quantities in the original estimate. The case was tried before the United States District Court in Boston, Mass., Judge Morton presiding. The judge in his decision said:

> We have here a contract to do work the extent of which neither party knew when the work was begun. They had a rough-and-ready estimate which was nowhere near the facts. If the defendant chose to make that sort of indefinite contract, I do not think that he can hold the plaintiff to the penalty and liquidated damages if the work was not done on time. If the defendant wanted to hold onto that, I think it was the defendant's place to familiarize himself with the extent of the work in hand and give directions.

It should be mentioned that this was a preliminary decision, in which the case was placed in line for a jury trial of the question at issue.

Anchor-Bolt Holes Drilled by Gasoline-Air Outfit

By H. L. Hicks*

The New York Edison Co. has under construction an electric transmission line from Elmsford to Croton Lake, N. Y., a distance of 18 mi. For the greater part of its length it follows the line of the Catskill Aqueduct, and this eliminated the work of clearing the right-of-way.

The latticed steel towers are to be spaced at 100-ft. intervals and will be 60 ft. in height, except at angles and curves in the line where 70-ft. towers will be erected. The foundation work has been in progress for the past six months. The towers are to be bolted to 6-ft. steel anchor bolts, or "stubs," embedded in reinforced concrete. These stubs are 2 in. in diameter and are without heads, dependence being placed upon the holding power of the corrugated surface. The right-angle flanges to which the towers will be bolted are 3 in. wide by 12 in. long and are drilled for six ¾-in. bolts.

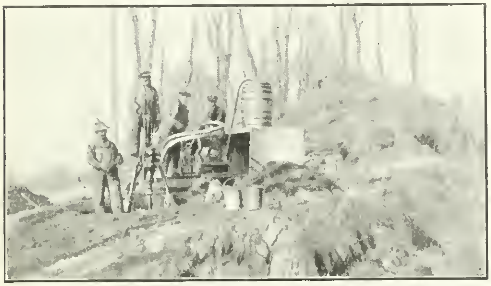


FIG. 1. SHOWING ROUGH GROUND OVER WHICH DRILL HAD TO BE TRANSPORTED

In laying out the line it was found that at 12% of the locations rock would be encountered. This necessitated setting many of the stubs in solid rock and drilling large-diameter holes up to 5 ft. in depth.

The large amount of hole drilling made it advisable to employ machine drills, and the Ingersoll-Rand "gasoline-air" drill was selected for the work.

This is the first recorded installation of this type of drill in this section of the country. The gasoline-air drill (Fig. 1) consists of a tripod-mounted piston drill operated by a pulsator similar to the Temple-Ingersoll electric-air outfit. The pulsator in this case is driven by a 6-hp. single-cylinder gasoline motor which with fuel tank and pulsator is mounted on a small wheeled truck. The drill is reciprocated by pulsations of air acting in a closed circuit on alternate sides of the drill piston.

The pulsator unit weighs about 600 lb., the comparative lightness and compactness being a great advantage under the conditions.

For convenience in handling on soft ground the truck mounting the engine and pulsator was fastened to skids (Fig. 2) and a removable wooden housing provided as a protection from the weather. The entire outfit was transported by wagon.

Bedrock was uncovered and the drill set up in the excavation. Particular care in setting up was necessary to keep the drill perpendicular and the four holes accurately spaced. The rock was very seamy. If the hole started to run off, pieces of iron were wedged around the drill steel to correct this.

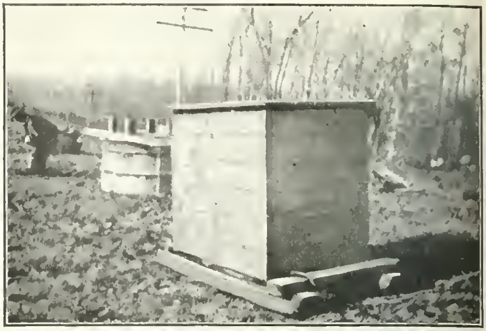


FIG. 2. ENGINE AND PULSATOR ON SKIDS FOR EASIER MOVING

Collapsible steel forms were set up, the stubs were grouted in the drill holes and the concrete then poured. The anchoring stubs were spaced 2½ ft. each way, being located by a templet and so held in place until the concrete had set (Fig. 3).

The circular concrete foundation is 3 ft. 10 in. in diameter with a hollow core 2½ ft. in diameter and projects 6 in. above the ground. This center space is subsequently filled with spoil. Where no rock is encountered, the concrete is extended to a full depth of 5 ft.

Observations of the performance of the gasoline-air drill in drilling a group of four holes showed a total of 21 ft. of drill hole in 4 hr., including the time of changing set-up and squaring the layout of holes. These observations were made on a day when the temperature ranged from 10° at 8 a.m. to 21° at noon. The fuel consumption averaged 1 gal. of gasoline and ⅕ pt. of oil per 10 ft. of drill hole. Crossbits were used, with drill holes bottoming at 2¾ in. The labor expense consisted of a drill runner at $2.50, a helper at $2.00 and an engine operator at $2.50 per day.

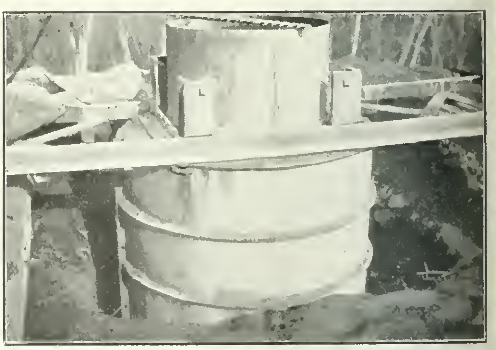


FIG. 3. FOUNDATION FORMS AND TEMPLET IN PLACE FOR POURING

The drill is operated intermittently, and the drill crew is employed part of the time on other work. It is therefore rather difficult to arrive at any accurate estimate of the operating cost per foot of drill hole.

The erection of the steel towers is progressing, and the line is being rapidly pushed to completion.

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*With Ingersoll-Rand Co., 11 Broadway, New York City.

Precise-Level Survey of the City of Portland, Ore.

By W. P. Hardesty*

SYNOPSIS—With city area of over 65 sq.mi. and hilly country—over 1,000 ft. difference of elevation—Portland lacked benchmarks. In a comprehensively planned survey over 2,000 bronze tablets and iron-pipe benchmarks were set, their elevations determined by precise levels and a full list published. The cost of the work was very low—net, about $4 per benchmark.

Portland had never had a comprehensive system of levels over any part of the city. The survey to be described was undertaken because of the inferior system of benchmarks, both as regards permanency and accuracy, that already existed. As there was considerable variation in different portions of the city and as there were but few really permanent marks, the survey included the accurate determination of points in widely scattered districts and also the establishment of what might be called "working benchmarks." The main result desired was the provision of thoroughly good, permanent, definite, easily located and accessible benchmarks, so distributed that one could be picked up in any locality where either preliminary surveys or improvement work was under way or was likely to be done.

The project was authorized by the city council and an appropriation made under the head of "Permanent Works." The survey to be made was officially named the "Bench-Level Survey." An outline of the system, methods and working rules, together with plans of standard benchmarks to be manufactured, was developed by the writer and approved by Robert G. Dieck, Commissioner of Public Works.

EQUIPMENT AND METHODS OF SURVEY

Equipment—Two precise levels were made to order for the work by Leupold & Voelpel, Portland. These are not Y-levels. The cost of each complete, with metallic mirror

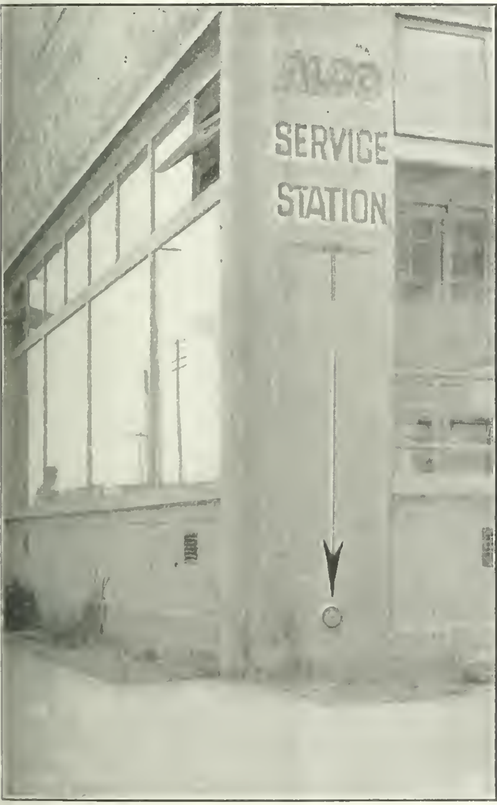

FIG. 1. TABLET BENCHMARK, CLASS A, IN CONCRETE WALL OF GARAGE

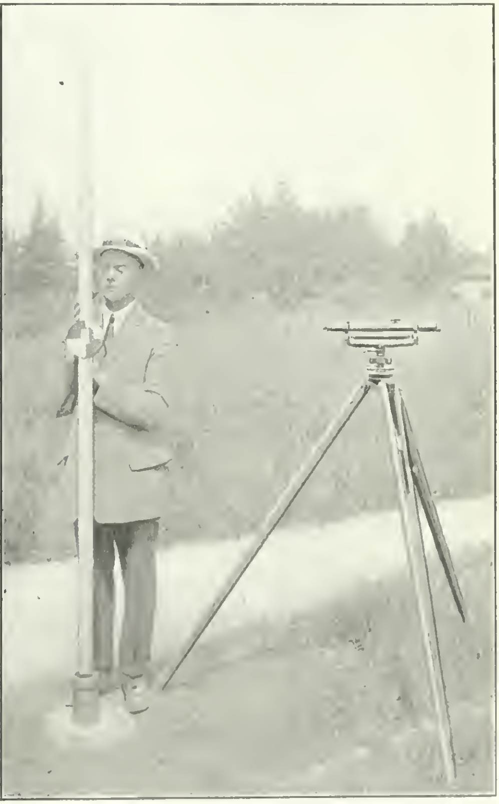

FIG. 2. IRON-PIPE BENCHMARK, SIZE I, WITH INVERTING PRECISE LEVEL ALONGSIDE

for reflecting level-vial scale, was $168. The instruments were made according to rigid specifications. One is erecting (18¼-in. length) and the other inverting (17½-in. length). Tripod heads with four leveling screws were used with these instruments.

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*Chief, Bureau of Surveys and Drafting, Department of Public Works, Portland, Ore.

There were also purchased two 10-ft. precise-level rods figured directly and two others with the figures inverted. These rods were in one piece, with a circular level mounted on the rod and a target reading by vernier to thousandths. The cost of the four rods delivered in Portland (manufactured in Seattle) was $75. The cost of smaller tools and items of equipment brought the total cost of the field outfit up to $427.50.

Ordinarily only one level, the inverting one, has been used, and all the work has been done by one party, as it was not thought justifiable to employ two crews on the survey, although the equipment had been purchased for two.

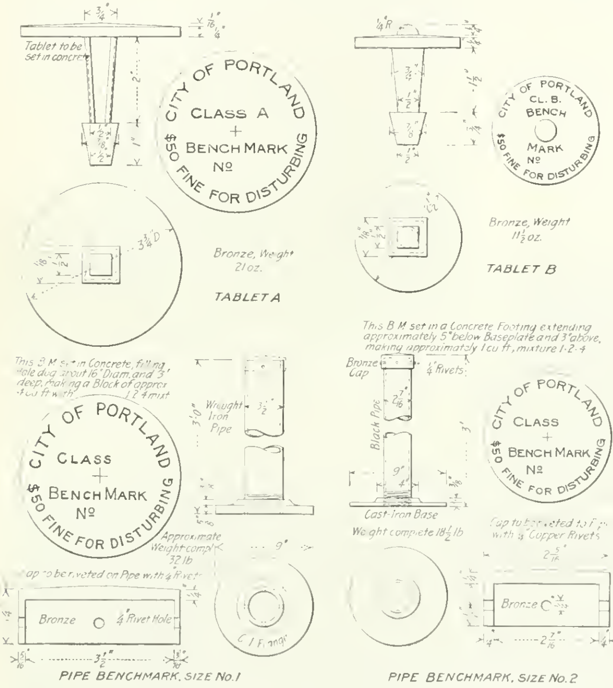
Tablet to be set in concrete
CITY OF PORTLAND
CLASS A
BENCH MARK
Nº
$50 FINE FOR DISTURBING
Bronze, Weight 21 oz.
TABLET A
CITY OF PORTLAND
CL. B. BENCH MARK
Nº
$50 FINE FOR DISTURBING
Bronze, Weight 1½ oz.
TABLET B
This B M set in Concrete, filling hole dug about 16" Diam. and 3' deep, making a Block of approx 4 cu ft with 1 2 4 mixt
CITY OF PORTLAND
CLASS
BENCH MARK
Nº
$50 FINE FOR DISTURBING
Wrought Iron Pipe
3'0"
Approximate Weight compl 32 lb
Cap to be riveted on Pipe with ¼ Rivets
Bronze
¼ Rivet Hole
3½"
C I Flange
This B M set in a Concrete Footing extending approximately 5" below Baseplate and 3" above, making approximately 1 cu ft, mixture 1-2-4
Bronze Cap
¼" Rivets
Black Pipe
2 7/16"
9"
4"
3'
Cast-Iron Base
Weight complete 18½ lb
CITY OF PORTLAND
CLASS
BENCH MARK
Nº
$50 FINE FOR DISTURBING
Cap to be riveted to Pipe with ¼" Copper Rivets
2 5/16"
Bronze
2 7/16"
PIPE BENCHMARK, SIZE No. 1
PIPE BENCHMARK, SIZE No. 2

FIG. 3. DIFFERENT TYPES OF BENCHMARKS IN PORTLAND PRECISE-LEVEL SURVEY

Organization of Party—The party consisted of the levelman and three rodmen. The rodwork was done by two rodmen in the customary manner for precise-level work, while the third rodman carried the instrument box and smaller pieces of equipment and stayed with the instrumentman and kept a full set of peg levels as they were read.

In addition, each rodman kept a record of all the sights taken on his rod, so that the combination of the two afforded an additional full set of levels. The length of each level sight was also measured with the stadia wires of the instrument and recorded, and the sums of backsights and foresights were occasionally equalized.

Limits of Error—Nearly the same standards were adopted for the survey as are used on the United States Coast and Geodetic Survey and on the precise levels of the United States Geological Survey, except that a much greater allowance of error was considered permissible on lines with a large range in elevation than in comparatively level country. The following limits were adopted: On lines with range of elevation not exceeding 100 ft. per mi., $0.025\sqrt{\text{miles run}}$; with range of 100 to 200 ft. per mi., $0.035\sqrt{\text{miles run}}$; 200 to 400 ft., $0.045\sqrt{\text{miles run}}$; over 400 ft. per mi., $0.055\sqrt{\text{miles run}}$. "Range of elevation" means the total rise or fall, or the sum of the two where there were both. The work, as a rule, came far within the foregoing limits of error, and only one or two lines had to be re-run. The datum plane adopted was that of the United States Geological Survey, a shift of about 2½ ft. from the old datum.

Before beginning the work the city was subdivided into 30 nets, varying in size and shape. The boundary of each net was first run in the forward direction and then the levels run in the reverse direction, so as to have a complete check on everything. After this were run the subdivision lines, which were termed crosscuts. Benchmarks of all kinds were established on the crosscuts as well as on the boundaries, or routes. The nets were platted on a map drawn to a 1,250-ft. scale, and the outlines of each one were plainly marked.

There were two general types of manufactured benchmarks used—(a) bronze tablets and (b) sections of wrought-iron pipe surmounted by a bronze cap. Of the tablets (see Fig. 3), Class *A*, the larger, is intended for the more permanent locations, such as in or on concrete walls, on bridge abutments, etc. Class *B* is placed in the more available locations, generally in concrete curbs, sometimes in concrete walks or on walls. A benchmark placed in a wall (as Class *A* more commonly was) is not nearly so convenient to use, because it requires a knife or carpenters' chisel to support the level rod.

The iron-pipe benchmarks were of two sizes, the design being nearly the same. Size 1 was first used, but it was decided to be unnecessarily large and expensive, so that after the first order of 50 was used up a smaller one (size 2) was adopted. Either one may be set in concrete (either in a footing or to nearly the full height) or may be planted in earth only.

These four kinds of benchmarks were designed after careful study of those used by the United States Geological Survey and of those adopted by Cincinnati and Pittsburgh, and they are believed to be improvements on all of these.

All of size 1 pipe benchmarks were set in concrete reaching to within about 6 in. of the top, the block of concrete thus containing over 4 cu.ft. So substantial are they that one in firm earth could well serve as a mooring post for a steamboat.

The first cost of the benchmarks (in lots of 30 to 100) was as follows:

	Each
Tablets, class A	$0.60
Tablets, class B	.30
Pipe, size 1	2.20
Pipe, size 2	1.75

In the case of the latter it was found that the total cost of size 1 in place (including the benchmark itself, labor of setting, team hire in transportation and cost of cement, sand and gravel) ran about $5 each, while that of size 2 ran about $3.

During the latter part of the survey a number of the smaller size were set without concrete, and these were called Class *B*. These, firmly planted in a hole and with the earth well tamped to above the ground, are believed to be more substantial than those of the United States Geological Survey (all similarly set), as the latter merely have the bottom of the iron pipe split to widen the base, while the Portland benchmark has a cast-iron base of 9-in. diameter screwed onto the bottom of the pipe. This gives a broad, flat base and also renders the tamped backfilling more effective.

All the pipe benchmarks were set with the top 6 to 10 in. above the ground.

Placing the Benchmarks—One of the first steps in the work was starting an instrumentman on a reconnoissance of the city (taking one net at a time) to select the best places for the benchmarks. His instructions covered the selection of suitable objects on which the tablets were to be set and of suitable spots for the pipes.

The matter of proper location and distribution of the sites was a vital one. The locator carried detail maps for each area in which he worked, and these showed all the established street-grade points. The frequency of benchmarks was logically greater in a rolling or hilly section than in a nearly flat one, for the convenience of future use. The instrumentman marked the points selected, using red bicycle enamel for concrete surfaces and stakes for the pipe sites. These marks and one copy of the duplicate loose-leaf notes taken describing the location were for the guidance of the benchmark setter later on. The other copy of the loose-leaf notes was for the level party.

It may be remarked that the frequency of benchmarks was largely dependent on the objects available for the tablets. In the localities not built up, especially those with very few sidewalks, dependence was placed mainly on pipes, and the number of these was necessarily limited.

The benchmark setter was a mechanic skilled in cement work. With a set of tools (small drills, chisels, single hammer, etc.) he made the rounds, drilling holes in the concrete surfaces selected and setting the tablets in a 1:1 cement mortar. For setting the pipes a wagon with team and driver was added for hauling the benchmarks, cement, sand, gravel and tools. The benchmark setter was often several weeks behind the reconnoissance man and at times was several months ahead of the level party.

To secure proper objects for the tablets and proper sites for the pipes frequently required going onto private property, and the written consent of the owner to the placing of the benchmark was in each case obtained. Two forms of permit were used—one for corporations and the other for private individuals. In all considerably over 100 permits had to be obtained.

In addition to the manufactured benchmarks the elevations were taken on the existing street monuments wherever the latter could be reached from the lines of levels. The street monuments are considered as being of about the same order as the Class *B* manufactured benchmarks.

Advantage was taken of the opportunity in running the levels to establish a large number of additional benchmarks on available points and objects. These were more commonly points on the concrete curbs, generally either on ring bolts in the curb or on one end of an angle-iron curb-guard at the sidewalk corners. These benchmarks are called Class *C*. While not so permanent and definite and so certain of identification in the field as the others, they are fully as good as the general run of benchmarks on most engineering works. These benchmarks were determined with the same degree of accuracy as the others.

It will be observed that only the manufactured benchmarks could be numbered, as the design provided space for the serial number to be placed. The numbers were assigned in consecutive order as the benchmarks were determined, without any regard to locality. The numbers were stamped on with a steel die. This numbering of benchmarks is a marked advantage, both as regards certainty of identification and ease of reference in tabulations and on maps. On the benchmark map constructed from the survey, each numbered benchmark was located in position and the number entered alongside, while the street monuments were also noted. Different symbols and colors were used for the different classes and types.

EXTENT AND PROGRESS OF THE WORK

Fieldwork by the level party began about the middle of March, 1914, and was finished at the end of July, 1915. The work was continuous except for an intermission of about 2½ mo. Over 500 mi. of level lines was run. As much of Portland's area is quite hilly, progress could not be so rapid as in a level locality. The extreme range in elevation of benchmarks set was 1,017 ft.

Area Covered—The total area within the Portland limits (including some water surface) is now 66.3 sq.mi. Of this area, 9.5 sq.mi. is taken by the recent annexation of Linnton, and the survey was not extended over Linnton. Practically all of the remainder of the city was covered, and several of the nets extended outside of the city. Over 6 sq.mi. outside the limits was thus covered, and an additional area of 2 sq.mi. (some of it in a different county) was traversed to the extent of running some main circuits.

Altogether about 65 sq.mi. gross area was covered by the survey. The frequency of benchmarks ranged from 13 to about 60 per square mile within the city. Outside the city limits some areas have only 4 to 5 benchmarks per square mile.

Tabulation of Benchmarks—On the survey there were established and accurately determined in elevation the following number of benchmarks: 104 *A* tablets, 973 *B* tablets, 179 *A* iron-pipe benchmarks, 17 *B* iron-pipe benchmarks, 118 street monuments and 585 *C* benchmarks, making a total of 2,006. In addition, 17 United States Geological Survey benchmarks or points were checked on and the differences noted. All these benchmarks were listed in the tabulation afterward made.

The arrangement of such an immense number of benchmarks in a list for ready reference was a formidable undertaking, especially so because of the great diversity of the street systems and the irregularity because of topographical considerations existing in Portland. The benchmarks in any city are usually referred to by their street locations, though sometimes better designated by other features, such as railway lines, river or harbor lines, etc.

It was decided to divide Portland into eight areas or districts and to list the benchmarks in each one separately. A general alphabetical arrangement for the entire city did not promise well, because of the great number of street names and street numbers. An additional consideration was the fact that the list was to be published in loose-leaf form. As the work of many of the city surveyors is confined to certain sections of the city, the listing by districts permitted the separate use of just those leaves needed to cover the particular districts affected. The surveyor can thus place whatever leaves are necessary in his loose-leaf field binder with his regular survey notes, the size and punching of the regular survey leaves being the same as those of the benchmark publication.

The method used in listing was to compile a "consecutive" index of all the benchmarks in each district, supplemented by a short alphabetical list of those benchmarks where the street locations did not fall within the regular scheme. In addition, all of the nearly 1,300 numbered benchmarks were listed in a separate table in their numerical order. By this latter list, if the number of a benchmark be known, it can at once be turned to.

The benchmark tabulation was printed in booklet form in January, 1916. The booklet of 141 pages, of 4½x7¼-in. size, contains all the different lists, with full prefatory notes, explanations, table of contents and index. The issue consisted of 350 copies bound in flexible covers and also 350 sets of loose leaves (each set with loose-leaf covers for convenience of keeping).

Cost of Survey and Tabulation—Following are items composing the complete cost of the survey from the beginning of the preliminary work to the printing of the tabulation:

Salaries of field men	$5,076.85
Wages of benchmark setter	773.50
Salaries of office men in checking, adjusting, distributing errors of closure, indexing, compilation of lists of benchmarks, etc.	848.80
Hire of team and driver for hauling pipe benchmarks and materials for setting	145.25
Cement, sand and gravel for concrete for pipe benchmarks	54.39
Manufactured benchmarks of the four types (about $70 worth not yet used)	805.20
Equipment, including minor supplies for surveying	435.58
Street-car fare for employees	89.60
Miscellaneous items	33.54
Publication of the tabulation of benchmarks (350 bound copies and 350 loose-leaf copies)	245.00
Total	$8,507.71

If the value of the equipment (less some depreciation) and the value of the supplies—all available for future extensions—be allowed, the net cost of the survey reduces to not over $8,100. The *pro rata* cost for the 2,006 benchmarks established thus becomes about $1 each.

Attention is now called to the fact that a primary aim of this survey was to establish working benchmarks, as referred to at the beginning. In the precise-level surveys of other cities, such as those of New York and Chicago and to some extent those of Pittsburgh and Cincinnati, the primary object has been to carry precise levels out from an initial point so as substantially to cover the entire area of the city, but with the actual establishment of only occasional benchmarks. In these cities there was but little attempt made to put in working benchmarks, and the reference benchmarks established in the different sections or boroughs were depended on mainly as starting points. Secondary levels were naturally run from them by the regular city survey parties as occasion demanded, with the ordinary grade of leveling instruments. In Portland the aim has been to obtain a complete list of benchmarks for use by the city surveyors and others, the distribution being such that it will be seldom necessary to establish other intermediate benchmarks.

The covering of the city in this thorough manner was made all the more necessary by reason of the fact that nearly all the ordinary leveling in Portland has been done with transits, so that not a very high degree of accuracy is obtained. By having the permanent benchmarks at convenient intervals there will be no objection to continuing this practice, and work that would be needed in other cities in carrying out secondary sets of levels and the establishment of secondary benchmarks will be practically eliminated. For this reason the instrumental work in the future will be much lessened, and the cost of this bench-level survey could be very properly distributed over a number of years to come.

It will of course be necessary to extend the benchmark system with the growth of the city, both because of the expansion and annexation of contiguous territory and because of the building up of areas at present but thinly settled and in which but a limited number of benchmarks was established at the time of the survey by reason of so few available objects being at hand.

The project of covering the City of Portland with a comprehensive and precise level survey was initiated by Robert G. Dieck, Commissioner of the Department of Public Works, soon after his assumption of office in 1913. The execution of the survey and the resulting compilations have been under direct supervision of the writer.

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Changes in New Specifications for Paving in St. Louis

Since the adoption of the new charter in 1914 the City of St. Louis has abandoned the practice of having standard specifications for each form of street improvement. The Designing Division, of which W. W. Horner is chief, now prepares individual specifications for each street; and, while the principal features are the same in all, the attempt has been made to work out carefully the special details applicable only to the particular improvement. For this reason it is impossible to print complete specifications. The division now has loose printed sheets for certain common clauses, and the additional sheets are typewritten for each case. Some of the special details, which would be difficult to describe in specifications, are shown with accompanying notes on the plans for the work. (Typical plans for street improvements in St. Louis were described in *Engineering News*, Sept. 2, 1915.)

The concrete base for the majority of the improvements is being made 5 in. in thickness, but the base has been increased to as much as 7 in. in particular cases. Some of the main points in the new specifications are as follows:

Wood-block pavement consists of 3½ in. yellow pine blocks treated with 16 lb. of heavy oil. The blocks are laid on a ¾-in. dry-mortar cushion with bituminous-filled joints. The filler generally specified is a high-grade asphalt, but on one large contract special pitch filler is called for.

There have been no expansion troubles on any of the wood-block work, but on two pavements laid late last fall the blocks have bled rather badly during May and June of this year. Blocks laid this year and having apparently had a little longer final steaming do not as yet show any evidence of serious bleeding.

Of the very large yardage of vitrified-brick pavement in St. Louis, a considerable proportion is in bad condition because of the unsatisfactory sand bed that was used, and a number of contracts are now being let to re-cover these old brick pavements with an asphalt wearing surface.

Old Brick Pavements Surfaced with Asphalt

Specifications for resurfacing old brick with asphalt have been provided to meet three different conditions: First, where the old brick wearing surface is badly out of level on account of shifting of the sand cushion, the specifications provide for a rough readjustment of the brick. The pavement is then covered with binder in order to fill any remaining surface inequalities, after which a standard 1½-in. asphalt surface mixture is laid. Specifications provide for payment for the binder course by the ton and for the wearing surface by the square yard. They also provide for readjustment of curbing, for taking up old brick and for resetting old brick.

In the second case, on certain of the more important streets, it is proposed to provide new brick gutters. These gutters will be on a sharp slope in order to give a shoulder at their outer edge, against which the resurfacing material can be laid, and at the same time give an ample depth of curb face at their inner edge. In the third case, if a great portion of the old brick wearing surface is undisturbed and in good condition, it is proposed to readjust and carefully regrout all rough places, apply a thin paint coat of asphalt cement and a 1½-in. asphaltic wearing surface.

On account of the high cost of readjusting the brick in advance of the covering, as under the first condition noted, it appears doubtful whether this type of construction is warranted, because for a very small increase in cost the brick could be removed entirely, a small amount of concrete added and a standard sheet-asphalt pavement laid.

Brick Pavements for Streets and Alleys

Specifications for vitrified-brick pavement now provide for a wire-cut lug block, not repressed. On all street work the brick is laid on a ¾-in. bedding course of dry mortar of a 1 : 4 mix and is filled with a 1 : 2 mixture of portland-cement grout. For the alley pavements the brick are laid on a bedding course of limestone screenings.

During the past year three contracts have been let for brick-paved alleys, where a monolithic type of construction is provided for; that is, the brick and the mortar bedding course are to be laid on the fresh concrete and rolled with a hand roller. Prices on this work were approximately the same as for the first type mentioned, but none of the three alleys have as yet been constructed. It is doubtful if many alleys will be let on this specification, as the difficulty of carrying on this type of construction in a closely built-up alley would make the work unduly expensive.

One street having a 36-ft. roadway was paved by the monolithic method with very satisfactory results, but it was found that the wide roadway made the operations much more difficult than those on the usual narrow highway, so that the cost was materially greater than for the dry-mortar bed. No further attempt has been made to apply this method.

New Bituminous-Macadam Pavements

Following the decision of the Board of Public Service at the beginning of the fiscal year that no more waterbound telford macadam pavement would be laid, a new specification for telford was adopted, which provided for a 6-in. telford base, 3 in. of waterbound macadam and a 3-in. top course of bituminous macadam.

A high-grade asphalt has been specified for the binder in most of this work, but on one large contract refined tar was called for. On one contract also alternate bids will be taken for a base of 6-in. telford plus 3 in. waterbound macadam on the one hand and a 5-in. concrete base on the other.

More Concrete Curbing Being Used

Up to last year the curbing used had been almost entirely granite. Some limestone was tried several years ago, but it has given poor service. Nearly all the granite curbing has come from Georgia quarries and was formerly delivered for from 55c. to 58c. per lin.ft. on the cars. Since last year, when the specifications for curb were revised and a little better workmanship required, the prices have risen steadily until the quotations in St. Louis are now about 75c. per lin.ft. This is apparently due somewhat to the revision of the specification, to close inspection and largely to labor conditions at the quarries.

The division began last year to specify concrete curb in connection with bituminous-macadam work; and since the rise in price of granite, concrete curb is being specified on all except the most important streets.

Eliminating Fieldwork

The tendency is to make careful designs and preliminary estimates for each piece of work and to take bids in as much detail as possible in order that the contractors may have no occasion to estimate contingencies.

On account of the general increase in prices of materials and labor since these specifications were adopted it is difficult to ascertain to what extent the present form of plans, specifications and bidding is affecting the cost of work, but there is no doubt that it has tended toward simplification of the work in the field.

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Depreciation in Cost Accounting—The Federal Trade Commission is urging on every business man the absolute necessity of making proper provision for depreciation and doing it monthly or at least quarterly. I think I can safely say that no accounting system will receive the indorsement of the commission unless it does provide for the inclusion of this most important item of cost. Statistics show that the percentage of business men who do not provide for depreciation is very large, running over 50%, and this is one of the causes that have a great influence on the business death rate. Nearly every man is perfectly willing to include in his cost all items for which he pays out actual money, but he is inclined to overlook items, such as depreciation, that do not require a visible outlay. Many manufacturers and merchants do not charge any depreciation and give as a reason that they keep their plant and stock in first-class condition. This is one of the erroneous ideas in business today. Every machine, building and apparatus, like every man, has a certain period of life; and no matter how much care is taken of equipment, death is bound to come.—From an address by E. N. Hurley, Chairman, Federal Trade Commission.

Building the Rolling-Crest Dam Across Grand River

SYNOPSIS—The largest steel rolling-crest dam in this country has just been completed by the United States Reclamation Service over the Grand River near Grand Junction, Colo. In "Engineering News," July 6, 1916, F. Teichman, one of the engineers in the service, described the design of the dam. This article, prepared by one of the editors, describes the construction features.

Work on the Grand River dam was begun Aug. 27, 1913, but owing to the European War and unforeseen difficulties in arranging for the fabrication of the steel rollers and operating mechanism the construction operations were prolonged far beyond the original estimate.

Essentially the dam consists of a standard concrete masonry ogee weir, the crest of which is at El. 4,782, with an apron about 33 ft. long and 2 to 6 ft. thick with its top at El. 4,774, a little below the normal bed of the Grand River, and a front apron covered with puddle. On the weir is 420 ft. of rolling crest, 10 ft. 3 in. high, in six units of 70 ft. each. At the west end of the dam is a 60-ft. sluiceway controlled by a rolling crest of the same type, but 15 ft. 4 in. high, as the elevation of the sluiceway sill is 5 ft. lower than the crest of the ogee weir. The roller crests are of a type having its origin in Germany, and are built under patents owned by the Machinenfabrik Augsburg-Nurnberg A. G.

The right-hand (shore) wall of the sluiceway contains the canal intake regulator gates, nine in number, each 7x7 ft. The sill of the intake gates is at El. 4,785.25, or 8.25 ft. higher than the sill of the sluiceway and 6.25 ft. higher than the floor at the entrance to the sluiceway. The maximum height of water in the canal is 4,791.5 ft. for a discharge of 1,125 sec.-ft. The gates cost $6,079, the Hinman Hydraulic Manufacturing Co., Denver, being the contractor.

Ogee Weir and Piers

The dam substructure rests on gravel. Borings made 30 ft. in the bed of the stream showed the bedrock to be soft sandstone. The cross-section of the weir was made long to restrict the flow of the undercurrent and unusually heavy to resist sliding.

The diversion dam and canal headgates are one structure. The canal draws water at right-angles to the current so as to have the least interference from drift, and water is drawn from the upper strata so as to have a minimum of silt. The axis of the ogee weir is at right-angles to the river, except for a slight bend at the east end to meet the wall of the adjoining Orchard Mesa canal at right angles.

Construction of a dam at the site chosen was complicated by the presence of the tracks on the Denver & Rio Grande R. R. side and the canal of the Orchard Mesa Irrigation District. Both the railway tracks and canal bank had to be permanently raised and protected. The original intention was to supply the Orchard Mesa canal from this dam, but this arrangement could not be satisfactorily made with the Irrigation District.

The general scheme of construction was to build the sluiceway first and then, diverting the river through it, build the ogee weir and piers. A trestle was built across the river a short distance above the dam and filled with rock and earth to form a coffer-dam. The work was done under difficulties as the highest water on record occurred during this time. A cableway was erected over the center of the dam for handling materials.

All machines were electric driven. Power was obtained from the steam-generating plant at Cameo over a transmission line three miles long. Transmission was made at 16,500 volts a.c. and was stepped down by transformers in the substation to 2,200 volts a.c. and converted into 250 volts d.c. for all equipment. Sand and stone for the concrete was taken from a sandstone quarry on the east bank, opposite the dam. The over-burden as removed was used to tighten the coffer-dam and for the puddle on the upstream apron. The rock was handled by a stiff-leg derrick which dumped onto the feeding platform for a Gates gyratory crusher and Davis sand rolls. These discharged into the same bucket elevator running to a revolving screen mounted over hopperbottomed bins. Gates in the bottom of the bins emptied into measuring boxes for the mixer.

Negotiations for Fabrication of Rollers

In the latter part of 1913 it was considered that both time and money would be saved by having the steel rollers designed and fabricated by the patentees, the Machinenfabrik Augsburg-Nurnberg A. G. The German firm ac-

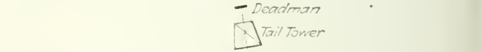
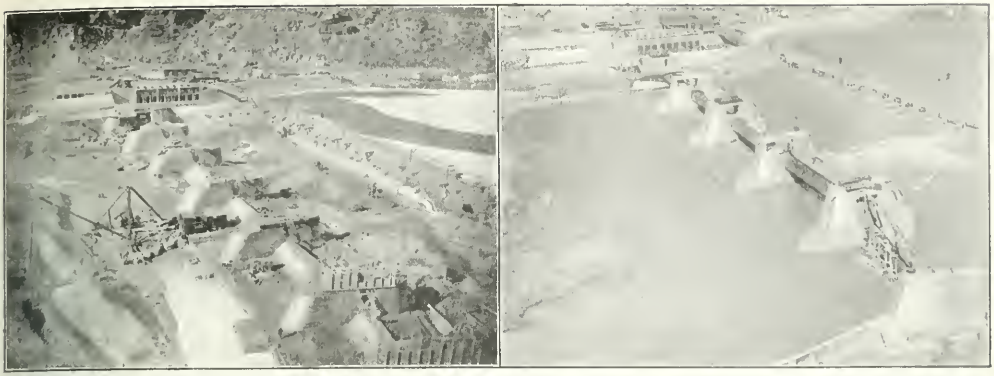


FIG. 1. GENERAL LAYOUT OF GRAND VALLEY DIVERSION DAM



FIGS. 2 AND 3. VIEWS OF GRAND VALLEY DIVERSION DAM DURING CONSTRUCTION

Fig. 2—Construction view, taken from the east side looking west toward sluiceway and canal headgates while dam site was still dry. Fig. 3—Same view as in Fig. 2; taken after rollers were up

cepted the contract in September, 1913. A set of plans was received at the Washington office of the Reclamation Service on Apr. 11, 1914, and submitted to the project office where they were reviewed and reported upon May 22, 1914. Fabrication of certain parts was begun in Germany.

Early in August, 1914, it became evident that because of the European War the German company would not be able to complete its contract and tentative plans were made for beginning the preparation of drawings and specifications for American manufacturers. Later the German company announced its inability to proceed with the work, and F. Teichman, Designing Engineer, Reclamation Service, proceeded at once to Washington and in the course of a few months entirely worked over the German designs to conform to American practice. C. H. Branscombe assisted in this work. Plans and specifications were completed and submitted to bidders Dec. 23, 1914. Owing to the fact that this is the first steel roller dam fabricated in this country the following list of bids and bidders is of interest:

Name of Bidder	Unit	Total
Engineers' estimate	3.5c.	$20,531.00
Riter-Conley Manufacturing Co., Pittsburgh, Penn.	2.55c.	14,958.30
Pennsylvania Bridge Co., Beaver Falls, Penn.	2.94c.	17,246.04
Stacy-Schmidt Manufacturing Co., York, Penn.	3.2c.	18.771.20
American Bridge Co., Baltimore, Md.	3.2c.	18,771.20
Independent Bridge Co., Pittsburgh, Penn.	3.46c.	20,296.36
St. Paul Foundry Co., St. Paul, Minn.	3.55c.	20,824.30
Minneapolis Steel and Machinery Co., Minneapolis, Minn.	3.72c.	21,821.52
Milwaukee Bridge Co., Milwaukee, Wis.	3.72c.	21,821.52
Chicago Bridge and Iron Works, Chicago, Ill.	3.75c.	21,997.50
Allis-Chalmers Co., Milwaukee, Wis.	3.8c.	22,290.80
Reummeli-Dawley Manufacturing Co., St. Louis, Mo.	3.9c.	22,877.40
Pittsburgh-Des Moines Steel Co., Pittsburgh, Penn.	3.97c.	23,289.02
Kansas City Structural Steel Co., Kansas City, Mo.	4.0c.	23,464.00
McMyler Interstate Co., Bedford, Ohio	4.76c.	27,922.16
Treadwell Construction Co., Midland, Penn.	5.375c.	31,529.75
Whitehead & Kales Iron Works, Detroit, Mich.	5.8c.	34,022.80
William Cramp & Sons, Philadelphia, Penn.	8.55c.	50,154.30

The contract was let to the low bidder, the Riter-Conley Manufacturing Co., of Pittsburgh, for $14,958.30. The erection and freight costs are not included in this or the other figures given. The erection was done by the Reclamation Service forces.

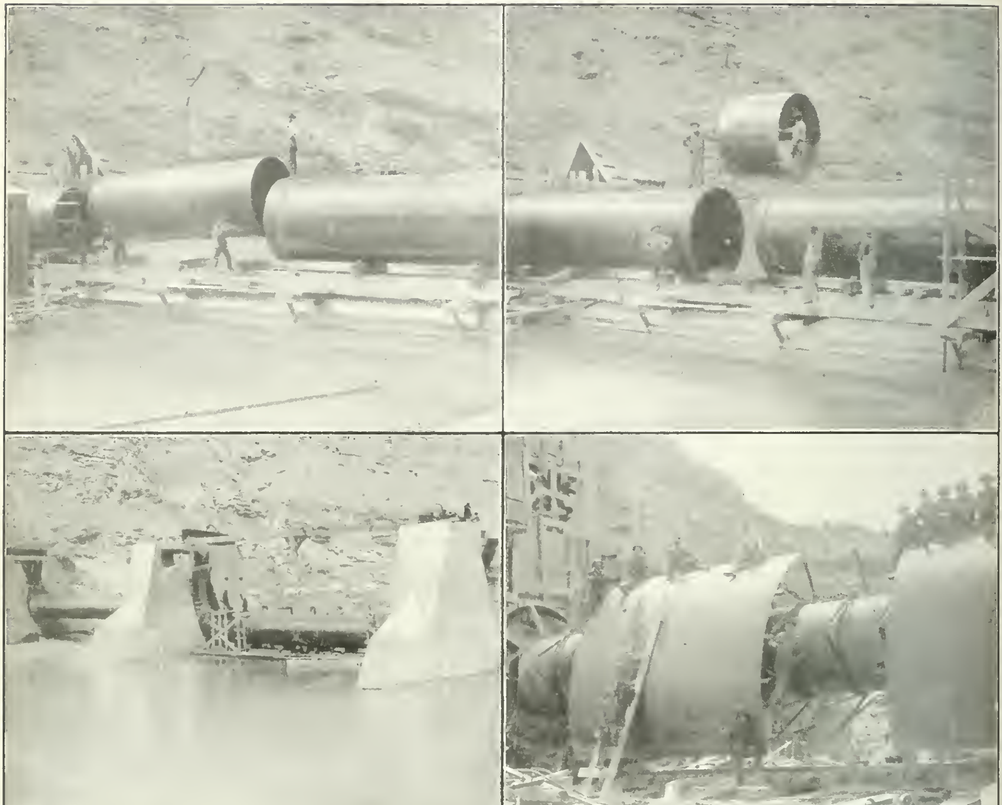
Having arranged for the manufacture of the rollers in this country it was still considered desirable to attempt arrangements with the German patentees for the manufacture of the hoists and chains. The hoist for the heaviest—the 60 ft. roller—was ordered, but orders for the hoists for the 70-ft. rollers were held pending bids from American firms. The bid of the Minneapolis Steel and Manufacturing Co., Minneapolis, Minn., was as low as the German bid and the contract for the six 70-ft. roller hoists was let to this firm for $825 each. The order for the 60-ft. roller hoist placed in Germany was then recalled and let to the Link-Belt Co., Chicago, Ill., for $1,600.

The only parts then left in the hands of the German manufacturers were the steel chains and sprockets, including shafts, but eventually these too had to be contracted for in this country. The German firm did, however, manufacture and ship to this country in January, 1915, the cast-steel toothed racks for the piers and the toothed rims for the rollers.

The steel supports for the racks were furnished by the Minneapolis Steel and Machinery Co. These supports were drilled with $\frac{7}{8}$-in. holes and the $\frac{3}{4}$-in. holes in the rack were reamed to $\frac{7}{8}$-in.; the racks were then fastened to the supports with tight-fitting, turned bolts. The original design called for $\frac{3}{4}$-in. bolts. The two upper sections of the rack are not attached to the supports but are merely held in the pier in place by tight-fitting anchor bolts.

Erection of Roller Crests

The original program for the erection of the roller crests was as follows: (1) Construct a coffer-dam from pier *c* upstream to the main coffer-dam, and demolish the main coffer-dam between this junction and the east bank, or in front of spans *ab* and *bc*; (2) erect rollers *cd*, *de* and *ef*, and at the same time, by placing heavy rock with the cableway across the sluiceway channel, turn all the river through spans *ab* and *bc* and begin work in the sluiceway (i.e., finish concrete abutment *h* and pier *g*, place the paving in the tailrace and erect the sluiceway roller); (3) when the three rollers between piers *c* and *f* should be erected, raise them out of danger and demolish the coffer-dam in front of them, at the same time rebuilding the coffer-dam in front of spans *a* to *c*; and so soon as water could be turned from these spans erect the rollers upon them and finally demolish the remains of the coffer-dam. (See Fig. 1 for locations of sections noted.)



FIGS. 4 TO 9. CONSTRUCTION VIEWS OF THE ROLLER-CREST DAM, GRAND VALLEY PROJECT, U. S. RECLAMATION SERVICE

Fig. 4 (Upper Left)—Placing roller sections by cableway. Fig. 5 (Upper Right)—Placing the closing section of roller shown in Fig. 4. Fig. 6 (Middle Left)—Erection of roller BC, showing falsework suspended from truss beam. Fig. 7 (Middle Right)—Placing shields on the sluiceway roller. Fig. 8 (Lower Left)—Sluiceway roller in place. Fig. 9 (Lower Right)—End of sluiceway roller, showing track extension on the upstream side of pier, which takes the place of safety chains in the original design. Note also that the shield is boarded over

This program was essentially carried out except the erection of the sluiceway roller simultaneously with the rollers *cd*, *de* and *ef*. The increase in head resulting from damming the sluiceway caused such leakage through the coffer-dam as to endanger it; hence the diversion of the flow from the sluiceway was postponed until the three rollers *c* to *f* were erected and raised to a position where the flow under them would not interfere with continuing work upon them, and the coffer-dam protecting them would no longer be required.

The erection of the first roller was begun Mar. 25, 1915. This roller was shipped in five sections—the two ends, each about 13 ft. long, upon which the toothed rims were attached; the two adjoining pieces each about 21 ft. long and a closing section 6½ ft. long. The two end sections were swung into their approximate positions on timber falsework by means of the cableway, and with bars and jacks the proper teeth on the racks which had been set and the rims were brought into mesh.

The two adjacent sections of the roller were then joined to the ends and held in place by barrel pins and fitting-up bolts. The four sections were then adjusted for alignment at all parts of the circumference. The opening for the closing section was made about ¼-in. larger than the length required, and the slip or closing section swung into place. The end sections were then drawn together by pulling jacks and the splice-plates put on and held by barrel pins and fitting-up bolts.

The roller was next tested by wye level and the riveting commenced. When the riveting was completed on the roller proper, not including the shields and end shields, the roller was raised to give 8 ft. clearance over the ogee weir. It was here held in place by 12x12-in. Oregon fir posts, one under each end, strongly braced and fitting into a hole chipped in the bottom of the recess. This recess was then planked up to insure against displacement of the post by floating débris. In this position the shields were riveted to the rollers.

In erecting the roller *bc* a trussed beam of 8x18-in. Oregon fir was constructed and placed across the space between piers *b* and *c*, about 7 ft. downstream from the sill of the rollers. To this beam six cables were fastened and dropped down to support the downstream ends of the caps upon which the falsework was erected. Work on the roller *ab* was carried out in the same manner. In both instances extreme high water threatened the safety of the falsework and only quick work saved the situation.

The erection of the five rollers *a* to *f* was pushed with all possible speed, but during this period there were times when it was expedient to work on roller *fg*, which is east of pier *g* and inclosed on the opposite side by the sluiceway wall. It was blocked off by coffer-dams built both up and downstream from pier *f*. The apron below this roller was built around the sump to which drainage water was run during construction work. As soon as the sections of the roller had been assembled and riveted it was raised 8 ft. clear of the weir and the shields riveted in place. A temporary sill and sealing strips were attached and the roller lowered on the crest of the weir, effectually shutting off the water from this span and protecting the bay below and the coffer-dam above from pier *f* to the corner of the sluiceway.

The erection of the sluiceway roller did not begin until the early part of June, 1915. The sluiceway was cut off by three coffer-dams. The method adopted differed only slightly from that employed for erecting the 70-ft. rollers. The falsework for pieces Nos. 2 and 4 was built on flat cars running on a 36-in. gage track laid parallel to the sill, the flat apron of the spillway favoring this method. The erection and riveting of the sluiceway roller was carried out during a flood season, when the discharge of the river reached a maximum of 21,000 sec.-ft.

PAVING SLUICEWAY AND SLOPES

The next operation was the concreting of the drainage sump and the paving of the downstream end of the sluiceway channel, after which the sluiceway roller was raised and the others lowered, diverting the entire flow through the sluiceway and finally demolishing the coffer-dams.

The heavy riprap below the downstream apron was placed with a 15-ton derrick, and a 36-in. gage truck was built along the spoil bank to bring the stone within reach of the derrick. This work was begun about midway between piers *f* and *g* and proceeded eastward. When the east abutment was reached the derrick continued downstream and also laid the slope paving downstream from the east abutment. Previous to placing the slope paving a footing wall 3 ft. wide and averaging 4½ ft. deep was built on solid rock. The embankment upon which the slope paving is laid is 10 ft. wide on top and forms the right-hand, or river side, embankment of the Orchard Mesa canal.

OPERATING MECHANISM FOR ROLLERS

In March, 1915, steps were taken to have the chains and chain shafts made in this country. All except a sample set, which was made by the Vulcan Iron Works, Denver, Colo., are being made by the Lakeside Bridge and Steel Co., Milwaukee, Wis.; the contract price was $5,147 for the chain shafts and operating chains and $891 for the safety chains. Subsequently the part of the design calling for the safety chains was discarded in favor of triangular bents of structural steel, which form the upper part of the upstream roller tracks (see Fig. 9). The bids for the safety chains were rejected and the contract for the track extensions awarded to the Vulcan Iron Works, Denver, for $125. Since September, 1915, the rollers have been operated by shifting the single chain for the 70-ft. roller from one to another, and by temporary rigging from the cableway, in order to enable the diversion of water for seasoning and priming the canals.

The permanent power plant for the operating of the roller crests and canal headgates consists of a gasoline-engine-driven electric generator (25 kw.) which will supply current to six 10-hp. motors, operating the hoists for the 70-ft. rollers, one 20-hp. motor for the 60-ft. roller, and a 3 hp. motor for the headgates. A storage battery will also be installed, to be charged by the generator set. The battery will furnish enough power to operate one roller. The gears are also capable of being operated by a hand-winch.

The service bridge connecting the operating houses and intermediate piers consists of seven 3-hinge steel arch spans. Six are 70 ft. in length from pier wall to pier wall and one is 60 ft. The width of the bridge is 6 ft. inside the lower chords. The rise of the arches is, in each instance, 7 ft. and the curve is approximately parabolic. The floor is 3-in. planking at an elevation of 4,809.25, which is the finished elevation of the piers *a*, *c*, *e* and *g*. The latticed handrail on the upstream side is continuous from piers *a* to *h*. The service bridge was built by the Des Moines Bridge and Iron Works, Des Moines, Iowa, and cost 2.8c. per lb. It weighs 45 tons.

CONCLUSION AND ACKNOWLEDGMENTS

The elevation of the tops of the roller crests is 4,792.25 ft. For an assumed high-water level above the dam of 4,792.5 ft. the discharge over the dam and sluiceway, with all movable crests raised, is estimated at 50,000 sec.-ft. Besides this 2,000 sec.-ft. can be bypassed through the canals on each side of the river. The elevation of the tracks of the Denver & Rio Grande R.R. was raised from 4,792 to 4,797 ft.

It will be necessary at times to divert the whole flow of the river into the project canal. This requirement eliminated the possibility of using wickets or other inexpensive types of movable crest, on account of the leakage. The choice was therefore restricted to roller crests or large Stoney sluicegates. The greater ease with which the rollers could be operated was the determining factor. A roller was selected for the sluiceway gate on account of the lower cost and for uniformity in operating mechanism. The committee of Reclamation Service Engineers responsible for the adoption of the design is composed of R. F. Walter, D. C. Henry, J. H. Miner, F. Teichman and O. T. Reedy.

As previously noted Mr. Teichman was the designing engineer; Mr. Miner is project manager and O. T. Reedy was construction engineer in charge of erection until the summer of 1915, after which the project manager, Mr. Miner, was in direct charge. The chief engineer of the Reclamation Service is Arthur P. Davis, and Chief of Construction is F. E. Weymouth.

For the material of which this article is composed *Engineering News* is indebted to E. H. Baldwin, who was Acting Chief of Construction, and to Mr. Miner. The text is based largely on extracts from the project histories of 1914 and 1915 and on other data gathered on the site of the work by one of the editors.

Kansas Experience in Running Small Sewage Works

By F. M. Veatch*

SYNOPSIS—The need of and economy of efficient supervision of small sewage-disposal works is shown by Kansas experience with plain and two-story septic tanks, contact beds and their dosing devices.

The following observations are based on an investigation by the writer of the operation of sewage-disposal plants in the State of Kansas during a period of two years. It is believed that what may be said of Kansas plants is also applicable to those of other states.

The types of disposal plants found in Kansas are septic tanks, either ordinary or two-stage, contact beds, and one installation each of disinfection and of subsurface irrigation. Several sand filters and one trickling filter are under construction.

ORDINARY AND TWO-STAGE SEPTIC TANKS

By variation of the length of the detention period of a tank, it may be operated either as a plain settling tank or as a septic tank. The greater number of our tanks are composed of two or more compartments which fact allows for some flexibility in operation, but a knowledge of the principles which underlie the working of the tanks is necessary for the successful adaptation of plant capacity to sewage flow.

All of our plants are subject to variation in sewage flow, due in some cases to leaky sewers or to fluctuations in the ground-water level, and in others to the uses to which the sewers are put. Therefore, it is easily seen that a plant cannot be expected to give the same purification through this range of conditions unless its capacity is correspondingly varied.

A point which has received little or no attention at our plants is the gradual change of capacity of tanks due to the accumulation of sludge. Owing to the wide range of conditions met with in different plants, it is impossible to set an optimum detention period for all plants, but this must be determined for each individual case, by experiment.

Many of our plants are so located that they receive their sewage in a very fresh condition, and in these cases there is no material benefit to be obtained by allowing the sewage to remain in a tank any longer than is necessary for the deposition of the greater part of the solids. The benefit to be gained by the sludge digestion that might take place by the use of the longer period is more than overbalanced by the increased difficulty of subsequent treatment either by dilution or on filters. In several cases the writer has found the effluent of tanks and occasionally those of contact beds, to require more water for their safe dilution than did the raw sewage, owing to lack of cleaning at the proper time or to improper detention periods. In such a case the plant is a detriment to a city and the money spent for its construction is a total loss so long as such conditions are allowed to prevail.

The advantage of the two-stage septic tank lies in the isolation of the digesting sludge from the settling sewage and to effect this the operation of the plant must receive daily attention. Gas vents should be kept open to prevent gas-lifted particles of sludge from entering the settling chamber. Scum should be removed from the surfaces of the settling chamber. The height of the sludge in the digestion chamber should be so regulated that it will at no time be nearer than a foot or so to the settling sewage. Sludge pipes and valves should receive sufficient attention to insure their readiness for operation at all times.

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*Assistant Engineer, State Board of Health, Lawrence, Kan.

The extreme offensiveness of the collections on screens and the danger of backing up of the sewage make their cleaning a necessity as often as they become clogged, since a poorly operated screening chamber is worse than useless.

Dosing Chambers and Devices

Failure to flush dosing chambers has frequently been a source of trouble in our plants, and the subsequent treatment of good tank effluents has on this account been made more difficult. Holding the effluent in contact with septic sludge in a dosing chamber has the same or worse effect than an equivalent lengthening of the detention period in the tank. We have increased the efficiency of some of our contact beds by changing the piping of the dosing siphon, so as to allow the tank to discharge at a lower level, thus decreasing the period in the chamber.

No matter what the design of a dosing device may be, it must be thoroughly understood by the operator, in order that small repairs and adjustments may be quickly made, when necessary.

When seen for the first time any device seems to be merely a maze of piping and it is not surprising that much trouble has been encountered in their operation by men who do not understand their construction. The writer has been called upon to put a dosing apparatus into operation when all that was necessary was the correct adjustment of a three-way cock. Every plant operator should have a setting plan of his device and should be so familiar with it that he is able to vary its operation at will. Such drawings may be had free of charge from the manufacturers of the apparatus.

Where secondary treatment is practiced, the importance of the successful operation of the dosing apparatus cannot be overestimated. Time after time the writer has visited plants, after having been assured that they were operating successfully, only to find the dosing device out of order and the whole plant out of commission. Any device will at times fail to operate, but if it is immediately attended to no permanent injury results. Several cases have been noted by the writer where a contact bed has been practically ruined by the failure of an alternating siphon to take its seal, thus allowing the sewage to run through one bed continuously.

Need of Care in Operating Contact Beds

Treatment on contact beds cannot be successfully practiced without much care in the adjustment of the operation cycle to the rate of flow of sewage. This cycle must be selected with due regard for the character of the tank effluent treated, as well as for the rate of flow, and can only be chosen by trial in each plant. In general, the results of our beds have been the best in cases where relatively fresh tank effluent has been treated and the writer has yet to see a stable effluent produced by a plant which treats the effluent of a tank with a detention period of over twelve hours.

Cases have been found where no attempt has been made to set the valves in the timing chambers so that each bed will have an equal contact period, and in such cases no efficiency need be expected.

Lack of protection from back water has proved a source of trouble in several of our contact beds. This has happened in plants well protected by levees and in many cases has been due merely to the failure to close an outlet valve and bypass the sewage at times of flood. A single flood from one of our turbid Kansas streams will do more toward clogging the stone in a contact bed than several years of careful operation.

The length of time that a contact bed will operate successfully, without cleaning, is determined largely by the care it receives. We have beds that have been in operation for eight years and are still in good order, but we also have others that have become so clogged in the course of a year or so that they will have to be renewed before a good effluent is produced. The cleaning of contact-bed material is a very expensive proposition and the economy of efficient supervision is very plainly shown by the decreased cost of upkeep due to the increase of the period between cleanings.

Amount of Supervision Required

It is not intended to recommend the employment of an expert for the handling of each plant. In Kansas and many other states this is attended to by the State Board of Health, which maintains an engineering department, the services of which are at the disposal of plant operators who wish help or instruction. Furthermore, the entire time of one man will hardly be required for the work but an average of three hours each day will in most cases more than suffice for the routine work. In practically every case it is possible to give this man enough other city work to fill in his time. More help will of course be required when units are cleaned.

The duties of the plant operator should consist of: 1. The making of a daily trip to the plant. 2. Making sure that all parts of the plant are in working order and in operation. 3. Making a few simple tests to determine the amount of sewage being treated, and the character of the effluent. 4. The recording of his results in a systematic log.

It has been stated that the services of an expert need not be secured. This is true but it is not meant that the work of any common laborer will suffice. The man should be intelligent, quick to learn and above all he must be a willing worker and take an interest in the plant.

The necessary tests for the operation of the ordinary small plant are: 1. Flow gaging. 2. Relative stability. 3. Settling solids.

Importance of Flow Gagings and of Tests

The rate of flow through any plant must be determined before it can be intelligently operated. A permanent weir is probably the most satisfactory equipment for this purpose, although in some plants good results may be obtained by noting the rise in the dosing chamber. Gagings should be made throughout an entire day at intervals of one hour or less every month or so in order to determine the exact daily flow, and the hourly variation. If this is done the operator may calculate the approximate daily flow from his hourly variation curve. A better method would be to use an automatic recording gage in connection with the weir. The first cost of such a gage is high, but the time saved soon pays for it.

The relative stability test as outlined in the standard methods of the American Public Health Association is very easily made and is recommended to the small plant operator. It will be found at times that effluents must be diluted with water before the test may be made and in this case it will not, strictly speaking, be the relative stability that is tested for, but rather the amount of dilution required to produce a certain relative stability.

The use of Imhoff cones or settling glasses as an aid to the operation of tanks and contact beds is recommended to the operators of our plants. While these glasses may not give results comparable with the actual suspended solids test, much practical good may be derived from their use, as a check on plant operation.

Economy of Proper Supervision

In the above statements, the production of a good effluent has been emphasized as a reason for efficient supervision and the subject treated from the standpoint of the sanitary engineer. However, when the subject is analyzed with dollars and cents as a basis the economy of supervision is none the less evident. In the first place, a sewage-disposal plant represents an investment of several thousand dollars, the interest on which is represented by useful work by the plant in the prevention of nuisances. In the second place, a plant is composed of parts subject to more or less rapid deterioration, the useful life of which depends on proper care. Therefore the city that allows its plant to work below maximum efficiency is suffering loss just as surely as the money lender who is unable to collect interest on his loans.

Examples of loss by the above means have often been noted in our plants. In one instance an expensive apparatus was installed for the treatment of septic tank effluent with liquid chlorine. This machine gave good results during a two-months' test by the writer, but less than four months later he found, on an inspection trip, that the machine had been allowed to operate with a leaky union on the chlorine feed pipe, and as a result was in such a state of corrosion that its practical renewal was necessary. In this case a lead gasket and a very few minutes of time would have saved the city an amount equal to the cost of supervision for several months.

In another case, that of a plain septic tank, a sludge-pumping outfit was installed when the plant was built. This outfit consisted of a 6-in. centrifugal pump driven by a 20-hp. gasoline engine. The tank was constructed so large that up to the time of the inspection (four years) no sludge pumping had been done. At present the engine is in such a state, owing to misuse by trespassers and lack of attention at times of high water, that it is doubtful whether it can ever be used and it is certain that an expenditure of a considerable sum of money for labor and materials is necessary before sludge pumping may be done. This case represents an investment of over $1,000, from which no return has ever been realized. Other like instances might be cited but the above are representative of this phase of the problem.

Too often a city considers that its obligation is discharged by the construction of a sewage-disposal plant, and fails to realize that its upkeep is just as important a consideration as is its construction. There is also by far too great a tendency toward resting the blame of poor results from sewage-disposal plants upon the shoulders of the designers.

In Kansas, at least, much of the present unfavorable criticism of the practice of sewage disposal would be quieted if each individual plant was so operated that its maximum efficiency could at all times be obtained. As every one familiar with the subject knows, the practice of sewage disposal has undergone great changes in the past fifteen years, and, as a result, some of the earlier plants are somewhat obsolete. This, however, should not be made the criterion by which plants are judged.

Concrete Hydrant and Valve Chambers, Salt Lake City

The city engineering department of Salt Lake City, Utah, which is headed by Sylvester Q. Cannon, has a standard setting for fire hydrants and their valves which makes all parts of the hydrant accessible.

Instead of planting the fire hydrant in the ground with a separate valve box in the middle of the street, as is common practice, both the hydrant and valve are enclosed in a concrete chamber as illustrated herewith.

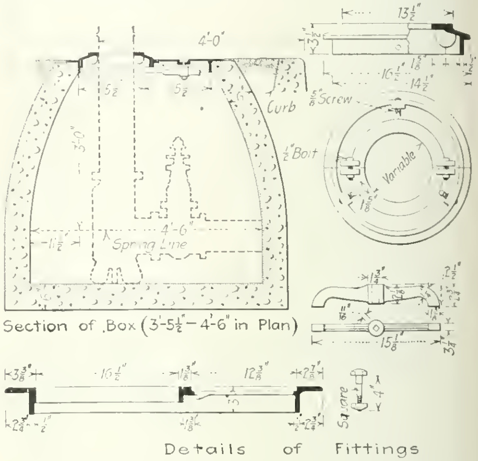


FIG. 1. STANDARD FIRE HYDRANT SETTING

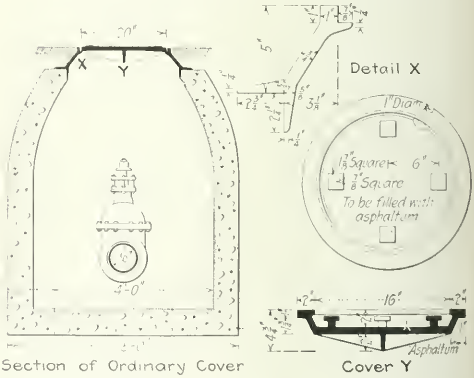


FIG. 2. STANDARD VALVE SETTING, SALT LAKE CITY

No trouble has been experienced in Salt Lake City from freezing on account of the exposed connection of the fire hydrant, but temperatures there are not extreme.

The hydrant stands 4 ft. back from the curb, so that the valve box is entirely under the sidewalk. This is possible in Salt Lake City because of the very wide streets and sidewalks. In many cities a hydrant so placed would be a serious obstruction to traffic.

The standard water-works valve chamber, for valves from 6 to 12 in. in size, is shown by Fig. 2. A similar box but of larger dimensions is used for all water-main valves. Two covers are shown, a plain iron casting and an asphalt-filled casting for use on asphalt-paved streets.

Water-Power Storage Reservoir with Pumping Station

SYNOPSIS—In connection with the use of Bear Lake, Utah, as a storage reservoir for the control of Bear River and the conservation of water from the upper reaches of the river, a unique project has been developed. Bear Lake lies in the lower reaches of Bear River, there being 3,000 sq.mi. of drainage area above. The storage capacity of the lake is large relative to the annual stream flow. To restore the impounded water to the river the pumping station is being built with five 300-sec.-ft. units, the largest for as great head. Construction problems brought about by local topography and some details of equipment are given.

A pumping station of 1,500-sec.-ft. capacity is being built by the Utah Power and Light Co., at Bear Lake, 100 mi. northeast of Salt Lake City, in connection with the development of this lake as a storage reservoir for the control of flow in Bear River and the conservation of all of the water in the upper reaches of the Bear River drainage area for use in both power and irrigation.

As shown in Fig. 1, Bear River flows down past Bear Lake about 5 mi. distant. The storage capacity of Bear Lake is large relative to the total annual stream flow. There was originally a small natural outlet of insignificant capacity from the lake basin to the river, but it was some 20 mi. long and crossed a very flat swamp. During the high river stages of spring, water sometimes flowed back from the river. The pumping station is to lift the stored water for discharge back into Bear River without the necessity of expensive works for a gravity channel draining the lake. The station will be operated by electric power developed on the stream regulated.

The Utah Power and Light Co. obtains its power from hydro-electric stations, the largest and most important of which are on Bear River. There are four stations of 67,500-kw. total capacity utilizing the same water through a total head of 865 ft.

Bear Lake Storage Project

Bear Lake is a deep body of water approximately 21 mi. long and 8 mi. wide. At the north end there is the large swamp, already referred to, and a shallow lake called Mud Lake, which is 6 mi. long and 5 mi. wide. The inlet canals through which water is diverted from Bear River discharge into the north end of Mud Lake, and the water then runs 6 mi. before coming into Bear Lake. When Bear Lake has been pumped down over 5 ft. practically all the bottom of Mud Lake will be exposed. In Bear Lake proper the shores are very steep and there is relatively little difference in area between the high and low water levels. One foot of drawdown of the lake equals 68,000 acre-ft. The total capacity available is approximately 1,300,000 acre-ft., or 57 billion cubic feet. The drainage area of Bear River above Bear Lake is approximately 3,000 sq.mi.; the drainage area of Bear Lake proper is approximately 400 sq.mi. The capacity of the inlet canals is 5,000 sec.-ft., so that practically all flood waters can be diverted into Bear Lake.

Irrigation is quite extensively carried on in the Bear River drainage area, the water being diverted directly from the main river and also from a great many of its small tributary streams. The regulation of the river flow for power purposes automatically regulates the flow for irrigation also, and besides preventing a shortage of water in dry years on the land now under cultivation, will provide water for irrigating large additional areas, both by gravity and electric pumping distribution.

A canal has been dredged through the north swamp from a point called Lifton on the north end of the lake 14 mi. north to Bear River at Junction. When the lake is full there is approximately 8 ft. fall between the surface of the lake and the surface of the river at Junction. Almost all of this fall is necessary for the grade of the canal for the maximum required capacity. It is possible to draw the water from the lake by gravity to a depth of approximately 4 ft. by means of this outlet canal, but the quantity of course reduces as the lake level goes down and the hydraulic grade of the canal flattens out.

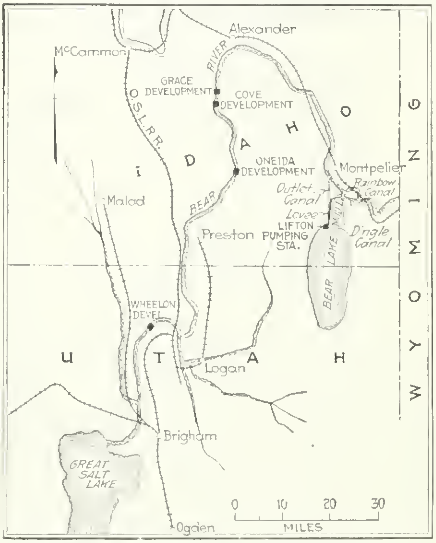
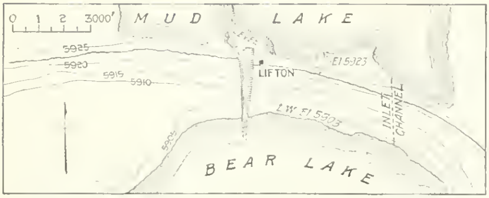


FIG. 1. MAP OF BEAR RIVER POWER SYSTEM

The pumping plant will make available for storage purposes all the water in the lake for a depth of practically 21 ft. During a year of average flow, the variation in the lake level necessary to equalize Bear River just below the reservoir would be approximately 3.5 ft. The large capacity of the reservoir will make it possible not only to equalize the stream flow throughout an average year, but it will make it possible to equalize the stream flow throughout any series of extraordinary dry years of which there is any record.

Past records indicate that so to equalize the flow of the river only 12 ft. of the depth of the lake is necessary However, the pumping station has been designed so that



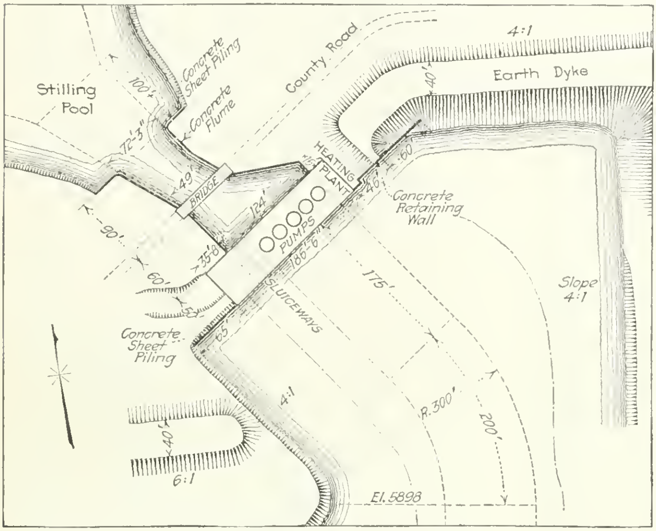


FIG. 2. LAYOUT OF LIFTON STATION

the use of 20 ft. of storage will be possible, in order to provide for errors and inaccuracies in the data, and also to make it possible to use the storage reservoir to equalize the power output from streams other than Bear River. Such equalization of power output will make more water available for irrigation during the summer months than would be available if the stream flow were equalized throughout the year. Just how far down it may be desirable at some time in the future to pump the water in the lake is problematical, and, since the additional cost for placing the suction of the pumps a few feet deeper is very small, it was decided to build the plant with several feet of additional capacity available.

It was necessary to locate the pumping station on a sand bar called "The Causeway," which extends entirely across the north end of the lake and separates Bear Lake from Mud Lake and the swamp. The material all about this locality is a very fine sand mixed with clay, and this extends to an unknown depth. The only variation is in the percentage of sand and clay. This material flows so readily in water that the wave action against The Causeway has flattened the material out so that the bottom of the lake where it is 20 ft. deep is approximately 2,000 ft. from the north shore. It is planned to dredge a large channel through this beach to the pumping plant, which is located approximately 150 ft. away from the shore line of Bear Lake. The station is situated back from the shore line on account of the fact that heavy windstorms sometimes break up the ice on the intake and drift it up on The Causeway to a height of 10 or 12 ft. For this reason the pumping plant has been put on the side of the channel, and if large quantities of ice are blown into the channel the ice will slide up on the shore at the end, where there are no structures.

It is expected that the maintenance of this channel from the lake to the pumping station may be quite a difficult problem, as the action at the mouth may gradually fill it up with sand. The construction of a permanent intake channel would involve such large expenditure that it was decided to maintain the channel by dredging it very large at first and by additional dredging in the future as might be found necessary. On account of the peculiar foundation conditions, the building is built on a concrete mat supported on piles. In order to place this mat and unwater it, an open wooden caisson 140x60 ft. and 44 ft. deep was used. This caisson, which is by far the largest yet built in the world, will be described in a future article.

Pumping Station Equipment

The pumping station will contain five vertical-shaft units, each having a nominal capacity of 300 sec.-ft. The head will vary from nothing to 20 ft., and variable-speed motors and two types of impellers have been provided for best operation at both high and low heads. The accompanying sketches show the arrangement of the principal and auxiliary apparatus in the station.

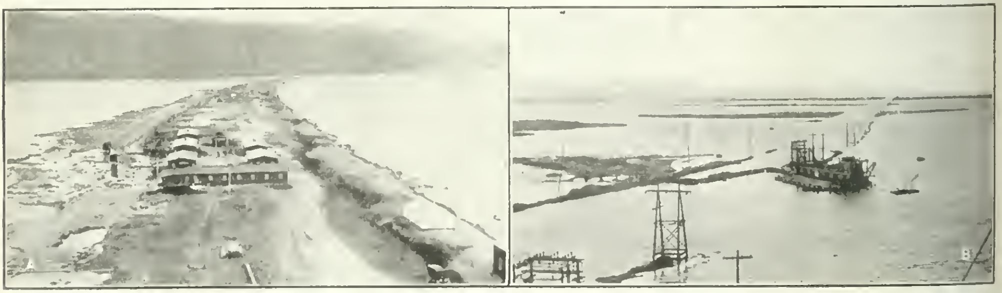


FIG. 3. TWO VIEWS OF WORK AT BEAR LAKE, UTAH

A—Looking east along the Causeway. B—Looking north along the discharge canal. Both views from top of concreting tower

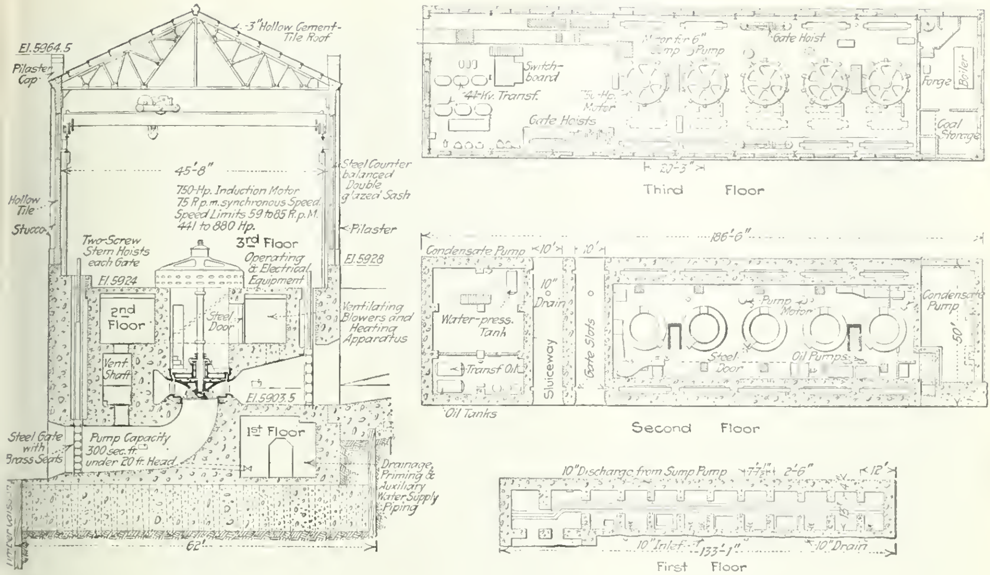


FIG. 4. SECTIONAL PLANS AND ELEVATIONS OF LIFTON STATION

The pumps in the Lifton Station have, so far as known, he largest rate of discharge for as high head—300 ec.-ft. (134,500 gal. per min. or 194,000,000 gal. per ay) against 16 ft. and running at 77.5 r.p.m. The contruction, as shown in Fig. 5, is very similar to recent ertical-shaft single-runner Francis-turbine units. The asing and suction tube are molded in the concrete founations. The vanes around the impeller are not diffuion vanes as they conform to the free path of the flow; hey are cast solid with the foundation ring supporting n part the concrete of the casing and the motor above. 'he steady bearing is of the water-lubricated lignumvitae type, and is held by a diaphragm immediately above the impeller. A Kingsbury thrust bearing, mounted on the motor bracket, carries the revolving element of each pump.

All five pumps are alike and are designed to draw the lake down 20 ft. Normal full load speed of motors is 72.5 r.p.m., at which speed the pumps will have a capacity of 300 sec.-ft. up to 13 ft. head. It is planned to install speed regulators later which will give a speed range of 58.4 to 82.9 r.p.m. These regulators will give each pump a capacity of 250 sec.-ft. for the maximum operating head of 20 ft. At low heads, the pumps will be operated at a speed lower than normal, for economy in power consumption and also for controlling the capacity. A second type of runner has been designed for use in these pumps for reducing the power consumption at very low heads. Up to and including 5 ft. head, this second type will have a capacity of 300 sec.-ft., and will have reduced capacities up to 10 ft. The designs for this development were prepared in the engineering offices of the Electric Bond and Share Co., of New York City. The direct supervision of construction has been by the Phoenix Construction Co., of Salt Lake City. The pumps were made by I. P. Morris & Co., of Philadelphia, and the motors and electrical equipment by the General Electric Co., of Schenectady. As stated before, a description of the design and construction of the large caisson foundation for the pumps will be published in an early issue.

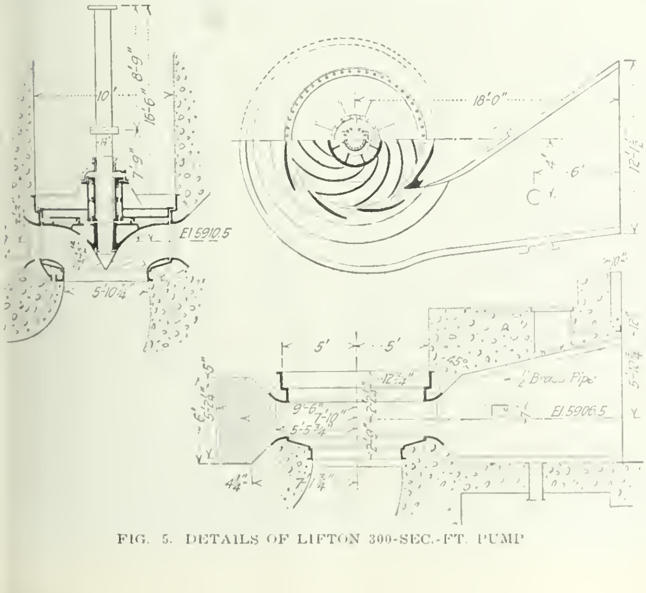


FIG. 5. DETAILS OF LIFTON 300-SEC.-FT. PUMP

Details of Roof-Arch Collapse in Atlanta

The roof of a building on S. Pryor St., Atlanta, Ga., used as a skating rink, collapsed and fell about 9:30 p.m., June 9, killing three people and injuring more or less seriously about ten more. Two of those killed and most of the injured were caught under the falling roof; one of the employees of the rink was struck by falling brick from the broken front parapet wall as he climbed through a window. The building has been used to stage boxing contests, and one drawing a large crowd was held there recently. The cause of the accident has not been determined by the city authorities.

The building was 101 ft. wide and 165 ft. long, facing east on Pryor St. It was built about a year ago, and the lumber used in its construction seems to be in good condition. No plans of the building are available, as the city does not require the filing with the building department of plans of one-story structures. The architect who designed it (G. W. Foote) has retired since that time, and all his less important plans, of which he considered this one, were destroyed for lack of room.

The accompanying sketch shows the details of design as well as could be gathered from the trusses themselves. All the lumber seems to be merchantable-grade Southern yellow pine. The dimensions given on the sketch are for rough lumber, while all that used is finished on four sides, making the dimensions less by ⅛ to ⅜, depending on the thickness, etc. The walls of the building are something over 20 ft. high of 3x4x8¼-in. vitrified paving blocks laid in lime mortar. The front wall and the first 100 ft. of each side wall are 16 in. thick; the remainder of the side walls and the rear walls are 8 in. thick, with 8x20-in. pilasters spaced 11 ft. center to center.

The roof trusses, spaced 11 ft., are of an arch design, rising sharply from the floor at the ends (batter about 3¾ to 12), and are nearly flat for the larger middle portion of the span. The boards of which the top and bottom chords are composed are laid flat (Fig. 4) and nailed, about one 8d. nail per foot showing on top. The radial and diagonal struts are in two planes, as shown (Figs. 2 and 3), the diagonals alternating from panel to panel. The ends of the trusses rest on concrete footings about 1 ft. below the level of the main skating floor. There is an observation floor running entirely around the building, elevated about 10 in. above the main floor, and at the rear there is a second floor or platform 10 in. above the first. There were no fixed benches or seats, but a number of chairs were placed promiscuously along the observation floor. At the rear of the hall there is a pile of temporary benches used during the recent boxing match and now stacked up out of the way.

The roof was nearly flat, with a light pitch toward the front of the building so as to carry the rain water to city drains in the street. It was a light-weight roof of felt, tar and gravel laid on 1-in. sheeting nailed to 2x6-in. purlins, which in turn were supported on 4x6-in. rafters running directly over the trusses. The rafters were supported on 4x6-in. posts about 11 ft. apart, which stood on top of the roof trusses. The pitch of the roof was given by varying the lengths of these posts, as the trusses were all set at the same elevation. The trusses were held together by 2x6-in. ties about 10 ft. center to center, nailed flat on top of the top chord with five or six 20d. nails at each connection.

The ties were ordered put in by the building inspector after the construction started. The posts were toe-nailed to the tops of the trusses and the rafters toe-nailed to the posts, using four or five 10d. nails at each connection. The purlins were toe-nailed to the rafters, using one 8d. nail at each rafter. Where the ends of the purlins met, if they lapped sufficiently, they were nailed together with one 8d. nail and each of them toe-nailed to the rafter.

The purlins were stock 22-ft. material. What lap they had, if any, was whatever extra length the lumber chanced to have, that is, there does not appear to have been any intention to tie the purlins together at the ends with the object of making them continuous. In some places the lap was as much as 4 in., generally less and sometimes almost none at all. All purlins were laid with even joints and the sheeting was laid in similar manner, making continuous joints along certain purlins (foreground of Fig. 2, background of Fig. 4). Running along the middle of the building on top of the rafters from about 30 ft. from the front to about 45 ft. from the rear was a monitor of light construction, mostly windows, added to the original design after the construction was under way (Fig. 5).

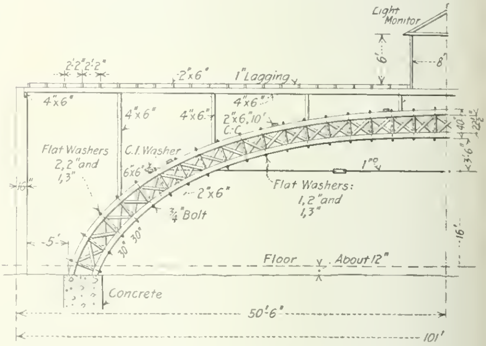
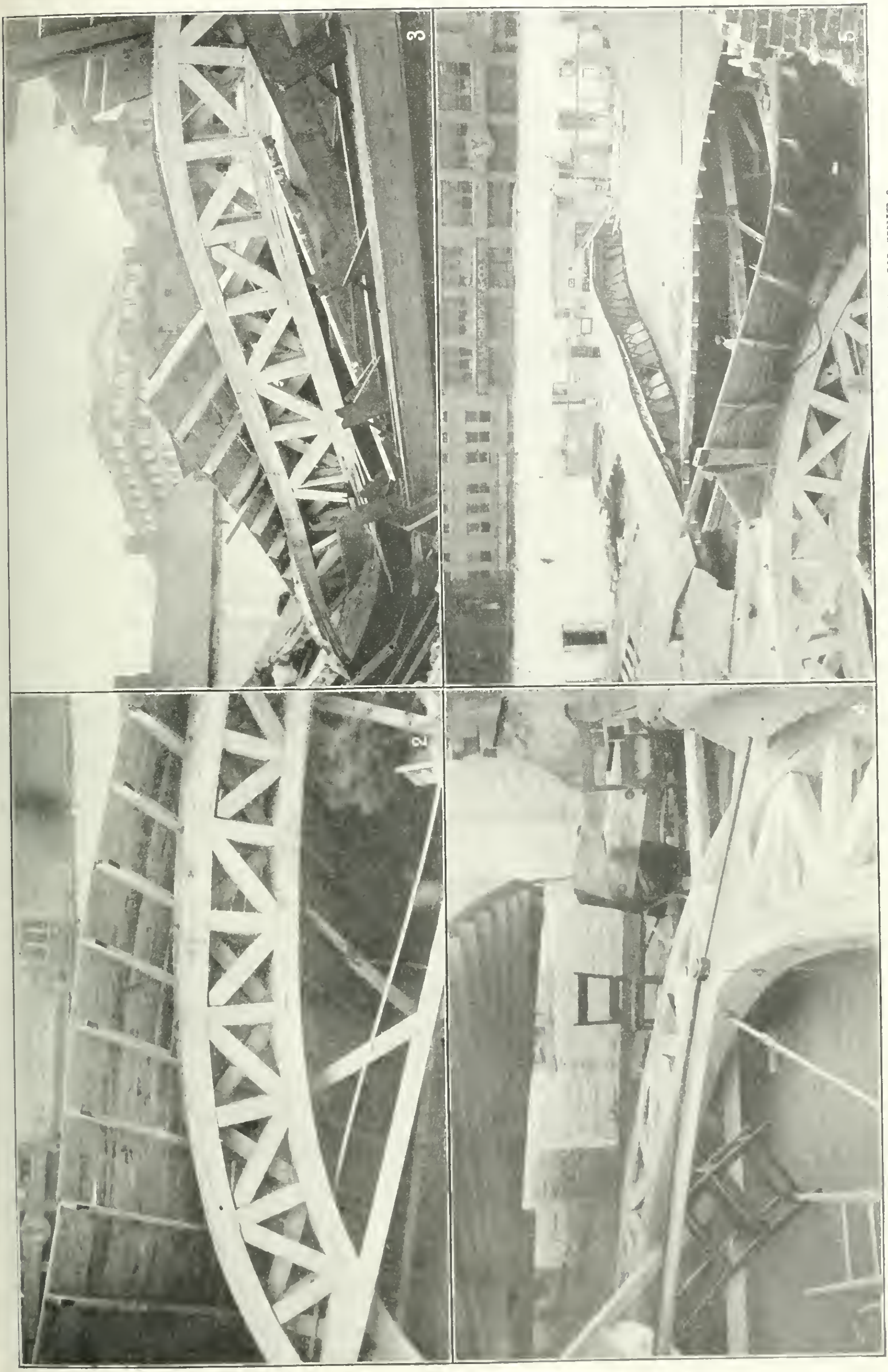


FIG. 1. DETAILS OF ONE OF THE ARCHES

The roof trusses were designed, built and erected without the tie-rods. During the erection there was a hard rain, and water several inches deep was impounded on top of the roof immediately to the rear of the skylight, showing that the trusses must have sagged under their own weight and the weight of the roof above them. They were immediately jacked up and propped and the ties put in to hold them up. (The building inspector says he ordered them in; the architect says he put them in of his own accord.) Only two of the trusses sagged under the weight of the water, and they were strengthened with additional braces in the form of a ¼x12-in. plate several feet long fastened by lagscrews to the side of the arch at the haunch at each end and a long plate of the same strength, fastened to the other side of the truss, reached from one of these shorter plates to the other and overlapped a little. A similar long plate is screwed to the rear side of the last truss.

The forward truss was 22 ft. in from the front wall. At 11 ft. from the wall the roof was supported on 2x4 rafters nailed to 4x4-in. posts, which were set on the top of a light wooden partition wall about 8 ft. high,



FIGS. 2 TO 5. VIEWS OF THE TIMBER ARCH TRUSSES OF SKATING RINK THAT COLLAPSED AT ATLANTA, GA., ON JUNE 9.

separating the offices, dressing rooms, etc., from the main hall.

The workmanship generally seems to have been fair, though the jointing of the diagonals of the trusses was not exact.

All the arched trusses fell toward the rear of the building and lie, lapping over one another, with the feet near where they stood. Only two of those visible are broken—the rear truss, in two places, and one near the middle of the building, in one place. Both were broken sidewise from striking obstructions as they fell. The rear truss is partly supported by a small room at each end, which reaches from the truss hard up against the rear wall, the room walls being about 8 ft. high. It might have been the push of the trusses transmitted through the 2x6 ties and the wall frames of these rooms, aided by the blow of the falling truss nearer the top of the wall, that caused the rear wall to fall.

It fell outward against a bank, almost as a complete wall, breaking loose near each end (one end shown in Fig. 5) and practically at the floor level. Parts of the wall, including the pilasters, are still intact. The window frames lean up against the bank, with the brick still in place above the frames.

The roof fell practically vertically. The condition of the glass in the monitor windows would seem to indicate that it fell all at once, producing litle strain in the monitor frame. The roof parted at most of the purlin joints and at some of the sheeting joints (Fig. 5). The first 22-ft. section at the front of the building stayed practically in place, supported by the posts on the partition wall. It was removed next day by order of the building department. Apparently this section was pulled down a little way at the rear end, as a part of the concrete-coped brick parapet along the front of the building was pried off and fell on the sidewalk. Six or seven courses of the tops of several pilasters along the south wall were pulled off by the plate as the roof fell. The pilasters generally are tied to the walls every header course, but the tops of these particular ones were not tied.

There are a few things about the design of this roof that deserve notice: The roof trusses apparently were not able to support the weight of the roof as originally constructed, so that reinforcing ties were put in after the trusses were up and the roof on. There was no sway bracing—nothing to prevent the trusses from falling over, once they overbalanced their less than 10-in. foot. The 2x6-in. ties later put in by order of the building inspector helped steady individual trusses, so that they must all have acted together, at least to the extent of the strength of the nails holding the ties. The posts supporting the roof above the trusses stood unbraced on top of the trusses, so that if the truss got out of plumb or the post itself were not exactly vertical, the weight of the roof above would have a tendency to push them over. The purlins were all laid with even joints, so that the roof did not have the stiffening that broken joints would give and parted in sections when the roof fell. The sheeting was similarly laid with a similar result.

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Curves for Irrigation-Ditch Velocity and Discharge

By L. R. Douglass*

Recently the writer was called upon to cross-section and measure a ditch some five or more miles in length, with a view of accurately determining the maximum velocities and discharges. Cross-sections were taken every 100 ft., and oftener where thought necessary. In order to eliminate the long and tedious calculation of Kutter's formula and also to save time and allow for a more intelligent study of each varying section, the accompanying diagrams were evolved.

Their use can be most easily explained by example. Take a ditch whose top width is 12 ft., bottom width 10 ft. and depth 2 ft. The grade or slope is 5 ft. to the mile, or for convenience 5 ft. in 5,000 ft. By calculation the wetted perimeter is found to be 14.47+.

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*Of Danford & Douglass, Civil and Mining Engineers, Trinidad, Colo.

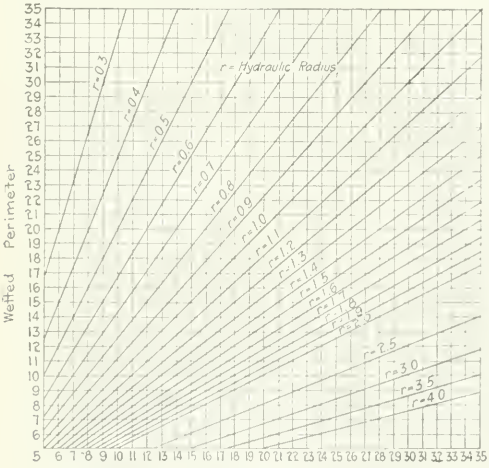

FIG. 1

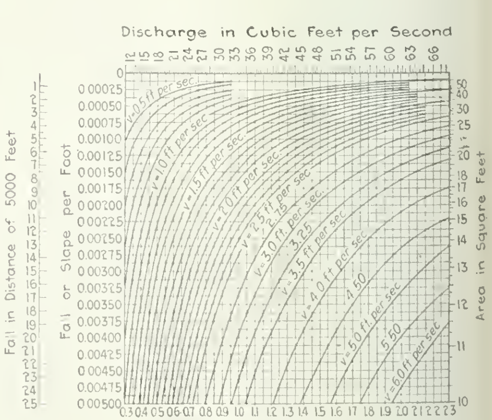

FIG. 2

CURVES FOR FINDING VELOCITY AND DISCHARGE OF OPEN CHANNELS

In Fig. 1 find the area 22 at the bottom and run ver-ically upward until an intersection is made with a line roduced horizontally from the wetted perimeter of 14.47. 'he hydraulic radius of 1.52+ is thus determined.

The next step is to find the velocity. Proceeding with 'ig. 2, we find the hydraulic radius of 1.52 at the bot-om of the sheet and run vertically upward to an inter-ection with the slope line of 5 ft. in 5.000, or slope of .001 per ft. This intersection point lies between the elocity curves 2.1 and 2.2 ft. per sec. By proportion-lly scaling (if greater accuracy than interpolating by ye is required) we find the intersection point to be at he velocity of 2.18 or 2.19 ft. per sec. Having the elocity, the discharge is then determined by taking the rea of 22 at the right of the sheet and producing it hori-ontally to the velocity line of 2.18. From the point hus found, run vertically upward to the discharge table t the top of the sheet, and the resulting discharge is ound to be 48 cu.ft. per sec., as nearly as can be read.

The velocity curves are based upon the value of n = .027 in Kutter's formula. This value is used where the anal is more or less irregular in regard to alignment nd cross-section, but free from stones and weeds. Such onditions almost always exist in the small irrigating anal ranging in discharge from 15 to 60 cu.ft. per sec.

With regard to the range in the velocity curves, it ay be well to state that in this country, where the soil mostly a sandy loam, velocities of 1.5 and 2.5 ft. per ec. may be considered as limiting: The first, in that it sufficient to prevent deposit of silt; and the second, ecause it is slightly below that which would cause ex-essive erosion. The curves without this zone, shown in ig. 2, were constructed to cover conditions as found in e ditch previously mentioned and have no particular alue except for like cases.

Actual calculation by Kutter's formula with n as 027 gives a velocity of 2.202 and a discharge of 48.44 u.ft. per sec., for the example assumed in order to illus-rate the use of the table. By increasing the size of e table and the number of velocity lines or curves, it readily seen that results can be obtained to a corre-pondingly greater accuracy.

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Platform Shelters of Concrete Unit Construction

The new station of the Southern Pacific Co. at Los ngeles, Calif., has the platforms covered by shelter roofs uilt of reinforced-concrete units. The roofs are of the 'butterfly" or concave type, sloping down from the eaves a central gutter. There are four platforms 710 ft. ng and 16 ft. wide, with roofs 18 ft. wide.

The main construction consists of a central row of -head columns, spaced 20 ft. c. to c. and carrying two ws of roof slabs 20 ft. long. This is shown clearly Fig. 1, with a locomotive crane placing the slabs in osition. The columns are 12x21 in. at the base and 2x18 in. at the top, with caps or heads 10 ft. long and 7 in. deep. On each side of the cap is a recess, form-ng a shelf for the end of the roof slab.

Reinforcing bars projecting from the ends of the slabs p each other over the top of the cap and are embedded cement mortar, which is filled in over the cap to the vel of the slabs. The longitudinal joint between the slabs is also filled with cement mortar. A roofing composition is laid upon the completed shelter. At intervals of about 340 ft. an expansion joint is provided, covered with copper flashing.

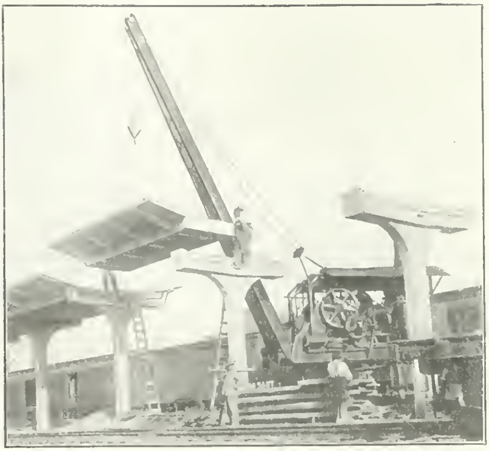
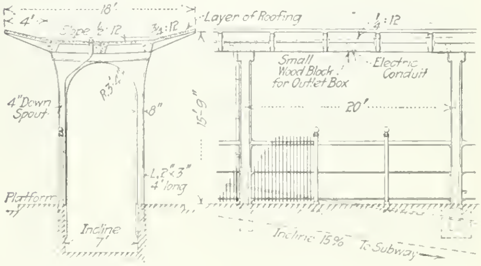


FIG. 1. PLACING ROOF SLABS OF PLATFORM SHELTERS BUILT OF CONCRETE UNITS; LOS ANGELES, CALIF.

The roof slab has a minimum thickness of 4 in. (increased to give an incline for drainage) and is stiffened by six transverse ribs. The columns are set in sockets, 18 in. deep, in pedestal footings.



Section through Incline

Elevation

FIG. 2. CONCRETE PLATFORM SHELTER WITH TWO-POST BENTS SPANNING INCLINE APPROACH

A variation in this construction is required where the inclined ramps connect the platforms with the subway beneath the tracks. Here the roof is carried by two-column bents, as shown in Fig. 2. These columns are 8x12 in., connected by an arched cap. They are set in steel sockets in the steel framing of the subway roof.

This station was designed and built under the direction of William Hood, Chief Engineer of the Southern Pacific Co. Similar platform shelters have been used in the Southern Pacific station at San Francisco, Calif., and in the new union station at Denver, Colo. They were built by the Van Sant-Houghton Co., of San Francisco, Calif.

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Artificial Ice Competes with Natural Ice—Although St Paul, Minn., is surrounded by spring-fed lakes and has the finest natural ice in the world, an artificial ice plant turning out 30,000 tons per year has been found to be a paying enterprise during the first twelve months of its operation by the Citizens Fuel and Ice Co

Field and Office

Innovations in Precise-Leveling Methods in Coast Survey

By William Bowie*

One of the most important changes in the United States Coast and Geodetic Survey precise-leveling methods is the mounting of the tripod on the frame of a railway motor car. John H. Peters, in charge of a Coast and Geodetic Survey precise-leveling party now operating in Indiana and Michigan, recently reported that he had leveled about 60 mi. with the tripod of his instrument mounted on a motor velocipede with which he transports his party. The results were so satisfactory that each of the three leveling parties of the survey now in the field will adopt this method of mounting the instrument.

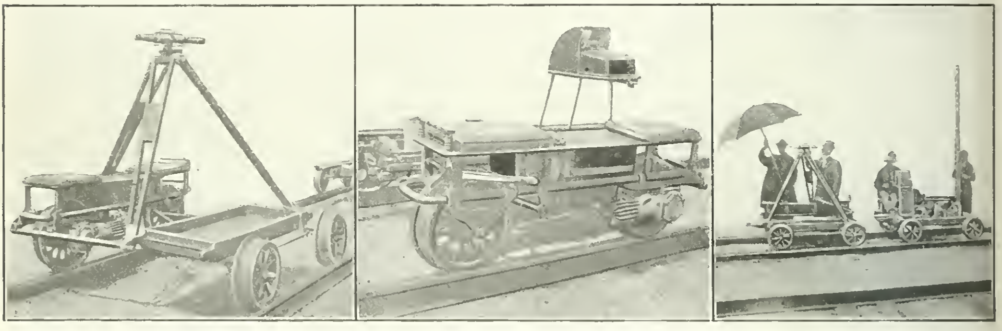
The 60 mi. were run in both forward and backward directions, and the accumulated discrepancies between the two runnings were only 3 mm. for the entire distance. The accumulated difference changed signs a number of times, showing that there was no systematic error in even a single running. It is certain therefore that the accuracy of the leveling is as great with the tripod mounted on the car as when it is set up on the ballast of the track, the universal custom to the present time.

The tripod is placed in position at the beginning of the day's work, and it is not dismounted until the party starts back to headquarters at the end of the day. It even remains on the car when the track is cleared for passing trains. Mr. Peters reported that the vibration of the car while traveling between instrument stations did not throw the instrument out of adjustment.

One can readily see advantages in this new way of setting up the tripod. It is free from the effect of the observer standing on the ties or ballast near a tripod leg. The car weighs 350 lb., so that the mounting is very firm and the height of the instrument remains constant while both sights are taken at a station. The time of setting up the tripod has been eliminated, and the time necessary to level the instrument is only a few seconds where the grade is uniform and the track straight. The leveling can be done quickly even where there are changes in grade and curvature of track between instrument stations.

It is possible that a mounting for the instrument different from that described may be devised which will be even better than the ordinary wooden tripod with the legs shortened. It might be somewhat more convenient to the observer, but probably would not result in greater speed and certainly not in increased accuracy.

There is no reason why the railroad leveling with the engineers' ordinary level should not be done in many cases with the tripod mounted on the car, as in the precise leveling by the Coast and Geodetic Survey. Even the hand velocipede car will no doubt be sufficiently rigid for the purpose.



FIGS. 1 TO 3. EQUIPMENT FOR FAST WORK IN PRECISE LEVELING, UNITED STATES COAST AND GEODETIC SURVEY

1—Level tripod mounted on railway motor car; 2—Adding machine by tabulating records; 3—Party and equipment complete

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Big Excavator Replaces Gold Dredge in Klondike

Nearly all the mining companies operating on a large scale in the Klondike on creek or river gravel use the ordinary type of floating dredge, but the North West Corporation, Ltd., is trying out the large electric-driven excavating machine illustrated in Fig. 1. This machine was reconstructed by Taylor & Hubbard, Leicester, England, from a German excavator[1], and was fitted by Leach & Goodall, of Leeds, with a washing plant and stacker for handling the coarse tailings. In the *Engineering and Mining Journal* of June 17, C. A. Thomas describes this excavator.

The complete machine weighs 170 tons and operates on two sets of tracks of 39½-in. gage, the outside rails being 23½ ft. apart. The machine is carried on four trucks having four wheels each. Each truck has two flanged

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*Chief, Division of Geodesy, United States Coast and Geodetic Survey

[1] Made by the Lübecker Maschinenbau Gesellschaft, Lübeck, Germany; described by George J. Young, "Brown-Coal Mining in Germany," Bull. Am. Inst. Min. E., February, 1916.

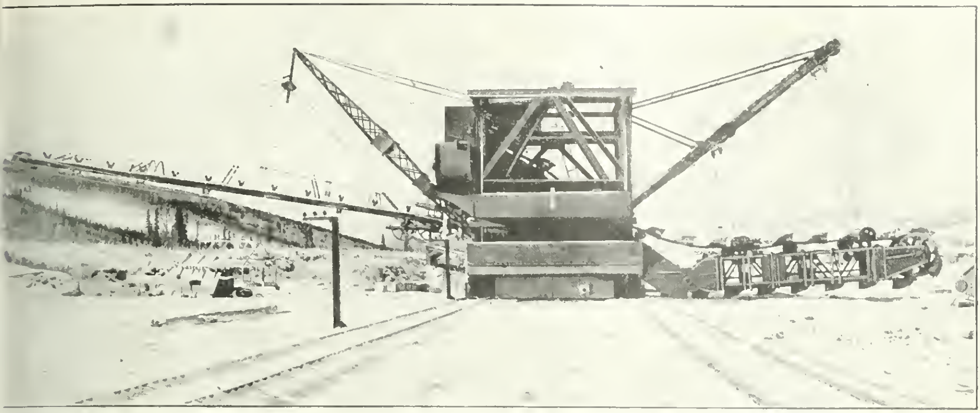

FIG. 1. LÜBECKER EXCAVATOR REMODELED FOR GOLD DIGGING IN THE KLONDIKE

ıeels on the outer side and two flat-surface wheels on the ner, the latter being the driving wheels to which power transmitted by a set of bevel gears. The frame is com-ɪsed principally of 12-in. channels and I-beams and is x22 ft. in plan. The excavator is 27 ft. 4 in. high.

The speed traveling parallel to the open cut can be ried from 3 to 10 ft. per min., and is determined by e depth to which the buckets are digging.

BUCKETS FILL IN TRAVELING TOWARD MACHINE

The buckets are open-connected, of riveted sheet steel th a cast-steel cutting lip. They are connected by steel ıks and pins, a cast-steel lug riveted to the sides of the ıcket forming one of the links of the chain. These gs and connecting links traveling in a channel on the ıderside of the ladder keep the bucket down against the aterial to be excavated and take the entire stress of dig-ng. The buckets are spaced 4 ft. 9 in. c. to c. The ɪeration of the excavator is explained thus:

> The buckets are filled as the line travels toward the ma-ine on the lower side of the ladder, which is the reverse of e ordinary dredge operation. After passing over the inter-edlate tumbler, the full bucket line travels up a sheet-steel ute, being held about 3 in. from the bottom by cast lugs on e sides of the chute. At the same time that the buckets are ing filled, the whole machine is propelled along its two sets tracks, corresponding to the swing of the floating dredge.
>
> As the line passes over the upper tumbler, the rear of the ıcket disengaging from the connecting chain allows its ntents to slide out the back end into the dump hopper. :fore the bucket passes over the top of the upper tumbler ls in an upside-down position over the hopper. The empty ıe returns to the lower tumbler in suspension or carried on ;ht flanged-wheel idlers.
>
> As the gravel is dumped into the hopper, it is dragged to e starboard side of the machine by an endless raker chain ɪmposed of cast links and crossbars, supported and driven cast sprocket wheels. At the end of the steel-plate com-rtment through which the raker chain carries the material be washed there is an opening that allows all material to op to a second compartment immediately below; and the me chain returning after passing over the sprocket idler, ags the material over a set of grizzly bars, approximately ft. long Two 8-in. spray pipes, extending the full length this compartment, furnish water for washing and separat-g the fines and gold from the coarse material. This operation ɪes away with the revolving or shaking screens of other pes of placer-mining machines. The fines, after passing rough the grizzly, are carried by steel sluices to the gold-ving tables. The coarse material is dragged by the cross-ırs of the raker chain past the grizzly-bar ends, where it lls into a metal chute and is conveyed by gravity to the acker.
>
> The tables are constructed in two 20-ft. sections of six sluices each, having a fall of 1½ ft. in 20 ft. and a total area of about 720 sq.ft. After the water and fines have passed over the last section, they are collected in a steel sluice and carried across the machine to the sand-elevator settling tank on the port side of the excavator. This settling tank is 27 ft. 7 in. by 54 in., with bottom sloping to the center, making a sump for the collection of sand for elevation by a bucket conveyor. These buckets elevate the sand to the top of the machine, where it is dumped into an extension of the steel chute that delivers the coarse material to the stacker. The water from the sand-elevator tank is conveyed across the machine to a series of steel settling tanks under the tables. From these tanks the water is repumped to the spray pipes over the grizzly bars, and in this way is used over and over for washing the gravel.

The stacker is 70 ft. long, equipped with a 24-in. canvas conveyor belt, and can neither be lowered nor elevated. The discharge end is 20 ft. above the rails.

The bucket line is driven by a 100-hp. motor through an intermediate shaft, on which is a friction clutch which can be set so the pinion will be automatically released if the stress becomes too great for the bucket line. A 30-hp. motor drives the ladder hoist, and it is this motor that propels the machine. The raker-chain, stacker, and sand-elevator drives are all taken from a countershaft connected to the 30-hp. motor. The electrical equipment was manufactured by the British Thompson-Houston Co., Ltd.

The machine is at present located on Dominion Creek, Yukon, Canada. Power will be furnished by the North Fork Power Co. from the North Fork of the Klondike River, 19 mi. from the present site. Current is transmitted at 33,000 volts and stepped down to 220.

⁂

The Stability of Material Towers of the temporary variety used to elevate building materials to the proper floor level, is an important consideration. This is especially true in view of the general spread of the compensation laws. In large cities towers of this character frequently serve a dozen stories and unless well-designed and constructed of sound timber add materially to the general hazard of the building trade. They must be braced and strutted and either guyed or anchored to the building. The subject is briefly treated in "Scaffolds," published by the Travelers Insurance Co., Hartford, Conn. This states that when a high building is to be erected it is better practice to add to the height of the hoist tower as demanded by the progress of the main construction. Sometimes a pair of towers are employed, in which case the two structures should be tied together by horizontal and diagonal stringers. It also notes that hoist towers are often sheathed with boards, and where this is done it is better to cover them on the inside Doing this, results in a smoother surface for the elevator. This excellent recommendation is by no means general practice. The main objection is that the area of the hoistway is reduced, unless the plan dimensions of the tower are increased.

Tracks for Heavy Excavators on River Diversion

Unusually heavy portable-track construction is required to support the heavy excavating machines working on the river-diversion channel of the Little River drainage district, near Cape Girardeau, Mo. The machines are Bucyrus 175-ton and 200-ton dragline excavators, each carried by four 4-wheel trucks on two 3-ft. tracks.

The track construction is shown in Fig. 1. Each track is in sections about 18 ft. long overall and 8 ft. wide. The base of the section is a course of 4x12-in. longitudinal planks, upon which are 8x12-in. crossties 8 ft. long, with two 12x12-in. track stringers carrying 100-lb. rails. The stringers are tied together by through-bolts and have transoms of spacing timbers between them. Under the ends of the rails are ½-in. steel plates 12x18 in., and ¾-in. bolts pass through the rail flanges and through the entire thickness of the track.

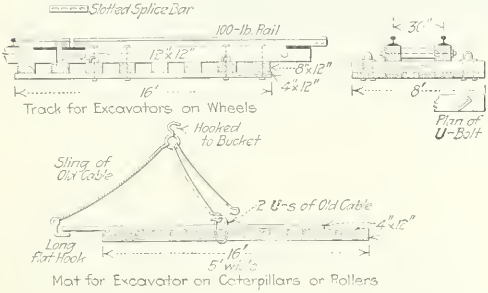

FIG. 1. TRACK AND MAT CONSTRUCTION FOR EXCAVATORS ON WHEELS AND CATERPILLARS

It will be seen that the track sections overlap. At one end the stringers project 30 in. beyond the base, and the rails project 10 in. beyond the stringers. Thus the rail ends and stringers of one section rest upon the stringers and crossties of the adjacent section. The rails are spliced with fishplates of 1x4-in. steel, with slotted holes.

The track sections are shifted as required by hitching them to the boom of the excavator. For attaching the slings there are four U-bolts, set diagonally in the ties. These are more satisfactory than eye-bolts.

The stripping of surface in advance of the main excavators is done by 90-ton Bucyrus dragline machines. Each of these is mounted on four caterpillars, as shown in Fig. 2; but even this base is not sufficient on the wet soft ground, which is further broken by numerous stump holes. To provide support for the caterpillar machines and also for lighter machines that travel on rollers, heavy timber mats or platforms are used, as illustrated in Fig. 1. These are 18x5 ft., built up of three layers of 4x12-in. planks. The longitudinal bottom planks are 16 ft. long, and those of the top layer project about 30 in., so as to lap over the next section.

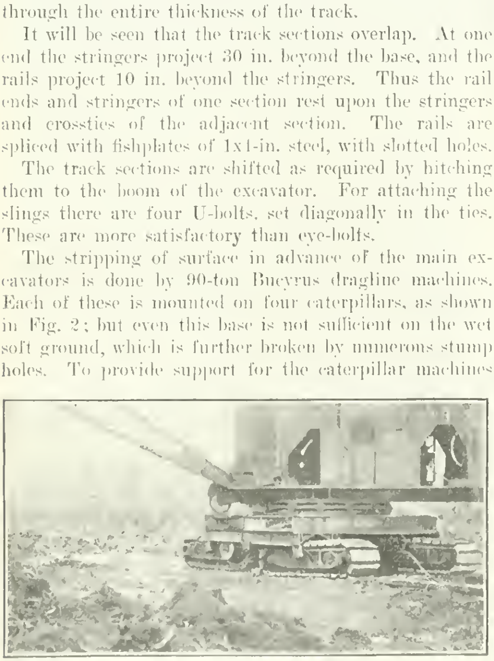

FIG. 2. DRAGLINE EXCAVATOR MOUNTED ON FOUR CATERPILLARS ON PLANK MATS

In shifting these sections they are attached to a three-part sling that is hooked over the excavator bucket. The sling is of old cable; one line carries a large flat hook to engage the projecting front edge of the mat; the others have ordinary hooks to engage U-loops placed slightly in advance of the center of gravity of the mat. The loops are made of old cable.

Information as to these details was furnished by S. T. Neely, Manager and Engineer of the Floesch Construction Co. (Rochester, N. Y., and Cape Girardeau, Mo.), which has the $1,260,000 contract for the work.

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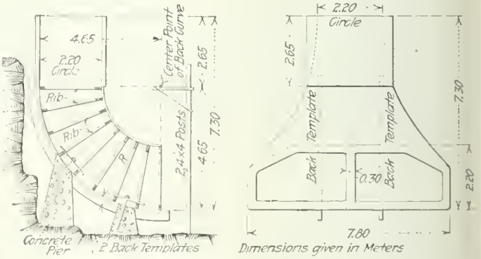
Forms for Heavy Concrete Draft-Tubes

By H. H. Braun*

In the construction of the five large draft-tubes for the 13,500-hp. turbines of the Ebro Irrigation and Power Co., near Lerida, Spain (described in *Engineering News*, Sept. 10, 1914, p. 536), the details of the formwork presented some difficulties. These tubes, of the general dimensions shown in the accompanying sketch, are fluted on the horizontal axis, turn a 90° curve and change from a circle at the top nearly to a rectangle at the bottom.



TIMBER FORMS FOR CONCRETE DRAFT TUBES

The forms were so large that it was necessary to erect them in place. Great care in location was imperative.

The top and bottom curves of the draft-tube are true circles, with the same center. The cross-section at nine different points, radial to the back curve, was determined and ribs built to these shapes, 1¼ in. being allowed all around for lagging. Two templets somewhat longer than the back curve and to the same radius, less 1¼ in. for lagging, were built of two layers of 3-in. plank and were made strong enough to bear the weight of the assembled form. One set of templets was used for all five draft-tubes.

Two posts were erected in front, bearing a light scaffold on which the true center of the back draft-tube curve was located with a transit and level. These centers were set about 3½ ft. each side of the center line of the unit, in line with the templets. The curved back templets were located by means of a 2x2-in. stick cut to the proper length, swinging from these centers, and then secured by blocking and bracing. The ribs were erected on these emplets, properly spaced by measuring along the templet, nd the direction determined by a string drawn from the enters on the scaffold. The ribs were held in place by racing. The form was then lagged, with the exception f two 6-in. strips where the ribs rested on the templets.

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*Room 1636, 120 Broadway, New York City.

As it was necessary to remove the blocking and temlets before concreting, two small saddles, or piers, with ix sleeve bolts in each, extending the entire width, were uilt underneath to carry the framing after the removal f the templets. The piers were concreted through holes 1 the draft-tube forms. After the concrete had set, the old-down bolts were tightened, the piers stripped and ie blocking and the templets removed, leaving the form ecurely bolted down on two concrete saddles. The mass oncrete was then poured, no additional bracing being equired.

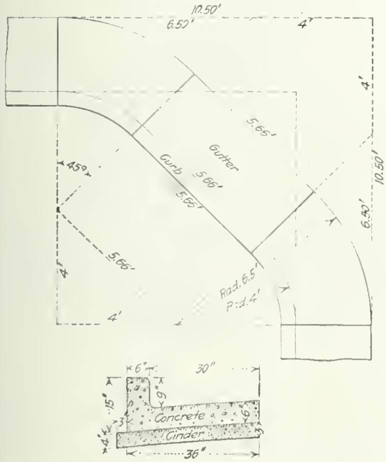
The power system was built by the Pearson Engineerig Corporation, under the direction of A. W. K. Billings, Ianaging Director, Fred W. Abbot, Manager of Conruction, with the writer in immediate charge of powerlant construction. Alfred Sauerbraun was in charge of ie Seros division.

* * *

Corner Inlet, Catchbasin and Curbing at Pueblo

Corner curb inlets and catchbasins are standard pracce in Pueblo, Colo. Instead of being on a 90° arc ie curb has two 45° arcs with a short tangent between. his allows the catchbasin inlet to come on a plane irface, as shown by Fig. 1.

The inlet is illustrated in Fig. 2. The interior is adily accessible from the gutter but not from the side-



IG. 1. DETAIL OF CORNER CURBING, PUEBLO, COLO.

alk. The top grating is designed to keep out leaves and her débris. Yet should the grating become clogged iere is always the 4½-in. opening under the curb.

The bottom of the inlet is built as a plane surface, oping toward the sewer outlet. This is constructed of ick in the detail shown, but in practice it is customy to make this wedge-shaped masonry of concrete, using one, brickbats and other coarse material. The inlet, id also all sewer manholes, are lined inside and outside with a plaster coat of cement mortar, the mixture used inside being 1:1 and outside 1:3.

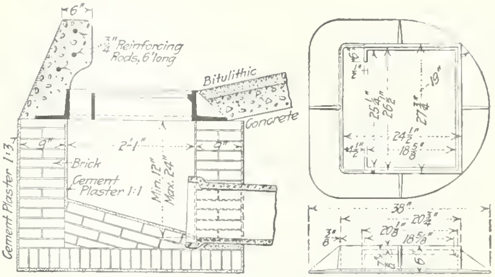


FIG. 2. DETAIL OF CURB INLETS, PUEBLO, COLO.

The foregoing data were obtained at the office of D. P. Gaymon, City Engineer, Pueblo, Colo.

* * *

Broken Cylinder Repaired by Autogenous Welding

By Patrick J. McGrath*

A steel pressure still for oil, 9 ft. 10½ in. in diameter by 30 ft. long, which had been hammer lap-welded in a gas fire originally, but had not been properly annealed, broke through the solid ⅝-in. steel plate for a length of 30 in. The break was parallel to, and about 12 in. from, one of the girth welds. At the time of the failure the cylinder was under a hydrostatic pressure of 150 lb. per sq.in. The crack was $^3/_{64}$ in. wide for practically its entire length.

Owing to the fact that it was not advisable to dismantle the fittings, it was necessary to make an autogenous weld. This was about 120° from the bottom (the cylinder being on its side) of the shell. It is generally conceded that the bottom of such welds contains slag and that a solid weld throughout the entire section is difficult to obtain in view of this fact.

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*Summit Road and Park Ave., Elizabeth, N. J.

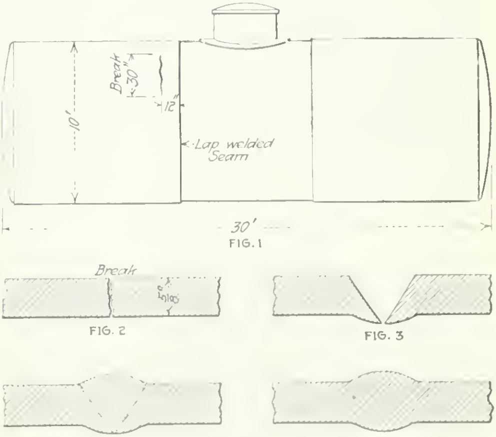


FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIGS. 1 TO 5. LOCATION OF BREAK IN CYLINDER AND SEVERAL STEPS IN WELDING IT

1—Location of crack. 2—Cross-section of plate, showing crack. 3—How crack was prepared for welding. 4—Well completed but not dressed. 5—Finished job.

The break was prepared for welding by cutting the customary V to the full depth of the plate, after which the edges of the apex of the V were heated to red by means of the torch and, by using a hand fuller tool, were set down in the manner shown in Fig. 3. Before filling the V we welded crossbridges at 8-in. intervals to prevent drawing together by contraction of the welded parts. The after effects of contraction, due largely to heat that escapes into the body of the plate when welding, were minimized by pouring water on the plate about 8 in. from each side of the weld.

After welding about 4 in., we thoroughly hammered the weld and adjoining metal from inside and out alternately, meanwhile holding on with a sledge on the opposite side of the plate. After welding, the inner surface was chipped until the solid metal under the scale was reached, when it was finished by grinding out every vestige of the break with a portable emery wheel.

⁂

Dragline Wagon Loader for Roadwork

A combination portable dragline excavator and wagon loader has been devised by Barbeau & Werring, state road contractors, Minneapolis, Minn. One of these is now on gravel-road construction at Worthington, Minn.

A gasoline engine operates by chain drives two hoisting drums, mounted on a light steel-frame truck, as shown in Figs. 2 and 3. The hauling-line hoist is at the top of the triangular body frame, and the outhaul line is manipulated from a hoist below.

The loaded skip is drawn upon an elevating hopper, which is raised into dumping position by the hauling line. At the top of the wagon frame the hopper and skip are in a position that causes the gravel to slide out through a chute into the wagon. No bin is provided.

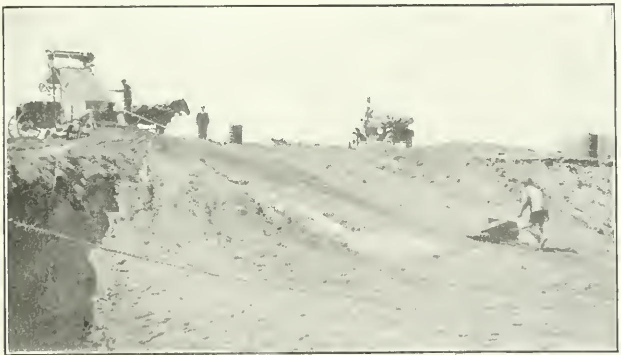
The apparatus is still experimental and is doubtless capable of improvement. W. F. Rosenwald is Division Engineer for the State Highway Department on this work.

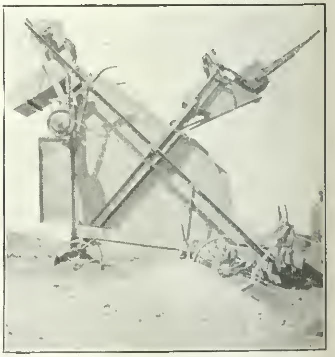
⁂

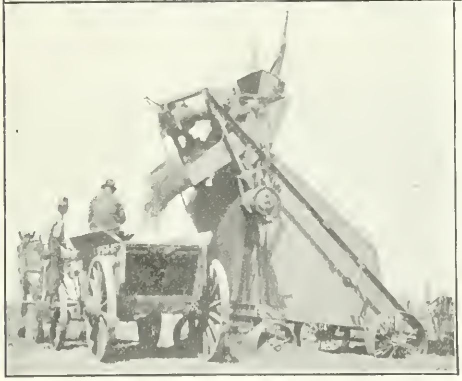
How to Handle a Misfire

When electric blasting caps are used and one or all of the holes fail, disconnect the wires from the blasting machine, and it is safe to go back immediately to investigate the trouble. The investigation should first consist of a search for broken wires, faulty connections or short-circuits.

When blasting caps and fuse are used, greater care must be exercised. It is never safe to go back immediately to a delayed shot that is primed with a blasting cap and fuse. The fuse may have been injured in tamping and instead of burning rapidly may smolder for a long time, then reignite the powder in the lower end of the fuse and fire the blast. The interval of waiting should be as long as possible, preferably until the next day if the firing is done in the afternoon. In all cases the wait should be several hours. When lighting fuse, be sure that the powder column is on fire, as time may be wasted in waiting for a blast whose fuse is not even lighted. Never use blasting-powder squibs and blasting powder for detonating dynamite charges.







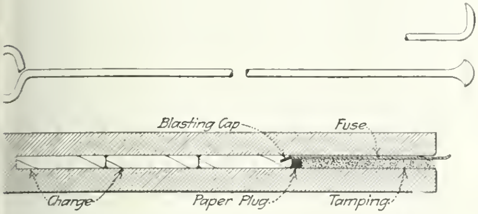
FIGS. 1 TO 3. A DRAGLINE WAGON LOADER ON MINNESOTA STATE ROAD CONSTRUCTION

If the hole is untamped or is tamped with water, make up another primer, place it on top of the charge, and fire. If the ground is soft and wet, put down another charge far enough away for drilling in safety, but close enough to cause detonation by concussion. When this is not possible, there are two methods of relief. The tamping can be carefully removed almost down to the charge with a spoon and hardwood probe. Extreme caution must be observed, especially when the cap is in the top cartridge of the charge, to prevent danger of firing the cap by friction or impact. The upper sketch (page 79) is a type of spoon recommended by the Du Pont Co.

When it is necessary to blast out a misfire by drilling and charging a second hole, much care should be used.

ch a hole must be far enough away from the charge to ake drilling and loading safe, but must be close enough insure the old charge being blown out together with e rock or confining ground.

When, for any reason, misfires may be expected, a od practice is to put a wad of paper or dry leaves imediately over the charge of explosive and pack the tampg on top of this. If it becomes necessary to remove the mping, this dry material makes an excellent index of st how far down it is safe to remove the tamping. All isfires should be placed under the direction of a careful d experienced workman, who should make his examation in a slow, methodical manner before beginning e work of repriming.



UPPER—A GOOD SPOON FOR REMOVING TAMPING. LOWER—PAPER PLUG PLACED OVER CHARGE

⁂

Where Dump Wagons Are Superior to Carts

Distributing concrete in drop-bottom dump wagons is usual. For a haul of more than two blocks the wagon superior on account of its greater capacity, in the same ay that large wheeled-scrapers are superior to small sliprapers for handling earth where the haul is long. A nger haul is also said to be practicable, even up to 10 or 2 blocks, thus reducing the number of moves or set-ups the concrete-mixing plant. With large loads the concte does not set during transportation.

Further, where slow-setting cement is used, there is a ssibility of establishing the mixer plant near the railway source of supply (as with asphalt plants) and distributg all or a large proportion of the concrete from this e point.

One contractor who has used both one-horse carts and vo-horse dump wagons is John A. Beebe, of Omaha, Neb. e states that as a result of his experience he sold the rmer and increased the number of the latter. He found difficult to hire single horses; the cost was nearly as uch as for a team, and the men leading or driving them ere apt to walk slowly at the end of the day. Teams for e wagons were easily obtained; the load did not tire the orses, and as the driver rode, he did not slow down the ace. In this way from 50 to 60% more concrete was laced in a working day, while both men and horses were ss tired after the work.

Another advantage is that the dump wagons can be sed also for hauling dirt or other material, while the arts must stand idle when not in use for hauling concrete. is latest work was in paving at Benson, Neb. The haul as one to three blocks, using Stroud wagons with ¾-yd. ads. A little sand was thrown in the bottom to prevent akage.

The Monarch Engineering Co., of Falls City, Neb., has sed the same make of wagons for hauling concrete in street work at that city and at Sabetha, Kan. The haul was from two to four city blocks of 300 ft., and the load was 30 cu.ft. (two batches) of 1:3:6 concrete. This firm's experience with carts and wagons has been about the same as that noted.

At Aurora, Ill., a large amount of concrete has been placed in this way, especially the base for street paving. Several contractors have used Western dump wagons for hauling both excavated material and concrete. The same equipment serves for hauling gravel when weather does not permit of concreting. As to the possibility of leakage, Mr. Tarble, City Engineer, states that this can be avoided by using practically new tight-closing wagons and exercising proper precaution in cleaning out after each dump. There has been very little trouble of this kind.

Mark H. Lynch, of Boston, Mass., and the Eureka Construction Co., of Tulsa, Okla., have used Watson dump wagons in this way. Some dump-wagon builders state that their wagons have been used for this purpose, but cannot mention specific cases. With the use of the high-side dump wagon, special arrangements are required to get it under the spout of the mixer. Usually the driveway is excavated to some extent, and the mixer raised by placing it on planks or blocking.

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Rock-Filled Wire-Mesh Bags for River Protection

The accompanying views show some of the flood-protection work on the Santa Ana River in California. The rock mounds or levees are laid inshore from the low-water lines of the river as a protection against encroachment in time of high water. The wire mesh is first laid in longitudinal strips and wired together. The boulders are

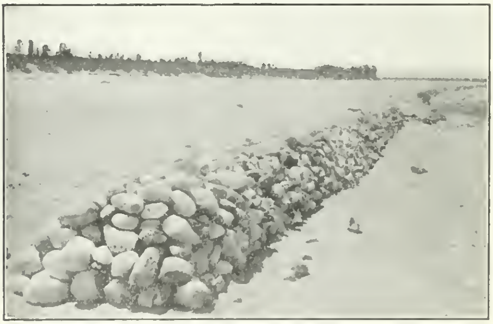


FIG. 1. ROCK MOUND LEVEES ON SANTA ANA RIVER

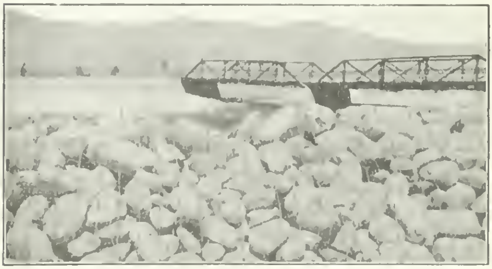
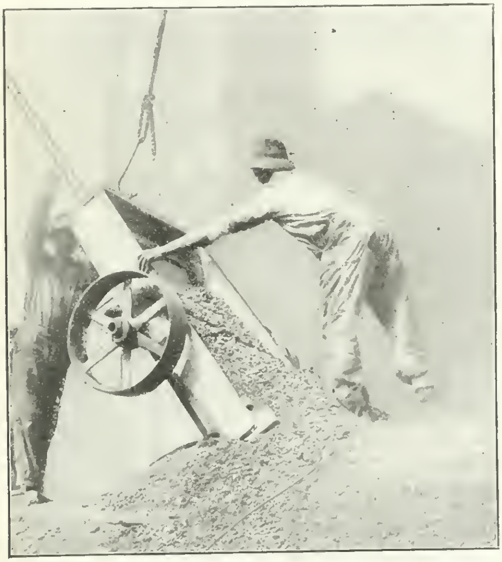


FIG. 2. NEAR VIEW OF ROCK MOUND IN WIRE MESH

then dumped on top to the desired shape and height, and the ends of the mesh are brought together and wired at the top. This forms a very flexible levee and one that will readily sink when undermined and thus stop undercutting. A similar system has been in vogue in India for some years. An installation there was described in *Engineering News*, May 6, 1909, p. 490. It is stated, however, that the system as used in California has been patented in this country by W. E. Pedley, of Riverside, Calif.

NOTES

A Gravel Cart Made of Scrap—The prohibitive cost of moving gravel by wheelbarrow up a steep grade was ingeniously overcome by a gravel cart built of scrap materials, by Edward Christman, well contractor, in building a well sump at Indian Head, Md., recently. The view shows the construction of the cart. Old pulleys on a piece of pipe formed the wheels and axle. The sills were made of 2x4s and the body was built of inch planks. A wire bridle served for towing, and the cart was steered by a 2x4-in. tongue. The motive power was the winch drum of the well-drilling machine, which wound in a wire cable running through snatchblocks and attached to the bridle. A load of 15 cu.ft. could be hauled 100 yd. and dumped, in a minute and a half.—Lieut. C. L. Lothrop, Jr., Indian Head, Md.



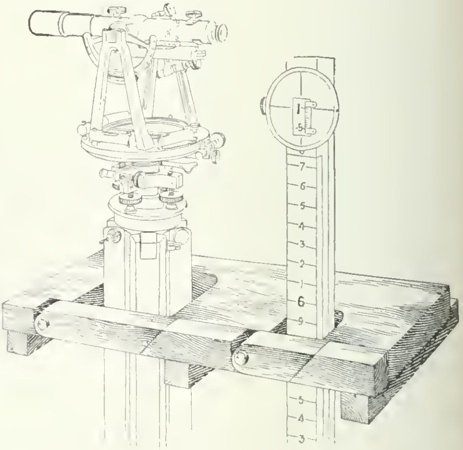
HOMEMADE GRAVEL CART WITH PULLEY WHEELS; PULLED BY CABLE AND STEERED BY TONGUE

Office and Yard Lighting were discussed by Ward Harrison recently, at a meeting of the Association of Iron and Steel Electrical Engineers, in Pittsburgh. The following are his opinions: During the past year the tendency in office and drafting-room lighting, even in industrial plants, became so decidedly in favor of indirect or semi-indirect units that scarcely a factory building is now erected in which this form of illumination is not employed in the office space. In installing a semi-indirect system bowls of great density must be chosen, otherwise the results will be but little superior to those obtained from direct lighting. The density of the glass should be such that the bowls are not markedly brighter than the ceiling. The extensive use of gas-filled tungsten lamps in street lighting has led recently to the development of the prismatic glass reflector, in which the prisms are kept free from dust by being placed on the inner surfaces of two glass bowls which are then fastened together and made air-tight. This fixture is quite as effective in yard lighting as in street illumination. For a 300-watt gas-filled tungsten lamp the intensity at angles near the horizontal is nearly 900 cp., and it is the light at these angles that is most effective in illuminating distant areas and dark corners. Flood lighting is beginning to show a utilitarian value as well as one purely decorative. It is useful in furnishing light in and about large industrial plants. If a gantry crane, for example, is to be repaired at night and no convenient facilities are available for obtaining electric light close at hand, a projector may be mounted in a window of a building many yards away and the centre of operation as satisfactorily illuminated as if a portable cluster were used. Aside from the matter of night repair and construction work, it is worth while for the plant electrician to keep on hand a number of these projectors for operation in case of strike or other disturbances. Lighting up the approaches to a plant in this effective manner by a battery of units has obvious advantages.

An Artesian Well to Float Dredges for digging a drainage canal near Crawfordsville, Ark., is to be put down by the Canal Construction Co., of Memphis. Instead of waiting for the fall rain to fill the ditches, a centrifugal pump will be used to lift the water. Seven dredges will be used in digging the canal. The latter will drain 90,000 acres. The contract price for the canal is $47,000.

A Handle for Carrying Duct Tile is used by workmen of the Rochester (N. Y.) Gas and Electric Co. It is made by bending a stiff rod into S shape. The top is grasped by the hand, and the bottom is slipped into the tile. The vitrified clay has sharp and burred edges that cut the men's hands; formerly the tiles were carried by slipping a pick handle or stick through a duct.

Surveying-Instrument Rack for the Field Office—When we had an instrument on the job we always begrudged the time necessary to take the transit off the tripod, put it away in its box, etc. On a recent job of the Samuel Austin & Sons Co. a wall rack was made in which the instrument with its tripod could be placed and so the need for dismounting obviated. A small shelf, say 2 ft. long, was built about 4 ft. off the floor, high enough to come almost to the top of the tripod standing vertically. Two notches were cut in the shelf, one to receive the head of the tripod, the other to take rods. The front of each notch was shut off by a vertically swinging gate which when closed locked in by the dovetail cut of its end. When the operator comes in off the job with the transit on the tripod he folds the legs of the tripod close together, stands it upright in its proper notch and shuts the gate in front of it. A possible improvement would be to provide a heavy oilcloth cover to put over the transit when it is in the rack.—Allen Brett, Cleveland, Ohio.



SURVEYING INSTRUMENT RACK FOR FIELD OFFICE

Removing Pulleys that have been rusted on shafts is frequently a troublesome job, but can generally be accomplished by heating the hub with a charcoal fire or some other means. The hub will expand, and the wheel can be easily removed. Care should be taken, however, not to heat the shaft, for if it expands as much as the hub nothing is gained.—"Power."

Editorials

Wanted: A Joint Committee on Nomenclature

The making of a technical definition is notoriously difficult. Local meanings are quite variable and the dictionaries are generally both inadequate and wrong. Consequently the individual or the small group that attempts to set down in precise terms just what some well known technical word is meant to convey is generally subjected to most critical comment, for it is strange but true that almost any engineer can on a moment's notice build up an opposition definition which he is prepared to defend against all comers.

And yet the fact is obvious that some standard definitions are most woefully needed. Take, for instance, concrete. It is safe to say that to nine engineers out of ten the word concrete—just plain unqualified concrete—means the hard stone-like substance resulting from the setting of a mixture of a hydraulic cement with some inert, inorganic aggregate. Yet the dictionary does not justify that definition, nor would the road men who talk of asphaltic concrete accept it. The narrow definition has been proposed by the Nomenclature committee of the American Concrete Institute. In contrast thereto, the Gypsum committee of the American Society for Testing Materials proposes a definition which would label as concrete a mixture of glue and sawdust.

This confusion is multiplied by the number of terms needing definition, particularly when such terms are jointly used in different industries. No small group can settle the difficulty. What is necessary is a joint committee of unquestioned standing and the widest of fields—a committee which will be able to weigh the claims for preference and will be of such authority that its pronouncements will by that fact *become* definitions.

What society will be the first to propose such an organization? It is no mean job that it would have before it; the French academy in many decades is only through the first dozen letters in its formulation of a dictionary of the French language. In its more restricted field a Joint Committee on Nomenclature would have just as hard and as useful a job.

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Sensational Questions in New Column Tests

The real situation surrounding the new column tests of the Bureau of Standards appears to be that the results are very fair and satisfying on the surface, but deeper down give cause for serious concern. It is not possible to find the latter in the few scanty data released by the Bureau in its present short memorandum. Fortunately some additional information is available. The general figures of results justify the most optimistic news as to column strength. They show performances not approached by the bridge-builder's skill in prior construction. Earlier tests showed that modern columns of standard bridge steel will develop a high strength—practically the yield-point of the metal. The great Washington test series made by the Bureau for the American Society of Civil Engineers, fully discussed in these columns some months ago, may be referred to for clear proof of this fact. Now come the new tests with most gratifying confirmation of the general law, by showing that high-strength special steels will improve the resistance of the column in proportion to the increased strength of the metal.

Thus it now appears certain that special and alloy steels retain their full advantage when fabricated into columns. All the assumptions which lead to the choice of such steels for very large bridges are thus approved.

No less emphatic approval is given to the work of the designing engineer. In these tests he is found to have been completely successful in the endeavor to construct an integral strut, a column which will fail in the body and not in details. The engineer has applied the metal to column service with 100% efficiency.

Two-thirds of the struts in the test series failed by integral body curvature; every detail held up. Only one-third failed by local crippling, and even these came close to the full-efficiency mark, since their strength figures compare closely with those obtained with the body failures.

These two certificates of merit naturally produce feelings of satisfaction. But further we may congratulate ourselves on obtaining the valuable teachings of the several detail failures observed in the tests. There are disclosed certain slight weaknesses in latticing, in pin jaws, in thin-plate flanges stitched together. By improving these details we may reasonably hope to attain a state of full-efficiency designing for every column. We are nearly at this point of perfection now, but with the help of the tests we come measurably closer to it.

It is pertinent now to mention the fact that the last of these tests were made nearly two years ago. In spite of this lapse of time, which doubtless permitted the memorandum of results to be prepared with great care, we learn only the optimistic side of the case from the facts stated in the text and the table of results. The text omits all reference to certain observations of utmost weight in their bearing on column strength.

The simple fact is that while the ultimate static strengths of the columns tested are very high, elastic failure occurred at alarmingly low loads. This one fact overthrows the entire structure of optimism erected on the high ultimate-strength results.

Only one stress-strain curve is shown in the memorandum, and it is reproduced in our abstract. This shows what may perhaps be called fairly good elastic behavior. The elastic limit as marked is located well above the point reached by ordinary working stresses. True, it is only half the ultimate strength of the column, yet on the other hand no reason is shown for paying any more attention than is customary to this evanescent phenomenon of an elastic limit.

But, unrevealed by the memorandum of the Bureau, a whole series of stress-strain curves shows elastic limits lying between 15,000 and 25,000 lb. per sq.in.! Does this mean that high-strength alloy steel is not even as good as ordinary bridge steel? Something must have been badly wrong with the material, or else the elastic limit is a snare and delusion and should be neglected in fixing safe working stresses.

The fact is, however, that these elastic limits were not mere irregularities in the stress-strain curve, but the points at which permanent set began. This was amply proved by release of load and reapplication. The point of beginning of set is universally recognized as an upper limit of possible loading, with regard to both variable static loads and to endurance. Therefore the truth appears to be that these columns of special steel, strong enough in the testing machine to go up to 50,000 lb. before failure, were not even as strong for service as columns of ordinary bridge steel with elastic limit of 25,000 lb.

A further fact of critical importance must be added: When, having applied such a load exceeding the elastic limit, the load is alternately raised and lowered a few thousand pounds per square inch, there is a continuous increase of permanent set. The column slowly yields under this jiggling of the load. The importance of this observation, even if only in a suggestive way, is too plain to be disregarded.

Precisely such load actions take place in the regular service of a column; the load is always varying, alternating from higher to lower. If in such service, with loads exceeding the original elastic limit, there is progressive yielding, then how can we depend on the ultimate safety, the endurance of columns subjected to such loads? It becomes clearer than ever, from this observation, that working stresses must be kept within the elastic limit, and that the special steel therefore failed to demonstrate its service value.

Part of the case is still without evidence, however. How does the column behave as to deflection while the increasing load is bending the stress-strain curve away from a straight line? Deflections are an important feature of column action, or rather of failure.

Observations show that there is no measurable deflection of the columns until a very high load is reached, a load well up toward ultimate strength. Very long before a load is reached at which deflection begins, the column has passed its elastic limit, and the diagram is curving decidedly as the metal undergoes permanent set.

This striking comparison, if it means anything, tells that the weakness of the column is not in its structure but in its metal. The engineer has done his part, and more than his part, in making the column keep in strict alignment up to a high load, even while the metal is compressing and undergoing permanent yield. The column as a structure holds up rigidly, with no trace of deflection, to a load-intensity of 40,000 lb.; but the metal in the column fails at half that load. The steel maker has not done his part.

These facts are so startling, and so new, that they surround the subject of steel columns with a wholly changed atmosphere. Most important deductions as to design and construction of columns are sure to flow from them, when they will have been confirmed broadly. It is conservative, therefore, to regard the publication of results of the new column tests as a sensational event in the field of structural knowledge.

Federal Funds Available for Road Construction

The passage by Congress of the act granting money from the Federal treasury to the several states for aid in road construction may be viewed from several different angles. There has been opposition to the bill on the ground that it was an attempt to make the wealthy cities and the populous states of the East, which contribute the bulk of the Federal revenue, help pay for the construction of roads in remote parts of the country. It has been predicted also that this bill is merely an entering wedge and that in the near future every rural congressman will go to Washington charged with the duty of bringing home as large appropriations as possible for the roads in his district, following the bad precedent set by the River and Harbor and the Public Buildings appropriation bills.

There is, however, a more hopeful aspect to this new departure in Federal legislation. That Federal aid to road construction was inevitable has been for some time recognized and was made clearly evident by the debate upon the bill in both houses of Congress. A large majority in both houses were strongly in favor of Federal aid and the debate was chiefly over the best manner of extending it. It should be understood that the Federal aid now extended is a very insignificant fraction of the total expenditure on road work in the United States. The $5,000,000 of Federal money which will be available next year is less than 2% of the amount which states and counties and towns are already expending on road work. If through the establishment of Federal aid and Federal supervision, an influence may be exerted which will cause the states to expend their own road appropriations with more intelligence and honesty, the indirect benefits resulting from the Federal appropriation may far exceed the amount of the money payment.

It is true that under the act as passed, Federal engineers are not to directly supervise the work of construction. The surveys, plans, specifications and estimates, however, are to be passed upon by the Federal authorities and the Secretary of Agriculture is not to pay over the Federal appropriation until he finds that the work is being constructed in compliance with the plans and specifications. Thus the primary responsibility for the conduct of the work is left where it should be left, with the state authorities which originate the plans; but it will be an excellent stimulus to good work to know that what is being done may have to undergo inspection by Federal engineers and that if the results of the inspection are unfavorable, the appropriation may be held up.

It is unfortunately the case that the great bulk of the highway and bridge construction in the United States is still carried on by county authorities without state supervision. County government is a matter in which the taxpayers and voters generally take comparatively little interest and as a result it is more or less permeated with politics and graft. Only a very small proportion of the counties in the United States employ engineers to carry on their construction work. Few of them in fact have work of sufficient magnitude to justify the employment of an engineer. There is no more important reform needed in the conduct of public work than the establishment of thorough state supervision of the work carried on by counties, especially in the fields of highway and bridge construction and maintenance. It is to be hoped that the Federal bureau which is to be established to supervise road construction on which Federal aid is extended, will be able to wield a powerful influence toward bringing about this very desirable result.

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Pumping Water for Power

Pumping water through a small head from one body to another to maintain an adequate supply through a considerable fall for the generation of power is not new. Especially has it been resorted to in emergencies. But so far as generally reported, the Bear Lake storage development of the Utah Power and Light Co., described elsewhere in this issue, presents the most extensive and interesting employment of this scheme. Bear Lake was an isolated body near the lower reaches of Bear River, but it was so advantageously situated that it could easily be made to receive the flood waters coming down from 3,000 sq.mi. of drainage area above, so as to provide regulation of river flow over any cycle of dry years on record. But the gradual paying out of the impounded waters was less simple. Obviously, there was the choice of a long and expensive outlet canal for gravity feed to the river or a short high-level canal with a large pumping station at the lake. Operating expenses of such a project were less than interest charges on the low-level canal plus the greater annual expense of maintaining the longer and deeper channel.

The pumping station itself is of great interest; looking at the section shown on another page, a striking similarity is seen with the latest type of hydro-electric generating station—witness the vertical-shaft pump with converging inlet passage, the spiral casing molded in the foundations, the direct-connected motor and the entire runner supported by a Kingsbury top bearing. Conveniently neglecting some details in the motors and impellers, this is a hydro-electric station running backward.

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Accurate Cost Accounting for Government Industries

The Federal Trade Commission and the Interstate Commerce Commission, are insisting, very properly, on the establishment of accurate cost-accounting methods by the corporations under their supervision. This is justified on the ground that only through the facts furnished by an accurate and honest accounting system can information be obtained that will enable a regulating commission so to control the operations of public utilities as to deal justly with the public, the employees and the owners of the company's securities.

It would seem that the Government ought to do itself, in conducting its own business, what it compels the owners of a private business to do. Unfortunately, it is the rare exception when government accounts are so made up that the actual cost of a piece of work can be known. Not only this, but Congress seems very loath to apply to Government work the accurate accounting methods that it is prompt to demand in connection with private industry.

In the recent debate in the House of Representatives on the appropriation of $11,000,000 to establish a Government armor-making plant, Congressman Butler offered an amendment that expert chartered accountants should be employed to open a set of books which would show every item that was spent in connection with the construction of the Government plant and the final cost per ton of armor for each month of operation. The House, however, rejected this amendment.

There is without doubt a large body of public opinion which favors Government ownership and operation of plants producing war munitions, as well as public utilities. Those who hold such views, however, surely cannot consistently oppose the demand that records shall be kept which will show the actual financial results of Government operation. Refusal to permit the establishment of such a cost-account system is a strong indication that accurate records of cost are not wanted and that Congress very much prefers to have the records in connection with its Government enterprises in such a condition that they may be open to manipulation for political purposes.

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Reputation Is Poor Bracing for a Roof

The belief that an architect's reputation or a building inspector's approval will hold up an unbraced structure received a rude shock from two recent cases of collapse, in Salt Lake City and Atlanta. Engineering science may note down in its records a double confirmation of the assumption hitherto made that what is not held up by solid substance of wood or steel or an equivalent is apt to fall down. Putting two and two together, *Engineering News* considers it as twice proved that a large roof requires, among other things, some tangible means of bracing in the longitudinal direction.

This demonstrated conclusion is recommended to the attention of the building-department officials of the above-named cities. By carefully heeding the teaching of the two accidents they may succeed in protecting the lives of their citizens in the future, though at the same time, of course, they will probably get into occasional controversy with some members of the architectural profession.

A circumstance well worth noting is that possibly these building officials could have secured for themselves the credit of deriving the important conclusion of the case, instead of leaving the discovery to *Engineering News*. It would have been necessary for them, however, to undertake the distasteful task of investigating the collapses. Concerning the Salt Lake City situation at least, the reporter who gathered the facts of the case found that city officials seemed desirous above all of forgetting the collapse and disclaiming responsibility. With this attitude of mind, of course, an investigation would have been unduly painful.

It is a pleasure to look back on the rapid and continuous progress made in city building-law administration during the last ten years. If the same rate of advance keeps up for the next decade, the building situation throughout the United States will be in excellent shape. It is certain that building inspectors will then be able to prevent the erection of unsafe architects' and carpenters' designs or, for that matter, of unsafe engineers' designs too. They will also have the power and the time, when accidents occur, to make prompt investigation, and utilize the results of the investigation to promote the safety of living in their city.

Letters to the Editor

Urging a Federal Department of Public Works

Sir—Referring to the editorial in *Engineering News* of June 8, "The Cohesive Power of Public Plunder," it is a healthy sign that the River and Harbor Bill appropriating $44,000,000 was carried in the Senate by a majority of only three votes. Comparing this vote with that on previous river and harbor bills, Senator Kenyon's prediction that "this is the last river and harbor bill framed along the lines of the present bill that will ever pass Congress" is likely to be fulfilled.

Is it not evident that a river and harbor bill to be of benefit to the country should be framed by men not only familiar with the needs of navigation, but with the special knowledge to say how those needs should be met?

The writer believes that the United States should have a Secretary of Public Works, whose sole and only business it should be to look after the public works carried on by the Federal Government, and whose honor and that of the President who appointed him would be either brightened or smirched according to the manner in which these works were carried out.

At present Federal public works are carried on by several departments, under subordinate bureaus. The Secretary of the Interior, the Secretary of War or any other secretary who has as part of his departmental organization some bureau that looks after some particular portion of the public works of our country need care little, so far as his standing as a cabinet officer goes, whether this particular public-works bureau is efficient or not. I cannot remember that any cabinet officer was ever severely criticized or that the President appointing such an officer lost any prestige because of wasteful or extravagant work in designing, building or maintaining any public work throughout the country.

The responsibility has been easily shifted. The buck has been passed with ease and celerity, excepting as criticism has fallen upon Congress at the time of passing the bill obtaining the funds for the work—and Congress is a hard thing upon which to fasten responsibility. Each individual composing it soon becomes an experienced buck-passer, and only in the past few years since sentiment has begun to crystallize somewhat upon these large appropriations has Congress felt any qualms upon the matter. I fully agree with you when you say:

> At least three-quarters of the senators fully understand the inherent corruption in the present method of making up river and harbor bills and would gladly welcome some method of framing such bills that would place the interests of commerce and navigation first and relieve members of Congress of the present responsibility for drawing all the money they can from the national treasury to be spent among their own constituents.

I sincerely hope that you will let no opportunity pass to recommend either the establishment of a Department of Public Works under a cabinet officer as secretary thereof, or some permanent national commission to control our public works for the benefit of navigation, as mentioned in the last paragraph of your editorial. You would be doing not only the engineering profession, for which you stand, but also the country at large a great service in pushing such a project. T. M. Ripley.

Watertown, N. Y., June 20, 1916.

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Fruits of Parsimony

Sir—The only criticism of your recent editorial "The Fruits of Parsimony," is that the title is too narrow. The failure of the dam at Plattsburg was but typical of our national irresponsibility, of a pleasant freedom from worry about consequences. We are not in the least penurious, merely very confident that everything will come out all right. This confidence is most touching until it culminates in an Iroquois fire, a "General Slocum" disaster, or the burning up of a lot of girls in a shirtwaist factory. Then comes a wave of horror, which the optimist hopes works a tiny permanent advance, and the great stream of our self-centered interest rolls placidly on.

"Preparedness" is today a word to conjure with. May we not hope that with all the monster parades and loud acclaim we may be stirred to an advance in the Preparedness that embraces all other kinds and is fundamental—that against needless and foolish loss, whether of property, life or ideals? G. M. B.

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Mr. Turner on Seattle Test

Sir—I note regarding your discussion of the flat-slab floor test at Seattle that you have not been quite as ready to accept a test on partly cured work as some other engineering papers. This test is merely a repetition of past history. In the John Deere Plow Co. building a $50,000 bond was written by me guaranteeing deflection on cured work. A premature test was made of a panel with a resulting deflection of 2 in. which should not have exceeded $\frac{5}{8}$ in. When the work was thoroughly dried out and cured the deflection was precisely that figured; to wit, $\frac{7}{16}$ in.

The relative deportment of the wall and interior panel is another indication of the condition of the work. The deflection of a wall panel is twice as great as an interior panel before the concrete is thoroughly dried through at the neutral plane. Afterward it is substantially the same. This phenomenon is familiar to all builders and is readily accounted for.

The displacement of the steel noted may account for 20% difference in deflection when the work is thoroughly cured; in the writer's judgment not more than that.

The results of merely making a test on partly cured work are much less serious, but involve the same error.

The erroneous idea that the number of days that concrete has been cast determines whether it is cured or not is still believed in to some extent by many engaged in the concrete business who have had experience in putting up two or three buildings in warm weather. The idea that concrete is safe when it is cured on the p and bottom surface of the floor and not cured in e center has resulted in the erroneous belief honestly tertained by many that there was no relation between flection and stress in reinforced floors. No relations ist when the concrete at the neutral plane is not oroughly dry and hard. When it is thoroughly cured that there is no appreciable horizontal shearing formation at the neutral plane, there is a precise relan between deflection and stress. This relation between rizontal shearing rigidity and flange rigidity when derstood will account clearly to all for such freak sults as that of the Seattle test. When the promised pplemental test is made, the accuracy of this statement ll be apparent.

In the case of the John Deere test made eight years o, there were many engineers who honestly entertained e view that 50-day concrete was as hard as the concrete er would be, and if it would not carry the load with e guaranteed deflection at that time it never would. hey could not conceive that the dampness of the basement and lack of circulation of the air could have used the drying out and hardening to be slow.

C. A. P. Turner.

Minneapolis, Minn., June 26, 1916.

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fany Unbiased Flat-Slab Tests

Sir—That part of Mr. Godfrey's letter (published in *ngineering News,* June 29, 1916, under the heading Pittsburgh Flat-Slab Ruling and the Seattle Test") which ntains his claim that the Seattle "mushroom" building atisfies Mr. Ferguson's ruling exactly" has been anered by Mr. Ferguson by definite calculations, showing e unwarranted nature of the claim. My own figures, ade some weeks ago, showed practically the same relt—namely, that the stresses observed in the Seattle test e what would be expected under the Pittsburgh ruling. he floor tested does not approximate a Pittsburgh design either strength or stiffness.

But Mr. Godfrey's letter contains other statements ually unwarranted, which should also be briefly noted your journal for the sake of accuracy. Mr. Godfrey fers to the Seattle test as "the solitary disinterested t," the plain implication being that all previous flatab tests are dishonest and unreliable. At my invitation r. Godfrey witnessed the test of the Larkin warehouse Chicago in 1912 and saw there Professors Talbot and ater and Messrs. Abrams, Nelson, Gonnerman and others om the University of Illinois Engineering Experiment tation at work. The readings were taken by these men d the test conducted with their expert knowledge and perience throughout. The test of the Franks Building Chicago was conducted by Prof. W. K. Hatt, of Purdue niversity, assisted by Professors Slater and Skofield and hers. Several other tests have been conducted under the me scientific auspices, and for my part I do not see w any fair-minded engineer can make such statements Mr. Godfrey does.

In the Larkin test three adjacent wall panels were aded before Mr. Godfrey's eyes; in other tests, accounts f which have been generally published, wall panels have en loaded, and yet Mr. Godfrey has repeatedly protested print that wall panels are never loaded. In one test e wall-panel load was held in place for a full year. Of urse, I understand that these tests afford no support for Mr. Godfrey in his present position, but it is only fair to point out that this letter of June 29 is based on a deliberate disregard of the great accumulation of scientific test data previously made by many agencies and on erroneous and unwarranted conclusions from the data of the single test actually considered.

Arthur R. Lord.

Chicago, Ill., July 3, 1916.

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Twin-Pipe Problem Solved by Hydraulic Slide-Rule

Sir—Mr. Kingsbury's solution, in *Engineering News* of June 29, of the flow in a double pipe line with varying sizes and with several coefficients by the Williams-Hazen formula is interesting and correct. It may be useful to your readers, however, to know that there is a much easier solution for this common problem. It can be carried out with the hydraulic tables mentioned or, still better, with the hydraulic slide-rule by the aid of which the tables were made.

Assume a quantity of water, say 10 million gallons, flowing through one of the lines, say the 30-in. line used by Mr. Kingsbury. With the coefficients assumed by him, the loss of head in this line for this quantity is found to be 1.67 ft. The same loss of head divided by the length of the other line gives a slope for it of 1.11 per 1,000. With this slope the second line is found to carry 4.83 million gallons per day. The total discharge is the sum of these quantities, 14.83 million gallons per day, with a loss of head of 1.67 ft. Putting the marker on the hydraulic slide-rule over a slope of 1.67 and bringing over it the figure 14.83 on scale No. 2 (taken to represent flow in gallons daily), the marker may then be moved and will give directly the quantities corresponding to any other heads. For instance, with 8 million gallons per day the head is found, by a single movement, to be 0.53 ft., as stated by Mr. Kingsbury. The proportions of flow through the two lines will be as the amounts found in the first computation—namely, as 4.83 and 10 are to the total of 14.83.

The results obtained are identical with Mr. Kingsbury's. The calculation is more rapid and no diagram need be made. The extension of this principle allows rapid solutions of still more complex problems involving multiple lines and lines in each of which there may be several pipe sizes involved.

Allen Hazen.

30 West 42nd St., New York City, June 30, 1916.

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Water-Supply Preparedness

Sir—The need for "preparedness" in water-supply matters is illustrated by the reported unpreparedness at Camp Whitman, brought out by the sudden call for mobilization of the New York State troops. If such conditions can obtain at a camp where preparations for reception of troops must have been under way for some time, it is not to be wondered at that emergency encampments are often so illy served.

To meet such situations, does it not seem desirable that systematic investigations should be made of the resources of the country for supplying safe water and maintaining supply systems under war conditions? The need of this seems to apply both to present reserved or appropriated areas and to locations that might later be needed for troop camps, hospitals, detention and concentration purposes.

For such a purpose clear and concise data should be available regarding present sources in order to judge of their ability to deliver adequate emergency supplies; the possibilities of additional undeveloped sources; the location of suitable materials to construct temporary supply works; and the availability of local water-works departments to supply men and materials for emergency work. Based on this information, general plans could be formulated as to what to do and how to do it quickly and efficiently, should necessity arise.

As the health and comfort of both soldiers and civilians depend largely on safe and adequate supplies of water, it seems desirable to take early measures to meet such emergencies as can be foreseen. This duty should probably come under War Department control, and most fittingly it seems now might be assigned to the Medical Corps. That division of the army is particularly concerned with the preservation of health and therefore seems best equipped to administer this work.

The details of organization and method, however, in order to get best results, should be directly under the supervision of competent water-works men familiar with both construction and maintenance problems. In the past many data have been collected for Government bureaus by well-meaning but untrained men and have failed to reach their utmost possible value.

In the unlooked-for event of an invasion of this country or the bombardment of its seacoast cities it is possible that the work suggested might also be of great value in helping to maintain present supplies and preventing or remedying serious interruption of service from enemy activity.

Caleb Mills Saville.

Hartford, Conn., June 26, 1916.

Cross Cut Power Station

Sir—The Cross Cut power plant described by J. W. Swaren in your issue of Apr. 20, 1916, was, before its completion, considered by some a questionable innovation in the development of low-head water power, and the engineers responsible for its design were subjected to much unfavorable criticism. As pointed out by Mr. Swaren, the silt-laden water, the necessity of fully utilizing the varying stream flow without interfering with irrigation demands below the plant, the long pipe lines and the extreme temperature variations each contributed to the difficulties of the problem. Each of these conditions has been successfully met by the design of the plant, and the merit of the design has been demonstrated by the efficiency attained and the satisfactory operation of the apparatus.

Reaction turbines operated on the Salt River project, with practically the same character of water at heads of about 200 ft., deteriorated so rapidly that their wicket gates and runners required renewal every three or four years, yet the Cross Cut wheels after about a year's operation still show an efficiency of over 79%, or 1% above the guaranty.

The wear has been confined almost entirely to the jet deflectors, and even these parts are kept out of action to a great extent by using a number of nozzles just sufficient to carry the maximum load. It is a rather significant fact that the manufacturers consented to an efficiency test to determine a bonus or penalty of $1,200 for each per cent. after the wheel had been in more or less continuous service for over a year. Practically full-load efficiency is maintained down to one-sixth power by successively cutting out nozzles.

The plant is being maintained and operated in three 8-hr. shifts by five men, including the chief operator and a janitor, and this is the best answer to any question as to the satisfactory operation of the equipment. A number of unexpected conditions developed when the plant was put in operation for the first time, and the engineers of the Pelton Co. are entitled to credit for their perseverance and ingenuity in correcting these difficulties. The fundamental conception of the plant and in fact many of the details of design are due to O. H. Ensign, Consulting Engineer for the United States Reclamation Service.

James M. Gaylord,
Electrical Engineer, United States
Reclamation Service.

Denver, Colo., June 15, 1916.

Railway Curves Measured on Arc or Chords

Sir—Responding to the note by T. A. Palmer in *Engineering News* of June 29, p. 1240, may I suggest that some years ago Professor Philbrick issued a railway engineers' fieldbook in which the definition of the degree was based on the arc of 100 ft. instead of on the chord. A very few years ago in response to a suggestion of mine made to the Track Committee of the American Railway Engineering Association the question whether to use this method or to continue the use of chord-degree curve was debated somewhat and put to a vote. There was an overwhelming majority in favor of present practice, but a respectable minority in favor of the system suggested by Mr. Palmer. At page 18 of the text on "Railroad Field Geometry," by the writer, the arc method is recommended; but, because of the action of the railway association, it was not generally used in the book, nor was it used (for the same reason) in the "Railroad Engineers' Field Manual," although on page iv of the preface the method is again recommended.

By the way, the reviewers of this same field manual (which is based on the decimal division of the degree instead of the sexagesimal) have almost unanimously indorsed the system, but with practically equal unanimity have said that American engineers are too conservative to introduce it, which strikes one as curious.

William G. Raymond.

State University of Iowa, Iowa City, July 1, 1916.

Sir—Regarding the inquiry of T. A. Palmer, there are many answers in the files of *Engineering News*; a fair sample is on p. 17 of the Engineering Literature Supplement, Feb. 16, 1911. As in all such discussions the old experienced engineer has the last word. But he is wrong, even though trains have gotten around his curves these many years.

We stick to the old approximate method only from superconservatism; for the same reason that radically different track and rolling stock are used here than in England under exactly the same conditions.

Mr. Palmer is on the right track for peace of mind and a clear conscience but he should not try to convert any one.

A. M. Haynes.

Denver, Colo., July 5, 1916.

New Facts About Materials and Methods of Test

A considerable number of important facts on properties of materials and tests, and descriptions of several new forms of test apparatus were brought out in technical papers read before the American Society for Testing Materials at its annual meeting, Atlantic City, N. J., June 27 to 30, 1916. The essential points are abstracted very briefly below, together with additional information or comment in discussion at the meeting.

The papers of most immediate practical bearing, perhaps, are those on hardening and on grain growth in steel, and on the cracking disease of brasses. They, as well as other parts of the proceedings of the meeting, put strong emphasis on micrographic-structure study, and a side-issue consequence of this is that the society will endeavor to standardize micrographic magnifications.

Cracking of Brass Tubes and Its Cure

The puzzling defects of rolled and drawn brass and bronze articles, which caused great loss of money on the Catskill Aqueduct, have produced corresponding trouble and expense elsewhere. Brass condenser tubes have given particular trouble from splitting. The Detroit Edison Co. could get no promise of relief from the condenser manufacturers. A. E. White then investigated the matter for them. He found the cause of splitting to lie in slip-planes developed in the grains by cold-working and allowed by insufficient annealing to persist. A specification was developed, based on the Navy Department specification, with micrographic tests added. The microscope is to detect unremoved strains in the metal (slip-planes) and also show whether the grain size is coarse; in both respects it is a check on annealing.

Very closely defined temperatures of anneal are vital. The change in structure was investigated with the microscope, and it was found that no change of structure from the original cold-worked and presumably injured condition was produced until an annealing temperature of nearly 400° C. was used. With annealing temperatures of 600° and over, the size of crystal grew very large, especially with long-continued heating. This represents damaged constitution, which must be avoided. The microscope clauses of the specification, based on these facts, are inserted with a view to insuring anneal on the one hand at sufficiently high temperature to efface the mechanical-strain injuries and on the other hand low enough to avoid coarsening of grain.

The tubes in question were of 60% copper and 40% zinc, approximately. The chemical impurities were of small amount, not enough to be a probable cause of the splitting.

Strong comments tending to uphold present rolling-mill practice were offered by W. R. Webster and W. B. Price. Mr. Webster, for instance, stated that since the navy's Bureau of Steam Engineering 15 years ago adopted a specification covering final annealing of brass condenser tubes, millions of tubes have been made without a single failure reported. Ductility and tube service have not been shown to have any connection. Claims that the degree of drawing per pass should be limited to avoid injury have not been demonstrated. There is no experience to show that annealing between passes must be at limited temperature to avoid grain growth. Mr. Price went farther than this, saying that the claims for light drafts are contrary to fact. At a reduction per pass of 30%, or three numbers on the B. & S. gage, crystal change occurs, and such heavy drafts are therefore necessary.

C. M. Chapman referred to the past difficulty of getting good condenser tubes and inquired for a reason. Mr. White, on the amount of reduction per pass, conceded that further investigation of the point is needed. In support of his specification he stated the simple fact that up to July, 1913, the company had found no relief from "season cracking" of condenser tubes, but thereafter, with the new specification, complete relief was obtained.

Saw-Toothed Stress-Strain Curves of Bronze Wire

Tests of bronze and similar wire by A. V. De Forest showed jagged or saw-toothed stress-strain curves under certain conditions. Only the part of the curve above the elastic limit was thus affected. Phosphor-bronze wire showed this effect slightly when heated to 126° C., and strongly at 180° C. Some brass wire showed it at room temperature when the load was applied slowly. A very effective special testing apparatus was used for the work, in which load was applied by water, and both the stretch of the wire and the load were registered by the motion of a beam of light on photographic paper. The author offered an explanation of the jagged character of the curves, based on the hypothesis that there is an amorphous substance in a thin layer between the grains of the metal and the further assumption that this substance becomes viscous at certain temperatures and allows a limited slip.

Prof. H. M. Howe, mentioning the fact that similar saw-toothing has been observed in stress-strain diagrams of steel, set forth some difficulties in the way of the author's explanation of the phenomenon.

Strong Aluminum Bronze

Alternating-stress tests of aluminum bronze showed very satisfactory endurance, as reported by W. M. Corse and G. F. Comstock. Comparisons were made with manganese bronze (of higher static strength), and the aluminum bronze stood a larger number of alternations. Both the Landgraf-Turner machine, which tests with large degrees of bending, and the White-Souther machine, which applies a definite stress (usually within the yield limit), were used.

Heat-treatment of aluminum bronze was found to produce higher elastic properties without greatly reduced ductility. The pieces were quenched in water from 850° C., later reheated to 650° C. and allowed to cool in the furnace. This treatment gave a proportional limit of 40,000 to 56,000 lb. per sq.in., a tensile strength of over 90,000, and elongation and reduction of area of 12 to 18%. The alternating-stress endurance also was good.

Hardness Changes in Hardening

In hardening steel at various quenching temperatures, Prof. H. M. Howe and A. G. Levy discovered striking discrepancies between hardness and transformation of structural constituents of the steel. Lower quenching temperature (but always above recalescence) produced little change in hardness, while the density increased progressively, showing progressive transformation of the hard to the soft constituents. Still lower quenching temperatures produce, first, a sudden loss of hardness at the recalescence point, and then a continued slower decrease of hardness, while the structure change is slight. The authors refer the change of hardness below recalescence to coalescence of the cementite and ferrite, regarded as a deterioration.

These investigations, made on 0.92 carbon steel, involved the use of both the Brinell ball method and the Shore scleroscope method of measuring hardness. The latter method was found to be specially valuable because it tested small areas. Certain observations on peculiarities of the Shore test are included in the paper ("Notes on the Hardening and Tempering of Eutectoid Carbon Steel and on the Shore Test").

Water-Quenched Steel Axle Equal to Oil-Quenched

Very thorough tests on two driver axles were made by the Pennsylvania R.R. to learn whether oil quenching or water quenching in the hardening process gives better results. The differences found were slight, but generally in favor of water quenching.

The two axles, 10 in. in diameter, forged from the same heat of steel, contained about 0.55% carbon, 0.57% manganese and 0.20% silicon. They were quenched at 1,550° F., one vertically in water and the other horizontally in a heavy oil, and then were heated to 1,175° and 1,200° F. respectively and cooled in air. From each, 45 longitudinal test specimens were cut, at five different places along the axle, in three radial planes and at three different distances from the inner bore. The grand average of all 45 pieces gave:

Quenching	Elastic Limit, Lb. per Sq.In.	Ultimate Strength, Lb. per Sq.In.	Elongation in 2 In., %	Reduction of Area, %
Water	54,509	96,482	23.1	42.2
Oil	51,118	96,415	24.2	43.4
Minimum of A. S. T. M. specifications	50,000	80,000	20.0	40.0

Micrographs showed good sorbitic structure, with diffuse ferrite in the water-quenched and a fine network of ferrite in the oil-quenched axle. Chemical analysis showed 10 to 15% segregation close to the inner bore, which is unusually high.

These results, reported by C. D. Young, Engineer of Tests of the railway, were interpreted by him as showing an advantage, or at least no disadvantage, in the use of water as quenching medium. He referred also to long experience of one treating plant with water quenching as showing that there is no undue danger (of cracking) in the use of water when the work is done carefully.

Nearly every phase of the steel subject is related to the question raised, as the discussion indicated. Quenching results are determined by rapidity of cooling, but not by the nature of the medium (Prof. H. M. Howe; Lawford H. Fry). The internal stresses existing in the metal during the quenching probably affect the transformation of structure in the axle (Prof. H. M. Howe). The oil-quenched axle may be the tougher on account of its lower elastic ratio. Tests have shown that while, before drawing back, oil-quenched steel has lower elastic limit than water-quenched, the change produced by drawing back is not the same for the same reheating temperature, and with increasing reheating temperature the elastic limit of oil-quenched steel holds up better and finally passes that of water-quenched steel (R. P. DeVries).

As to drawing-back temperature, Professor Howe said:

> It should exceed 400° C. by only enough to reduce the quenching stresses to harmlessness, or rather to reduce them till the benefit from their further removal ceases to equal the harm done by the accompanying increase of coalescence. If, for instance, the quenching stresses become thus harmless on drawing at, say 500°, then 500° is the proper drawing temperature. Should this leave the strength too great and the ductility too small, it would seem better to get the needed weakening and ductilizing through smaller carbon content than through higher drawing temperature.

But, replied Mr. Young, the treatment used is known from practice to give good service results. Whether lower ductility would still give good service is not known, but practical railway men would not like to try it. Lower drawing temperature would not meet the ductility specification. On the other hand, lower carbon would make it impossible to get the elastic limit up to 50,000. The treatment used gives the ductility of full annealing and 50% higher elastic limit (C. D. Young).

Cracking during hardening is not due to segregation, since case-hardened pieces do not crack and since the axles reported did not crack, although they had high segregation. The differences of the two sets of results in the paper are very slight as compared with the differences of methods of procedure, so that probably the latter are more responsible than the quenching medium (J. S. Unger).

A fundamental question was put by Prof. H. M. Howe: Is the objection to high elastic limit in railway steel a superstition, in view of the good service given by hard-drawn wire?

Forced circulation of the cooling medium was reported by L. H. Fry to give surprising results. In a comparative trial using compressed air as a means of producing circulation the elastic limit was 69,000 and the ultimate 105,000, while without circulation the figures were 49,500 and 95,000; the ductility was practically the same for both pieces, 21% elongation and 42% reduction of area. Details of the test were not given. He expressed the view that all cooling media produce cracks and that the best results are obtained by using oil and subsequently applying a proof test.

Dangerous Ferrite Growth in Low-Carbon Boiler Tubes

In forcing its boilers at high rates to carry peak loads, the Detroit Edison Co. had trouble from frequent bagging. The forcing is such that melted ash is found on top of tubes over 30 ft. above the grate. There is some scale formation, although only distilled water is used for make-up. Bagging occurs under scale deposits. A. E. White and H. F. Wood believed that the bagging was due, at least partly, to deterioration of the tube steel from recrystallization of the ferrite to a coarse structure. In sections of the tube wall they did indeed find coarse structure in a thin layer at the fire side of the wall. This led them to make studies of the conditions under which grain growth of low-carbon steel takes place.

Grain growth results from heating, but only after cold working or deformation below recalescence. The boiler tubes (seamless drawn) being deformed at low temperature, their heating in service might cause grain growth. Many careful experiments were therefore made on 0.11% carbon-steel samples, by annealing thoroughly, making a deep Brinell-ball impression on one face, cutting apart through the depression, and studying the structure by microscope before and after prolonged heating. Different heating temperatures required different lengths of time to produce grain growth. A law connecting the required time in minutes with the temperature in Centigrade degrees was deduced:

$$\textit{Temperature} = 722° - 52.4 \log_{10} \textit{time}$$

The experiments covered a temperature range from 550 to 675° C. It is planned to try higher-carbon tubes, of about 0.35 to 0.40% carbon, to cope with this coarsening of structure.

Sauveur, in 1912, showed that only in a fixed range of deformation does grain growth of ferrite take place. Jeffries recently showed that for every temperature there is a critical strain, and for every strain a temperature, producing grain growth. Pearlite, however, is a bar to growth of the ferrite when it incloses the latter. Sauveur never found growth with steel over 0.12% carbon; and if this proves to hold true, it would not be necessary to raise the carbon of tubes very much in order to stop the coarsening (H. M. Howe).

The weakening effect of recrystallization extends through only a small part of the tube section, for which reason it is hardly a sufficient explanation of bagging. The great drop in the tensile strength of steel at high temperatures—to practically zero above 800°—is enough to account for the action. If prior overstrain were responsible for recrystallization, the latter ought to be found inside the metal rather than at the outer surface. High-carbon steel will show the same kind of drop in strength at high temperatures as low-carbon steel, and the tubes will be harder to set tight and keep tight. The solution is to hold down the forcing of boilers. The tests were made on steel just under the line of 0.12% carbon. There is no difficulty in making or applying drawn tubes of 0.15 to 0.18% carbon (F. N. Speller).

The tubes in question showed recrystallization for a depth of one-eighth the thickness in from the fire side. At every point of bagging there was found either coarse crystallization or blowholes. Experience shows no difficulty in rolling 0.35 carbon tubes in, or in keeping them tight (A. E. White).

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Proportional Limit Identical with Elastic Limit

That there is no good ground for distinguishing proportional limit from elastic limit was asserted by several expert testers with wide knowledge of materials, in a topical discussion. J. E. Howard, in taking the view that sets do not develop before the proportional limit, objected to the term yield-point as lacking definite meaning. His discussion directed special attention, however, to the factors which give rise to early irregularities in the stress-strain diagram, including local sets due to initial strains or to nonhomogeneity and imperfect manipulation. He asserted that preliminary straining is not a proper means for removing initial strains and that annealing is the only satisfactory normalizing method.

T. D. Lynch advocated fixing the yield-point at an elongation of 0.5%; for steels below 100,000 lb. per sq.in. yield-point this should agree well with the value read either with dividers or by drop of beam. He drew a distinction between material characterized by a slow curvature of the diagram between proportional limit and yield-point, and material characterized by abrupt change (the two limits close together). The abrupt type of curve may be produced in material of the gradual class by mechanical work or by heat-treatment. The difficulty of determining yield-point by dividers or drop of beam in material of the gradual class was claimed to justify the proposed definition by an elongation figure. Mr. Lynch holds that in modern work designers must have accurate information on the proportional limit.

H. F. Moore and F. B. Seely concluded from test data and experience that probably no stress-strain curve is straight in the lower part and that curvature starts at once. If this is true, the proportional limit is a matter of the sensitiveness of the instruments used. Some precise test measurements were made to get a comparison of various methods proposed for elastic-limit determination. In these tests an averaging extensometer was found to give a diagram equivalent to the average curve constructed from gage readings on three lines. The influence of the grips—threaded and wedge—was found to be erratic, and more work on the subject is needed.

R. P. De Vries cited elastic hysteresis as proof that speed of straining does affect the stress readings. The existence of a yield-point as a practically useful limit must be recognized. H. L. Morse advocated dropping the term elastic limit in favor of proportional limit, the two defining the same point. L. H. Fry shared in the latter view. C. D. Young called attention to the new definition of elastic limit just adopted by the Steel Committee as one practically useful in the laboratory that must accept material quickly and determine the critical points without tedious refinement. This definition simply makes change of rate of elongation the criterion and leaves open the question of how it is to be observed; an extensometer with dial gage is used for the purpose at Altoona. Uniform rate of applying stress is premised.

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Measuring Linseed-Oil Foots

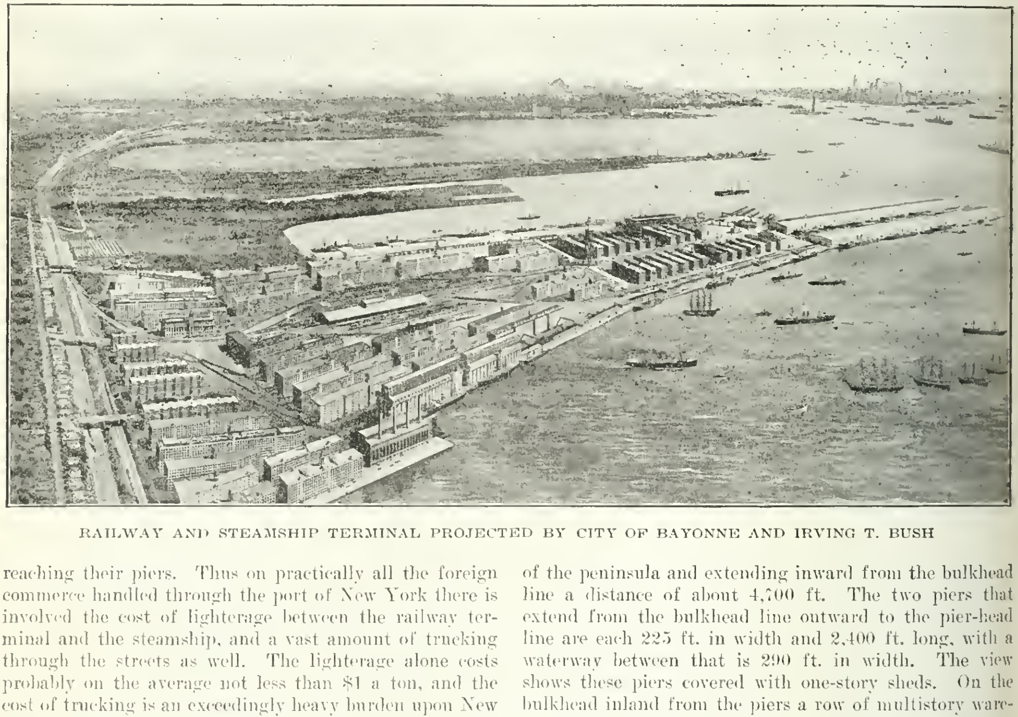
In view of special attention directed during the past year to the possible harmful influence of foots, or deposits, in linseed oil, interest attaches to the method devised by C. D. Holley for quick separation of foots in the laboratory, determining their amount with reliability and distinguishing an oil that has been duly aged from one that has not been aged. The method depends on treatment of the oil with phosphoric acid and naphtha, after treatment allowing the liquid to separate, when foots collect on top of the phosphoric acid. H. A. Gardner suggested heating and letting the oil stand over night, to precipitate albuminous substances, after which the benzine thinning will cause the foots to settle out quickly.

[*Further abstracts will appear in coming issues.*]

New Jersey Freight Terminal for the Port of New York

Every engineer who has studied the problem of freight handling in the port of New York understands that for economic transfer between ocean steamships and railways leading to the West a great freight terminal should be created on the New Jersey side of the North River.

The port of New York is the gateway for nearly half the foreign commerce of the United States. A very large proportion of this commerce does not originate at New York, but is brought there by the railways leading to the West. The ocean steamships entering the port are docked on the waterfront of the Boroughs of Manhattan and Brooklyn for the most part; and the few which are docked on the New Jersey side of the river have no railway lines reaching their piers. Thus on practically all the foreign commerce handled through the port of New York there is involved the cost of lighterage between the railway terminal and the steamship, and a vast amount of trucking through the streets as well. The lighterage alone costs probably on the average not less than $1 a ton, and the cost of trucking is an exceedingly heavy burden upon New York commerce. If, however, the railway car could be brought alongside the steamship, at a terminal on the western side of New York Harbor, all this expense would be eliminated.



RAILWAY AND STEAMSHIP TERMINAL PROJECTED BY CITY OF BAYONNE AND IRVING T. BUSH

During the past year the New Jersey Board of Commerce and Navigation has been actively studying the commercial development of the New Jersey shore of the North River. Plans have been developed by the Chief Engineer of the board, B. F. Cresson, Jr., for a great steamship and railway terminal to be located on the waterfront of Bayonne, between the Greenville terminal of the Pennsylvania R.R. on the north and the Standard Oil refineries and docks on the south. Negotiations are now in progress between Irving T. Bush, President of the Bush Terminal Co., and the city authorities of Bayonne, having in view the construction of a great freight terminal on this site, similar in general to the Bush plant in Brooklyn. As at present projected, the city and the corporation to be organized by Mr. Bush would jointly furnish the capital for the creation of the terminal and would share in the control of the property and in the profits.

The accompanying perspective sketch has been prepared from the preliminary plans to indicate something of what such a great terminal plant might eventually become. The ultimate development shown in the view would cover an area of about 400 acres of land now under water. The total volume of fill required to be placed to raise the now submerged ground to an elevation of 10 ft. above high water is estimated at 5,000,000 cu.yd. Much of the material for this fill would be obtained from the dredging necessary to make the channels. The plans contemplate channels of a depth of 35 ft., 350 ft. in width on each side of the peninsula and extending inward from the bulkhead line a distance of about 4,700 ft. The two piers that extend from the bulkhead line outward to the pier-head line are each 225 ft. in width and 2,400 ft. long, with a waterway between that is 290 ft. in width. The view shows these piers covered with one-story sheds. On the bulkhead inland from the piers a row of multistory warehouses for freight in transit is provided. Located at the center of this artificial peninsula is a railroad yard with a capacity of 2,000 to 2,500 cars, and tracks lead from this yard out onto the long piers and to every building on the property. From this yard direct rail connections can be made to all the railways terminating on the west shore of the Hudson. The plans also include grain elevators, a marine coaling plant, cold-storage warehouse, cargo-handling cranes and warehouses and factory buildings.

At present, plans are being worked out to determine with what minimum investment an operative plant can be created sufficiently large to provide the essential features of economic operation and capable of development with the growth of business. From present indications it is probable that such an initial plant can be constructed in Bayonne at a cost of $8,000,000 to $10,000,000.

Final Report on Elmhurst Disposal Plant

A final report to the Board of Estimate and Apportionment, City of New York, on the Landreth electrolytic sewage-disposal plant at Elmhurst, Long Island, has just been made by the City Board of Consulting Engineers (made up of the Chief Engineers of the Board of Estimate and Apportionment and the consulting engineers of the several boroughs of the city. The board considers the continued use of this plant as too expensive and uncertain and recommends the temporary use of chemical precipitation and sludge-drying beds at this point pending a permanent connection to projected sewers.

HISTORY OF THE ELMHURST PLANT

In 1900 a disposal plant was authorized by the Board of Public Improvements for Elmhurst. It consisted of four settling tanks and three sand filters. On account of the continuance of objectionable odors, in 1914 a small (25,000 gal.) experimental Landreth plant (employing simultaneous lime precipitation and electrolysis) was installed (by the Electro-Chemico Corporation, of Philadelphia). Reports on this machine were made (1) by P. M. Travis, Chemist, and E. I. Firth, Engineer, for the Borough of Queens, (2) by R. H. Brown and W. T. Carpenter for the Bureau of Sewer Plan, (3) by F. A. Cleveland for the Bureau of Municipal Research, and (4) by E. J. Fort and C. E. Gregory for the Bureau of Sewer Plan.

A large unit, capable of handling 750,000 gal. per day was installed in 1915 and two studies have been made on that, (5) one by W. P. Mason, J. C. Olsen, C. O. Mailloux and P. M. Travis for the Electro-Chemico Corporation, and the other (6) by the Bureau of Sewer Plan for the Board of Estimate and Apportionment.

There was not entire accord in the results of these investigations. For instance the first (Travis and Firth) report showed a requirement of 144 kw.-hr. per 1,000,000 gal. and 1,257 lb. lime. This electrolytic machine (vertical type) was 24x18 in. in section and 7 ft. 3 in. high. The current was split between carbon and steel electrodes, and paddles were revolved between these plates. No great technical skill was required for operation and no apparent wear was found on the iron electrodes. Immediate coagulation, wonderfully quick settlement and bactericidal action (99.819%) beyond possible action of lime alone was reported. The dissolved oxygen was "considerably increased" and the oxygen consumed by organic matter "enormously reduced."

The later reports (3) were less optimistic. For instance in the Brown-Carpenter-Cleveland series, time of passage through the machine was given as 2¼ min. and the time of filling the sedimentation tank 1½ hr. The previous high bacterial reductions were not repeated (only from 30 to 94% in effluent from the machine and from 97 to 100% in the settlement-tank effluent). The machine was found very sensitive to change in character of sewage. The reduction in total suspended solids was between 65 and 83%. The reduction in suspended organic matter was 3 to 7% in the machine effluent and 38% in the tank effluent. The reduction in consumed oxygen ran from 2 to 95% for machine effluent and 23 to 80% for tank effluent. The increase in dissolved oxygen for these two effluents was 18 to 87% and 53 to 68.5% respectively.

On running the machine with lime only (without current) the chemical results and bacterial reduction in machine effluent were equal to that of regular operation—except in the appearance of the flock and the higher dissolved oxygen content after sedimentation. Without the paddles the flock was formed slower and the bacterial reduction less. No bacterial reduction in machine effluent was obtained in operating with lime added at 375 lb. and 684 lb. per 1,000,000 gal. On increasing the content to 1,040 lb. the reduction was 72.3%. On 2,210 lb. the reduction was 94.1%. About 17½ cu.yd. of sludge (94% moisture) was formed per 1,000,000 gal.

The large plant as tested by Messrs. Mason, Olsen and Mailloux employed in order (1) screening, (2) addition of lime, (3) electrolysis, (4) sedimentation, (4) sludge pressing. The machine was a covered horizontal box 3x2¾ ft. in section and 23¼ ft. long. The flow was between sets of parallel steel plates with paddles revolving parallel to the plates. The maximum values of current supply were 125 volts and 40 amp. The time of flow through the tank was 68 sec. The time in the sedimentation tanks was about 4 hr. With 1,000 to 1,300 lb. hydrated lime per 1,000,000 gal. the raw sewage and machine and tank effluents showed, for instance, oxygen saturations of 25.5%, 31.8% and 45.5% and bacterial counts of 1,100,000, 846,000 and 800.

When lime was used in the machine (1,510 lb. per 1,000,000 gal.) but no current, the machine effluent became darker with smaller flocks. The bacterial reduction in raw sewage and machine and tank effluent was from 210,000 to 11,150 and 61,000 (for the last, bacteria rose to 9,360,000 after standing two days). The percentage of saturation for dissolved oxygen rose from 28.4% to 43.9 and 44.3%; the consumed oxygen in the final effluent was 25.7%.

In regard to costs, for a 1,000,000-gal. plant, Messrs. Mason, Olsen and Mailloux reported: 1,300 lb. lime, $5.14; current, 85 kw.-hr. for electrolysis, 60 kw.-hr. for agitation, 174 kw.-hr. for pumping, and 16 kw.-hr. for lime vat, at 4c., $13.40; sludge pressing and removal $5.11; labor and supervision $12.50; maintenance and supplies $1; total $37.15.

On account of the lack of accord of the reports they were all submitted to Earl B. Phelps of the United States Public Health Service Hygienic Laboratory for review and report. His findings were (1) that the final effluent was highly satisfactory, (2) that the method of sludge disposal was not satisfactory and could not be employed where there was real necessity for sewerage purification, (3) that there was good basis for honest difference of opinion as to whether the electrolysis contributed materially to the results, (4) that the cost was too great to compete under usual conditions with better known processes.

In considering what to recommend at Elmhurst the City Board of Consulting Engineers considered the annual cost per 1,000,000 gal. of the following: Electrochemical ($18.19) and activated sludge ($39.38) processes, sprinkling filters ($36.15), chemical precipitation ($30.63), pumping to 51st St. sewer ($24.05) and to Booth St. sewer ($22.15). The electrochemical process was dismissed because of cost and the uncertainty of results with stronger sewage.

News of the Engineering World

Reconstruction of Notable Large Bridges

The reconstruction of two noted bridges over the Ohio River will be a feature of the bridge engineering work of 1916. The first of these is the bridge of the Pennsylvania Lines at Louisville, Ky., which was built in 1869 and has therefore seen 47 years of active service. It was designed by and built under the direction of the late Albert Fink, then Chief Engineer of the Louisville Bridge Co. It consisted almost entirely of deck-truss spans of the Fink type. The two channel spans had subdivided triangular Warren through trusses, and the swing span had trusses with ordinary triangular web system.

Beginning at the north (Indiana) end the bridge had one span of 100 ft., one of 149 ft., three of 100 ft., 400-ft. channel span, six spans of 245½ ft., 370-ft. channel span, two of 227 ft., two of 210 ft., two of 180 ft., four of 149½ ft., 264-ft. swing span over the Louisville & Portland Canal, and two 50-ft. spans to the Kentucky approach. Interesting observations as to the longitudinal creeping of the bridge spans were given in *Engineering News*, Mar. 28, 1885.

There may be some changes in the span lengths of the new bridge. The War Department required a clear span of at least 200 ft. for the new draw, as noted in *Engineering News* of Dec. 18, 1913, and the railway company had proposed a cable-operated lift bridge over the canal in place of the present 264-ft. swing span. The company is now in litigation with the Federal Government in regard to the latter's requirements as to the spans, and until the decision is rendered by the United States Supreme Court no definite action can be taken. The design and construction of the new bridge will be under the direction of J. C. Bland, Engineer of Bridges for the Pennsylvania Lines. A contract has been placed for part of the work, and preparations are being made for the removal of the first spans at the south end. For this reason the local train service over the bridge has been discontinued.

The second Ohio River bridge referred to is that of the Cincinnati Southern Ry. (Cincinnati, New Orleans & Texas Pacific Ry.), at Cincinnati, Ohio. This present structure was completed in 1877. The main bridge has two 300-ft. truss spans at the north end, a 519-ft. channel span, a 370-ft. swing span and a 110-ft. shore span at the Kentucky end. This main structure was built by the Keystone Bridge Co., under the direction of its designer, J. H. Linville. The north or Cincinnati approach has six truss spans of 121 to 191 ft., and was built by the Baltimore Bridge Co. The structure is single-track throughout, with rails 106 ft. above low-water (or about 35 ft. above high-water).

The present piers will be used, with minor alterations at their tops, but will carry a double-track superstructure. The new bridge is being designed by Ralph Modjeski, consulting engineer, of Chicago; M. B. Case, who has been resident engineer for Mr. Modjeski on the new Memphis bridge, is now in charge of the surveys for the new Cincinnati bridge. The work will be under the general direction of Curtis Dougherty, Chief Engineer of the Cincinnati, New Orleans & Texas Pacific Ry. (Queen & Crescent Route).

Two other examples of the reconstruction of the superstructures of notable old bridges may be mentioned. The first is the Mississippi River bridge at Keokuk, Iowa. This was designed by J. H. Linville and built by the Keystone Bridge Co. in 1869-70. Its reconstruction (on the old piers) was completed early this year, and was described in *Engineering News* of Apr. 13, 1916. The second is the Missouri River bridge of the Union Pacific R.R. at Omaha, Neb. This was built in 1872 and partially rebuilt in 1887. The reconstruction was planned under the direction of R. L. Huntley, Chief Engineer of the Union Pacific R.R., and work is now in progress.

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National Engineer Reserve Act Now Effective

The legislation necessary to create a national engineer reserve was recently passed by Congress and signed by the president, becoming effective July 1. This bill, known as the Army Reorganization Act of 1916, provides for the organization of an Officers Reserve Corps including an engineer section or an Enlisted Reserve Corps. The War Department is now formulating the plan of organization and the requirements that will be prescribed for enrollment. As soon as practicable the War Department will invite the engineers of the country to apply for commissions in the reserve corps of engineers, and there will be available for those interested full and complete information as to the requirements for commissions in the several grades, from second lieutenant to major, and for master engineers and sergeants, and the method of procedure to secure commissions or enlistment. The following is an abstract of the principal clauses relating to the Officers Reserve and the Enlisted Reserve Corps.

> The commissions of all officers of the Officers Reserve Corps shall be in force for a period of five years unless sooner terminated in the discretion of the President. Such officers may be recommissioned, either in the same or higher grades, for successive periods of five years, subject to such examinations and qualifications as the President may prescribe and to the age limits prescribed herein: Provided, That officers of the Officers Reserve Corps shall have rank therein in the various sections of said Reserve Corps according to grades and to length of service in their grades.
>
> In time of actual or threatened hostilities the President may order officers of the Officers Reserve Corps, subject to such subsequent physical examinations as he may prescribe, to temporary duty with the Regular Army in grades thereof which cannot, for the time being, be filled by promotion, or as officers in volunteer or other organizations that may be authorized by law, or as officers at recruit rendezvous and depots, or on such other duty as the President may prescribe. While such reserve officers are on such service they shall, by virtue of their commissions as reserve officers, exercise command appropriate to their grade and rank in the organizations to which they may be assigned, and shall be entitled to the pay and allowances of the corresponding grades in the Regular Army, with increase of pay for length of active

service, as allowed by law for officers of the Regular Army, from the date upon which they shall be required by the terms of their orders to obey the same: Provided, That officers so ordered to active service shall take temporary rank among themselves and in their grades in the organizations to which assigned, according to the dates of orders placing them on active service; and they may be promoted, in accordance with such rank, to vacancies in volunteer organizations or to temporary vacancies in the Regular Army thereafter occurring in the organizations in which they shall be serving. . . .

To the extent provided for from time to time by appropriations for this specific purpose, the Secretary of War is authorized to order reserve officers to duty with troops or at field exercises, or for instruction, for periods not to exceed 15 days in any one calendar year, and while so serving such officers shall receive the pay and allowances of their respective grades in the Regular Army: Provided, That, with the consent of the reserve officers concerned, and within the limit of funds available for the purpose, such periods of duty may be extended for reserve officers as the Secretary of War may direct. . . .

For the purpose of securing an additional reserve of enlisted men for military service with the Engineer . . . Corps . . . of the Regular Army, an Enlisted Reserve Corps, to consist of such number of enlisted men of such grade or grades as may be designated by the President from time to time, is hereby authorized, such authorization to be effective on and after the first day of July, 1916.

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Limiting the Flow Through the Chicago Drainage Canals

A Senate amendment to the River and Harbor Appropriation Bill limiting the diversion of water from Lake Michigan through the Chicago drainage canals to 250,000 ft. per min. was noted in *Engineering News* of June 8, 1916, p. 1108. The Conference Committee eliminated this amendment in its report submitted on July 3 and at the same time struck out the provision granting authority to the State of Illinois to expend $5,000,000 on the improvement of the Illinois River in accordance with a law passed by the Illinois Legislature in June, 1915. Unless some change is made in the bill prior to its final passage by both houses, which is very unlikely, Congress will therefore have taken no action either legalizing or limiting the Chicago drainage canal and the State of Illinois will lack the authority to proceed with the work of improving navigation on the Illinois River.

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Structural Steel Companies in New Combination

The merger of the Pennsylvania Steel Co., Steelton, Penn., and the Maryland Steel Co., Sparrows Point, Md., announced some time ago, has been completed by the formation of a new company known as the Penn-Mary Steel Co., South Bethlehem, Penn., which will be a subsidiary of the Bethlehem Steel Co. A deed transferring the property of the Pennsylvania Steel Co. to the Penn-Mary company was filed at Harrisburg, July 7. It called for a consideration of $10,167,297. A mortgage held by the Bankers' Trust Co., Trustees, of New York City, for $60,000,000 was filed against the property at the same time.

Changes in the engineering and executive departments of the Steelton plant of the Pennsylvania Steel Co. have been announced by Vice-President W. F. Roberts, who is in charge of all plant operations, as follows: President, E. C. Felton, retires automatically; and while no place has yet been designated for Frank Tenney, secretary, he will be retained in some capacity. Frank B. Carney, superintendent of the Steelton plant, is made general metallurgist for the Bethlehem, Steelton and Sparrows Point plants with headquarters at South Bethlehem. William S. Rutherford is made head of the order department of the entire company with headquarters at South Bethlehem. Thomas Earl, superintendent of the bridge and construction department of the Steelton plant; Charles H. Mercer, chief engineer, and Lewis E. Johnson, assistant to Superintendent Earl, are transferred to South Bethlehem, where they become part of the sales and engineering force in charge of designing and field erection in connection with structural work. Carl B. Ely, assistant to Mr. Earl, has been appointed superintendent of the bridge and construction department in charge of operations.

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Joseph Otis Osgood

Joseph O. Osgood, chief engineer of the Central R.R. of New Jersey, whose death on June 28 was noted in last week's issue, was born at Cohasset, Mass., in 1848. He took special courses at the Massachusetts Institute of Technology in 1872 and 1877, but had long before then engaged in engineering work.

At 17 years of age he joined the engineering corps of the Eastern Shore R.R. (now a part of the Pennsylvania) as a rodman. Subsequently he was assistant engineer, and from 1870 to 1871 was transitman and resident engineer on the location and construction of the Portland & Ogdensburg Ry. He was made assistant to the chief engineer of the Maine Central R.R. in 1871.

Following his studies at the Massachusetts Institute of Technology, Mr. Osgood was made resident engineer

JOSEPH OTIS OSGOOD

for the State of Massachusetts on the improvement of the South Boston Flats. In 1878 he went West and for two years was division engineer of the Atchison, Topeka & Santa Fe Ry. on construction work in Colorado and New Mexico, and for two years was chief engineer of the California Southern R.R.

From 1883 to 1884 he was chief engineer of the Boston, Hoosac Tunnel & Western R.R.; after a year in private practice he became chief engineer of the Toledo, St. Louis & Kansas City R.R., and in 1887, chief engineer of the Lake Shore & Michigan Southern Ry. For the 12 years following 1889 he was a consulting engineer with offices in New York City. Since 1901 he had been chief engineer of the Central R.R. of New Jersey.

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The Excavation for the Rogers Pass Tunnel was finished on July 6. In the past year more than 3½ mi., has been excavated—working from two headings. This double-track tunnel is being built for the Canadian Pacific Ry., by Foley Bros., Welch and Stewart. A. C. Dennis is superintendent for the contractor.

Tribulations of Boston Public-Works Engineers — Since Mayor Curley removed 17 employees of the Public Works Department of Boston last January by abolishing their positions he has put nine of them back into other and subordinate positions. These do not include the three who resisted the mayor's action by legal means, and who, though ordered reinstated by the court, have not yet been put back. The case of these three is still under consideration by the city law department, which is planning to have the decision reviewed by the supreme court of the state.

The American International Terminal Co. has been incorporated in Delaware as a subsidiary of the American International Corporation which was organized some months ago by interests connected with the National City Bank of New York. The new corporation is organized to deal with the problem of transportation terminals, warehouses, etc., and will begin its work with a study of the conditions in New York City. The Vice-Presidents of the company are Geo. J. Baldwin and W. S. Kies; among the Directors are a number of officers of the National City Bank and E. F Webster, Henry R. Hays and O. E. Stevens of the Stone & Webster Co. William H. Lyford, of Chicago, has been appointed Consulting Engineer of the company.

Railway Employees Engaged in Train Service throughout the United States are now taking a general ballot giving authority to the officers of the trainmen's brotherhoods to declare a strike in case the railways will not grant the 8-hr. day with time and a half for overtime which the brotherhoods have demanded. Congress has as yet taken no action on the request of the National Chamber of Commerce that the Interstate Commerce Commission should be given authority to make an immediate investigation. At the recent convention of the Brotherhood of Locomotive Firemen and Engineers in Denver, a resolution was adopted protesting against any action by Congress. In preparation for the possible emergency of a strike of its employees engaged in train service, the Pennsylvania Railroad Co. issued a circular to its employees calling for volunteers to fill vacancies in the train service in the event of a strike and announcing that if such volunteers are called on for duty they will be given permanently the positions to which they may be assigned. Many of the employees now engaged in train service are receiving two or three times the wages of equally competent men employed in the repair shops, and are working shorter hours. The Pennsylvania announces that between 50,000 and 60,000 of its employees have volunteered in response to this circular, or more than twice the number that would be needed to take the place of the engineers, conductors, and other trainmen in the event of a strike.

The Federal Aid to Road Construction Bill, which was signed by the President on July 11, is substantially the Senate bill with a half-dozen minor changes. The bill makes an appropriation of $5,000,000 for the fiscal year ending June 30, 1917, and this appropriation is increased $5,000,000 for each successive year until for the year 1921 the sum of $25,000,000 is appropriated. Control of the appropriation is placed with the Department of Agriculture, which is authorized to deduct not exceeding 3% of the appropriation for the expenses of administration. Distribution of the appropriation to the several states is to be made in the following manner: One-third in the ratio of the area of the state to the total area of the United States; one-third in the ratio of the state's population to the population of the United States, and one-third in the ratio of the mileage of rural delivery routes in the state to the total. In order that a state may obtain the fund to which it is entitled, its legislature must assent to the provisions of the act and the State Highway Department must submit to the Secretary of Agriculture projects for the construction of rural post roads, with such surveys, plans, specifications, and estimates therefor as he may require. "The Secretary shall approve only such projects as may be substantial in character." Items for engineering, inspection and unforeseen contingencies must not exceed 10% of the total estimated cost. The proportion of the cost of the work payable from the Federal treasury must not exceed 50%. No payment shall be made in excess of $10,000 per mile, exclusive of the cost of bridges of more than 20 ft. clear span. Responsibility for maintenance of the roads so built is placed upon the state or its "civil subdivision"; and if any such roads are not properly maintained, the Secretary of Agriculture must refuse to grant further Federal appropriations to the delinquent state or section. The act further appropriates $1,000,000 for the fiscal year ending June 30, 1917, for the survey, construction and maintenance of roads and trails within or partly within the national forests. All work done by the Government under this act is to be carried on by employees selected from the eligible lists of the Civil Service Commission.

PERSONALS

G. L. Marick has been appointed Assistant Office Engineer of the Gulf, Colorado & Santa Fe Ry., at Galveston, Tex.

James Wall, of Pittsburgh, Penn., has been appointed a member of the County Engineer's staff of Allegheny County, Pennsylvania.

Harry Burgess, Major, Corps of Engineers, U. S. A., has been detailed to succeed Col. Mason M. Patrick, in charge of the Detroit, Mich., district.

John C. Oakes, Major, Corps of Engineers, U. S. A., has been detailed to succeed Col. George A. Zinn, in charge of the Philadelphia, Penn., district.

A. E. Owen, Assoc. M. Am. Soc. C. E., Principal Assistant Engineer of the Central R.R. of New Jersey, has been promoted to be Chief Engineer, succeeding the late J. O. Osgood.

William A. Judson, Lieutenant-Colonel, Corps of Engineers, U. S. A., has been detailed to succeed Col. John Biddle, in charge of the Baltimore, Md., district.

George P. Clay, an inspector in the fourth district of the Pennsylvania State Highway Department, at Franklin, Penn., has been promoted to be Road Superintendent of Erie County.

A. Engh has been appointed Assistant Bridge Engineer of the Chicago, Burlington & Quincy R.R. Lines East of the Missouri River, succeeding G. A. Haggander, promoted, as noted elsewhere.

R. M. Robinson, Jun. Am. Soc. C. E., has resigned his position with the Tennessee Copper Co., Copperhill, Tenn., to join the staff of the Clinchfield Products Corporation, Johnson City, Tenn.

H. H. Weinberg, an inspector in the 14th district of the Pennsylvania State Highway Department, at Washington, Penn., has been promoted to be Road Superintendent of Blair and Cambria Counties.

Judson R. West, Assoc. M. Am. Soc. C. E., has resigned as Chief Engineer of the Seattle (Wash.) Port Commission to accept the professorship of railroad engineering at Pei Yang University, Tientsin, China.

W. H. Franklin, Jun. Am. Soc. C. E., has resigned from the valuation department of the Chicago, Milwaukee & St. Paul Ry., at Seattle, Wash., to join the staff of the James Black Masonry and Construction Co., Seattle.

G. A. Haggander, Assistant Bridge Engineer of the Chicago, Burlington & Quincy R.R. Lines East of the Missouri River, has been promoted to be Bridge Engineer of the whole system, succeeding the late C. H. Cartlidge.

Thomas A. Laux, Assistant to the Chief Engineer of the Pennsylvania Steel Co., Steelton, Penn., is now Assistant to the Chief Engineer of the Bethlehem Steel Co., South Bethlehem, Penn. Mr. Laux is a civil engineer of Harrisburg, Penn.

J. H. Chapman, a graduate physician of Alabama State University and a former student in the course in public health at Harvard University, has been appointed Health Officer of Talladega County, Ala., at a salary of $3,000 per annum.

Henry O. Pond, M. Am. Soc. M. E., has resigned as Mechanical Engineer of Westinghouse Church Kerr & Co., New York City, to take charge of the timber, pulp and water-ower interests in the Northwest of E. B. Cadwell & Co., Inc., ew York City.

A. N. Wardle and **Ellis S. Tisdale,** both recent graduates of e course in sanitary engineering, Massachusetts Institute of echnology, have been appointed members of the engineering aff of the West Virginia State Department of Health, at harleston, W. Va.

J. P. Stevens, recently General Superintendent of the hesapeake & Ohio Ry., at Huntington, W. Va., has been pro- oted to be General Manager with headquarters at Richmond, a. He is a son of George W. Stevens, President of the hesapeake & Ohio; he is 31 years old and has been in the nploy of the railway since 1900.

John Bennett Bissell, formerly President of John Bennett issell, Inc., exporters, has resigned to join the organization the Blaw Steel Construction Co., Pittsburgh, Penn. Mr. issell will be Manager of the Export Department, and the astern Structural Sales Department, and will be located at e company offices, 165 Broadway, New York City.

Fred C. Alber, City Manager of Newburg, N. Y., has been moved by the city commissioners. He was formerly City rk Commissioner of Cleveland, Ohio. He was made City anager Jan. 1, and according to a Cleveland newspaper ac- unt, has had a hard time from the start, chiefly because was an outsider and because his salary of $5,000 per num was considered too much. He is succeeded by a local ysician, Dr. Henry Wilson.

Thomas C. Desmond, Assoc. M. Am. Soc. C. E., Consulting ngineer, 110 West 34th St., New York City, has been selected Col. Theodore Roosevelt to take charge of recruiting the giment of engineers, which is to be included in the colonel's my for Mexican or other service. Col. Laurance H. Grahame, rmerly of the Rough Riders, is coöperating in the work of ganizing the engineer regiment. Further data may be se- red by addressing Mr. Desmond.

Frank S. Krug, City Engineer of Cincinnati, Ohio, and ief Engineer of the City Rapid Transit Commission, will ceive one of the largest salaries paid to an American muni- pal engineer. As City Engineer he receives $6,000 per an- m, and as Chief Engineer of the Transit Commission he has en voted $9,000 more, making $15,000 per annum. Alfred aven, Chief Engineer of the Public Service Commission, New rk City, receives $20,000, which is probably the largest lary paid any municipal engineer in this country.

L. H. Allen, Division Superintendent of the Chesapeake & io Ry., at Huntington, W. Va., has been promoted to be neral Superintendent to succeed J. P. Stevens, promoted, as ted elsewhere. Mr. Allen is a graduate of Kentucky State llege and began his railway work as a rodman on the uthern Ry. in 1899. He was with the engineering depart- ent of the Chesapeake & Ohio from August, 1899, until two or ree years ago, when he joined the operating staff as a vision superintendent. He had previously been Engineer of aintenance-of-Way.

OBITUARY

H. J. Bowman, M. Can. Soc. C. E., of Bowman & Connor, onsulting Engineers, Berlin, Ont., died recently. He was a rmer city engineer of Berlin.

F. A. Creighton, M. Can. Soc. C. E., a consulting engineer Winnipeg, Man., former city engineer of Prince Rupert, C., was recently killed in action in France. He had ortly before received the cross of the Legion of Honor from e French Government for bravery at the front.

Joseph Ramsey, M. Am. Soc. C. E., President of the Lorain, shland & Southern R.R., former President of the Wabash R., died July 7 at his home in East Orange, N. J. He was rn at Pittsburgh, Penn., Apr. 17, 1850. He was educated at e Western University of Pennsylvania and in 1869 joined the gineer corps of the Pittsburgh, Cincinnati, Chicago & St. ouis Ry. For many years he was active in railway con- ruction in Pennsylvania and Ohio, serving as chief engineer small roads which were subsequently absorbed by the rger systems. He was Chief Engineer on the location and terward Chief Engineer on construction of the famous ll's Gap R.R. (from Bellwood to Irvona, Penn., now a part the Pennsylvania R.R.) From 1886 to 1890 Mr. Ramsey was ief Engineer of the Cincinnati, Hamilton & Dayton Ry. For year following he was Assistant to the President of the eveland, Cincinnati, Chicago & St. Louis (Big Four) Ry., and en for two years General Manager. He was Vice-Pres- ent and General Manager of the Wabash R.R. from 1895 to 01 and subsequently was President of this and subsidiary nes. While President of the Wabash Mr. Ramsey was sent to the Paris International Exposition as Railroad Commissioner of the United States. Since 1913 he had been President and General Manager of the Lorain, Ashland & Southern R.R. in Ohio, of which he supervised the construction.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenberg, Myers Building, Bethlehem, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

THE ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The Pacific Coast Gas Association will hold its 24th annual convention at Santa Barbara, Calif., Sept. 19 to 22.

The Pacific Association of Consulting Engineers holds its annual meeting in San Francisco, on Sept. 21. The secretary is C. H. Snyder, 251 Kearny St., San Francisco.

The Fifth Annual Safety Congress will be held by the National Safety Council, Oct. 16 to 21, in Detroit, Mich. The secretary is W. H. Cameron, Continental and Commercial Bank, Chicago.

The American Society of Mechanical Engineers, through the nominating committee, has reported the following nominees: For president, Ira N. Hollis, Worcester, Mass.; for vice-president for two years, Charles H. Benjamin, Lafayette, Ind.; Arthur M Greene, Jr., Troy, N. Y.; Charles T Plunkett, Adams, Mass.; for manager for three years, Robert H. Fernald, Philadelphia, Penn., William B. Gregory, New Orleans, La.; C. R. Weymouth, Berkeley, Calif.; for treasurer, William H Wiley, New York. The nominating committee was appointed by the president from five groups of the different geographic sections of the society, and consisted of Walter B. Snow, chairman, representing the Boston, New Haven and Worcester sections; H. M Montgomery, representing the Chicago, Milwaukee and Minnesota sections; E. H. Ohle, representing the Atlanta, Birmingham, St. Louis and Cincinnati sections; J. T. Whittlesey, representing the San Francisco and Los Angeles sections, and D. Robert Yarnall, representing the New York, Philadelphia and Buffalo sections.

Appliances and Materials

Lubricator for Elevator Guide Rails

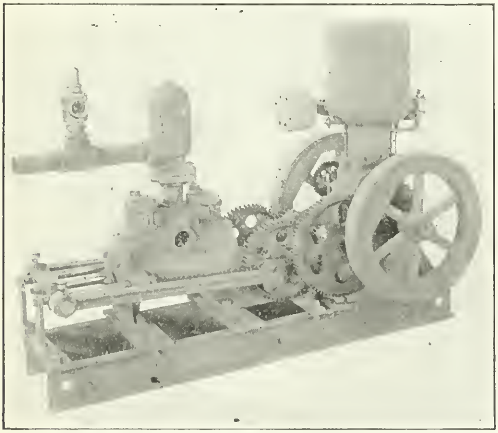
An elevator-rail lubricator of the type shown herewith is manufactured by Lewis F. Lyne, 39 Cortlandt St., New York City. It is an oil box cast from aluminum alloy and is ⅛ in. thick. Its only movable parts are three pairs of wicks intended to prevent glazing or caking over the surfaces. The wicks wipe off the edges and sides of the rails and at the same time deposit oil upon the cleaned surfaces. The feed is positive, no oil being delivered except when the car is running. The wicks are held by screws that can be loosened to allow the wicks to be pulled out a little when they become worn. Each box has a suitable support or bracket for attaching it to various types of elevator cars. It can be fastened to the counterweights as well as to the car proper.

* * *

Contractors' Pressure Pump

A high-pressure pumping outfit for use on construction work, delivering water considerable distances to supply boilers, concrete mixers, etc., is shown in the accompanying view. It consists of a single-cylinder vertical gasoline engine, gearing, and horizontal double-acting force pump mounted on a steel frame or bedplate as a single unit. The countershaft has two gearwheels carrying side rods which extend along the sides of the pump cylinder and are attached to the crosshead. These gearwheels are carried in an extension of the pump casting, so that the alignment is maintained permanently. The crosshead slides on guide rods attached to the cylinder head. There is a suction opening on both sides, and the discharge can be made at four points. The pump can deliver to a distance of three miles, and will work on a suction lift not exceeding 25 ft. It is made for pressures of 175, 225 and 300 lb.

The small-size outfit has a pump cylinder 3x5 in., 1½-in. suction and discharge openings, and runs at 55 r.p.m. It has a 3-hp. engine, and can deliver 900 gal. per hr. A larger machine with 5x5-in. cylinder, 2½-in. pipes and 8-hp. engine can deliver 2,400 gal. per hr. The weight of the outfit is only 625 lb. for the smaller and 1,635 lb. for the large size. These portable pressure pumping outfits are built by the Barnes Mfg. Co., of Mansfield, Ohio.



PORTABLE PRESSURE PUMP FOR CONTRACTORS

* * *

"Manograph" Differential Pressure Gage

The "Manograph" recording differential pressure gage devised by Paul Lanham, of Washington, D. C., for use on the water-leakage surveys of that city and described in "Engineering News," Jan. 6, 1915, is now being made by the Water Works Equipment Co., 50 Church St., New York City. New models have been added to the line—notably (1) an instrument for permanent station installation, and (2) a multiple-unit recorder for measuring the flow through a number of mains. It will be recalled that the Lanham scheme involves a mercury U-tube, a moving contact rod actuated by a water or other motor and an electric circuit controlling the recording pen.

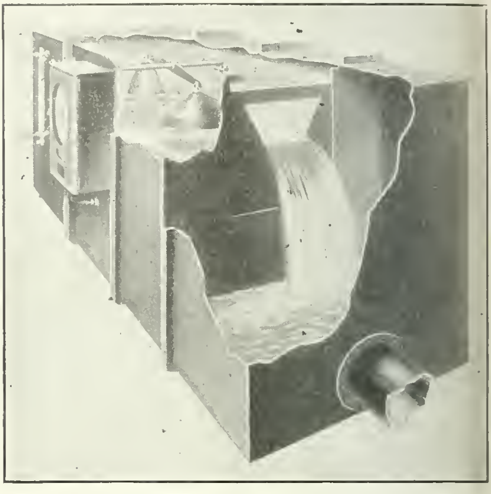
Dry Feeder for Water-Works Chemicals

A new dry feeder for lime, iron, soda ash, crushed alum, etc., in water-purification or softening plants is being made by the F. G. Gauntt Manufacturing Co., Fort Wayne, Ind. Cast-iron ends support a trough in which a worm agitator and feed screw revolve. The amount of material to be discharged is controlled by changing the length of an adjustable reach rod driving the feed. A machine with bronze worm and wood trough is also made for dryfeeding hypochlorite of lime, delivering from 4 to 200 lb. per hr.

* * *

Improved Weir Flow Meter

A new flow meter for feed-water tanks, etc., has been designed by E. G. Bailey, President of the Bailey Meter Co., 141 Milk St., Boston, Mass. As shown in the accompanying view, water flows over a V-notch weir from a high-level to a low-level compartment. Interest mostly centers on the mechanism for giving the recording-pen arm uniform motion proportional to the flow. A beam carries two unlike displacement members, and is fastened to a short shaft supported on monel-metal knife edges. One end of the shaft passes through a pressure-tight bearing and carries the recorder pen and integrator control directly on its outer end. The integrator disk is driven by the same clock that drives the chart; the counting train is suspended from a knife-edge bearing on the clock frame and is moved across the disk by an arm from the main shaft. The follower wheel has a large number of rollers to prevent wearing the disk, and its axis is inclined to eliminate slip.



BAILEY RECORDING WEIR METER

* * *

New Section of Lackawanna Steel Sheetpiling

A new Lackawanna 8½-in. section of steel sheetpiling has been added to this line, to give a wider range of selection. This new section is of the standard Lackawanna straight-web type, with interlock consisting of similar hooks and guards on both edges, and is for use where a .comparatively light section is required with high transverse strength and minimum weight—as in medium trench and coffer-dam work. The general advantages of the Lackawanna design are well known. In the development of this new section special attention was given to secure for this joint high tensional and transverse strength and at the same time to produce a pile that would have comparatively low weight per square foot, that would be simple, interlock perfectly and have the material so distributed as to give a high section modulus per lineal unit of wall.

The new section weighs 14.70 lb. per lin.ft. and 20.75 lb. per sq.ft. The least radius of gyration is 0.509 and the section modulus 1.1 per single section, 0.1294 per in. width and 1.555 per horizontal foot of wall interlocked in place. This section is to be compared with the older 7¼-in. piling—least radius of gyration 0.373; modulus of section, 0.567 for single section, 0.081 per in. width; weight, 12.54 lb. per lin.ft. and 21.5 lb. per sq.ft.

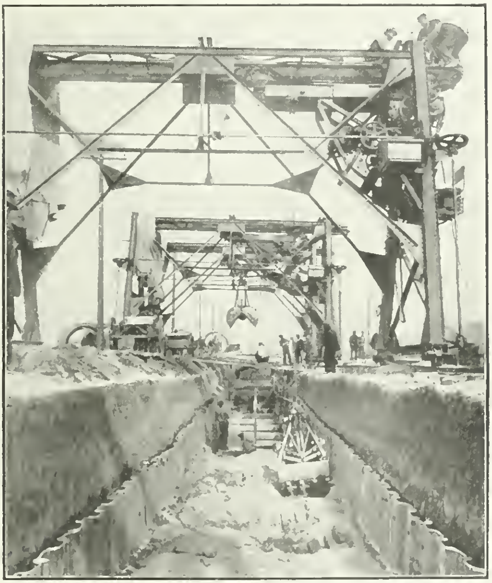
Lackawanna steel sheetpiling is made by the Lackawanna Steel Co., Lackawanna, N. Y.

Engineering News

VOLUME 76 JULY 20, 1916 NUMBER 3

Gantry Cranes Work on Sewer at Salt Lake City

The new intercepting sewer about completed at Salt Lake City, Utah, will form an outlet for all that portion of the sewerage system not tributary to the gravity sewer system. It begins at 10th South and 7th West streets, connecting there with the 60-in. main sewer, draining approximately 68 mi. of sewer recently onstructed. It runs thence northerly a total distance of 23,850 ft. to the intersection of 9th North and 11th West streets. This line is located in the western part of the city at practically the owest ground level, and will be deep enough to take care of the sewage from any por-ion of the city. The sewer s being built of lock-joint reinforced-concrete pipe made by the Pacific Lock Joint Pipe Co., under an agreement with the con-ractors, Messrs. Gibbons Bros., Reed & Roche. The grade of the sewer varies rom 0.104 to 0.45%. The depth of the trench varies rom 14.6 to 19.9 ft., with n average depth of 17.1 ft. The material encountered consists of alternate layers of clay and sand. The ground-water level is approximately 7 ft. below the urface. The contract mounts to $296,510. The lengths of pipe of each size nd unit prices are as fol-ows: 700 ft. of 30-in. pipe, $2.35 per lin.ft.; 2,437 ft. of 2-in., $3.73; 6,628 ft. of 60-in., $5.10; 8,838 ft. of 6-in., $6.50; 3,556 ft. of 72-in., $8; 1,692 ft. of 78-in. 10 per lin.ft. The unit price for excavation and back-lling was $0.97. The trench width for the 78-in. pipe verages 10 ft. 8 in. The pipe was made at the rate of pproximately 60 ft. per day for each size.



EXCAVATING AND SHEETING SEWER TRENCH 10⅔ FT. WIDE, SALT LAKE CITY, UTAH

Gantry in foreground digging with clamshell, next one in rear digging in strutted trench with orange-peel. Rear gantry engaged in setting concrete pipe

Lackawanna steel sheetpiling was driven by a pneu-natic hammer for each side of the trench. The first 6 r 8 ft. of excavation was taken out with teams and the remainder handled by clamshell and orange-peel buckets perated electrically and working from the gantry cranes hown in the view on this page. A separate gantry crane was used for handling the pipe and for pulling the sheetpiling. The material taken out of the trench was hauled back by dump carts along the line of the sewer and used for backfilling.

Three gantry cranes of the same general structural framing were employed. The first one went right behind the preliminary hand excavation and, with clamshell, made the next cut. Behind this the trench was strutted and the excavation made to grade with an orange-peel working from the second gantry between the struts. In the rear a third gantry lowered the reinforced-concrete pipe units to place.

The gantry cranes are framed of battered bents just above the rails on which they run, connected by a cross-frame which carries the electric motor and the transverse track on which runs in one case the buckets and in the other case the tongs for the pipe. The tracks are regulation rails laid, one on each side the trench, on short ties. The bucket cranes are provided with one 30-hp. and one 14½-hp. motor for the hoist and one 6½-hp. motor for the drive, while the pipe crane has a 15-hp. motor for the trolley and a 6½-hp. motor for the drive. These machines were made by the Sprague Electric Works of the General Electric Co. They are fairly common in coal handling practice but are novel for trenching machines.

A pumping plant will be installed at the lower end of this sewer to discharge the sewage into a gravity line, whence it will be carried to Great Salt Lake. Completion of these sewerage improvements will provide, in connection with the gravity outlet sewer, sufficient outlet capacity for a population of 500,000. The contract for the work was let Aug. 5, 1915, the time for completion being 200 days. The work is under the direction of Sylvester Q. Cannon, City Engineer, Salt Lake City.

Largest Dredging Caisson Sunk as Building Foundation

SYNOPSIS—An enormous open dredging well, or caisson, has been sunk during the past winter in Bear Lake, 100 mi. northeast of Salt Lake City, and in it are now being constructed the foundation and substructure of a pumping station of the Utah Power and Light Co. The purpose and design of this plant were presented in "Engineering News," July 13.

The location chosen for the Lifton pumping station is on a causeway separating the north end of the lake basin—now a separate sheet of water called Mud Lake—from Bear Lake itself. This beach is all very fine sand, considered a quicksand; borings to considerable depth, made by the owners preliminary to design, did not find the bottom of the sand stratum.

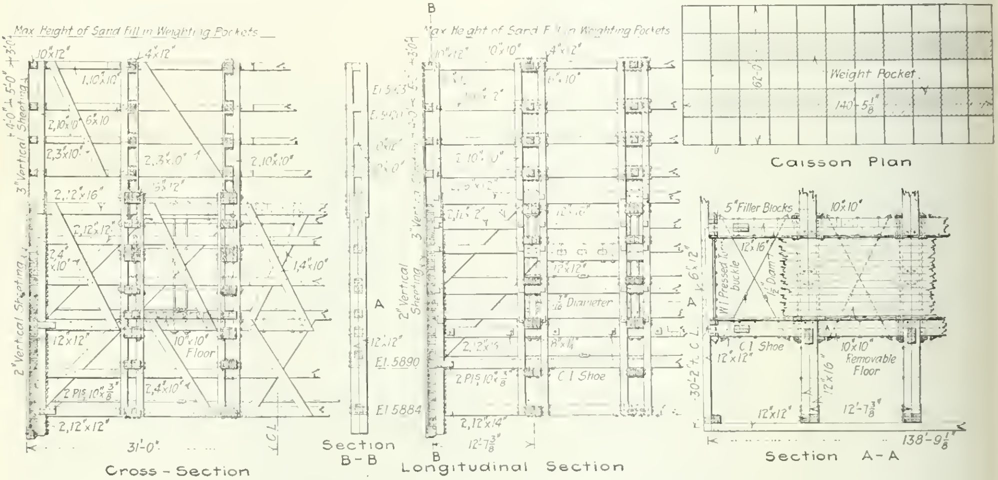


FIG. 1. FRAMING OF DREDGING CAISSON FOR FOUNDATION OF LIFTON PUMPING STATION

The type of foundation chosen was a pile group capped with a concrete mat or slab at the depth required by the pump intake—about 40 ft. below water level. The problem was to make the excavation, drive the piles, place the capping slab, and then build the concrete substructure of the pumping station, with its inlet and discharge passages formed in the concrete. The dredging-caisson method was adopted as the simplest and surest way of accomplishing these results.

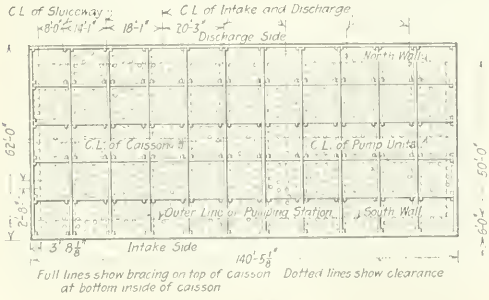


FIG. 2. PILE PLAN

The design of the caisson is shown in Fig. 1. The structure, 140 ft. long, 62½ ft. wide and 45 ft. high, is a shell of 12-in. timbers stiffened by series of interior struts in both directions at about 11 ft. spacing horizontally, and 2 to 4 ft. clear spacing vertically. This describes approximately the lower section or first build-up, which is the part of the caisson designed to resist the sinking stresses. The coffer-dam or second build-up, erected above when the first build-up had started sinking, consists of 3-in. sheeting on frame-ribs with interior bracing similar to that below but of larger vertical spacing.

Arrangements to secure sinking weight and transfer this to the working-chamber shell complicate the simple structure somewhat. The 55 pockets (five lines of 11 each) formed by the interior strutting were in part used as sinking-weight pockets. The middle and the two outer lines of eleven pockets were left open for excavation and the two intermediate lines were sheeted inside and filled with earth to load the structure down and sink it. To transmit the weight of this loading to the outer shell, a full set of diagonal batter posts and horizontal tie-rods was built into the framing, as shown in Fig. 1. These elements in effect formed series of Howe trusses across the width of the caisson, supplemented by queenpost trussing in the longitudinal direction.

The caisson contains about 800,000 ft. of timber, and 120 tons of rods and fastenings. All material had to be teamed in 12 mi. from the nearest railway station (Paris, Idaho). Timber was stacked in a large material yard arranged at one end of the site and was cut and framed in a carpenter's yard near the caisson site. Four derricks et alongside the caisson, two on each long side, placed the imber. Separate working drawings or cutting sheets were nade for the individual sticks of the timberwork, so that he carpenters were relieved of all work in interpreting he general drawings and determining the dimensions and uts. This uncommon procedure proved highly successful ifter the first start, and worked out to complete satisfacion.

Sinking the Caisson: Marsh Gas Outflow

It was the intention originally to sink the caisson by lredging, in accordance with normal practice. The sand vas counted on to flow sufficiently to enable buckets in he three rows of open compartments to clear the ground under the weight pockets, since it was known that when listurbed and mixed with water this sand takes very flat slopes. However, the material in place was found to be an extremely solid mass, compacted and dried out by lying undisturbed for a long time. Neither clamshell nor orangepeel buckets would bite in sufficiently to let the vork progress at a reasonable rate. In fact, the material vas so tight that the seepage into the caisson was negligible, even at its lowest level. Hand shoveling was reorted to, and the material was hoisted out by skips.

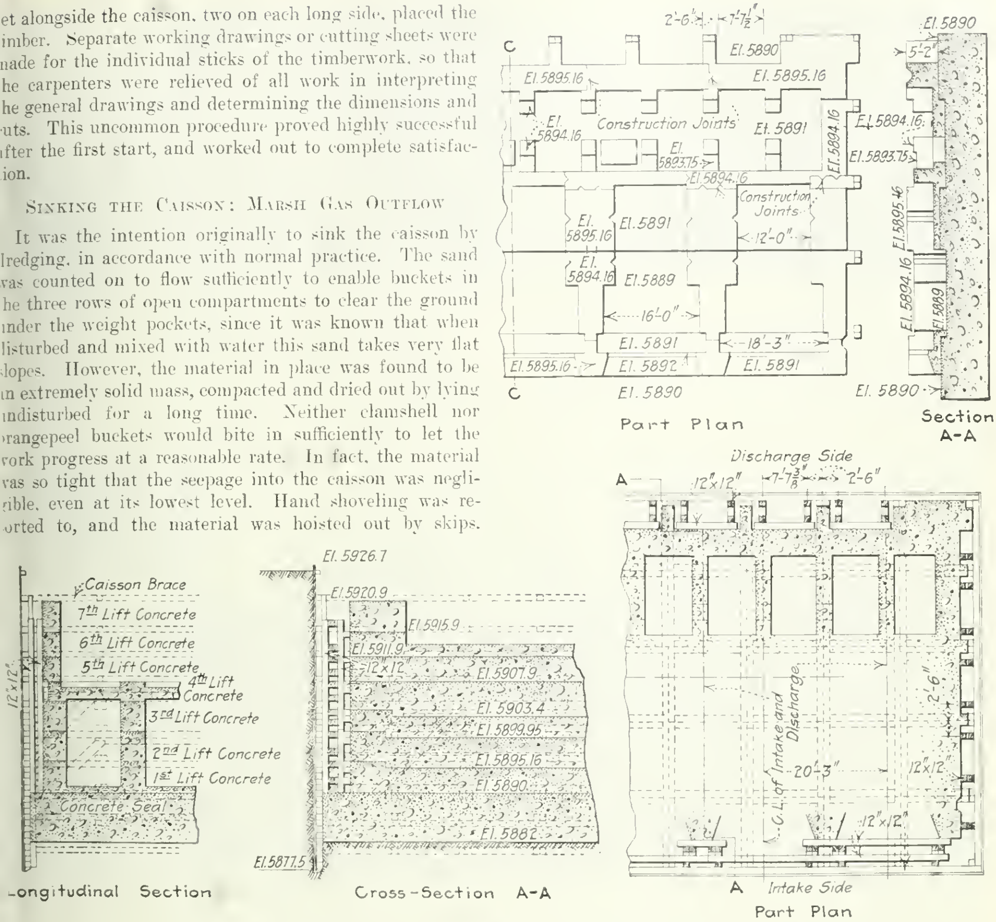


FIG. 3. SECTIONS SHOWING ARRANGEMENT OF CONCRETING WITHIN CAISSON

The sand being such that it became of running charcter when disturbed and under the influence of moving ater, the sinking created a belt of disorganized sand all round the shell of the caisson. The frictional drag of the aisson as it went down and the downward seepage of ater along the shell of the caisson made the material nstable. This caused a certain amount of trouble, with ome runs or blows that were just short of being danerous. The wide cutting edge of the caisson (see Fig. 1) equired the excavation to undercut this edge almost comletely. Conditions were thus created that favored sudden lowing in of quantities of sand. Even without such ovement there was a continuous flow of sand downward long the side and into the caisson as the sinking proressed. This disturbed the surface immediately adjacent the caisson. The pile towers supporting the derricks ere in one or two cases put out of business by subsidences rom this source.

More serious difficulty was caused by outflows of marsh as from the soil in the caisson. The gas was always presnt, but for long periods it blew out under pressure and the aggregate of gas flow was of enormous volume. Occasionally the jets of gas were lighted and they would then flame up four or five feet high in a steady geyser.

Beyond the difficulties just mentioned, the caisson sinking proceeded smoothly and uneventfully. It was started on Feb. 19, 1916, and the caisson reached its final elevation, about 16½ ft. below ground, on Apr. 6. The maximum rate of excavation was 1,000 cu.yd. a day. In the working time mentioned, a week was taken out for putting on the second lift. The theoretical amount of caisson excavation was 13,000 cu.yd. Actually about 17,000 cu.yd. was excavated.

Pile Foundations

The caisson is only a temporary device, a means of making the excavation and constructing the foundation, not a load-carrying element. The weight is carried by a pile group spaced at practically minimum spacing all over the caisson bottom.

It proved to be impossible to drive piles on account of the hard condition of the sand already referred to. All

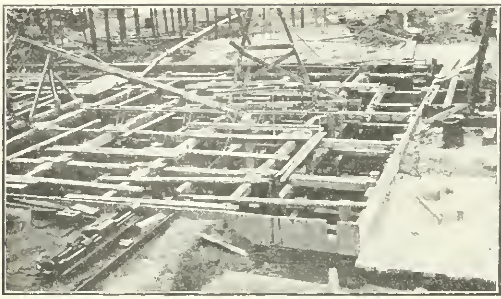


FIG. 5. CAISSONS SUNK TO BOTTOM

Top of cofferdam showing. Chute in place for concreting middle line of pockets

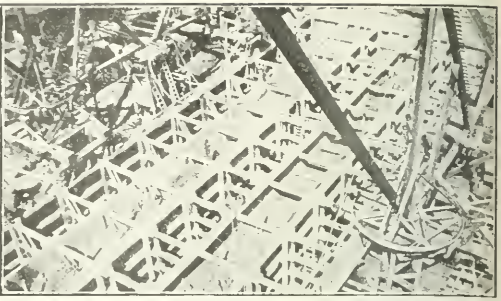


FIG. 6. CAISSON DURING SINKING

Top view showing dirt in weight pocket and other three lines of pockets open for dredging

of them had to be jetted down. A penetration of 35 ft. below caisson bottom was decided upon as satisfactory and the originally ordered 65-ft. piles were cut off after driving.

During this jetting operation the sand rose up 4 ft. within the bottom of the caisson. This was essentially inflow from along the sides of the caisson under the cutting edge. About 2 ft. of this material was blown out by a sand ejector after the pile work was completed.

The concrete pile-cap or seal course, a slab approximately 8 ft. thick engaging the upper 3 or 4 ft. of the piles, was deposited in a continuous operation, the work extending over some two weeks. The bottom of the caisson at this time, as previously, was practically dry. During the work gas had to be taken care of by piping through the seal concrete, the pipes being plugged subsequently.

Concreting Arrangements

Sand and gravel suitable for concrete had to be brought from a point about 3½ mi. away. Here a dragline excavator was set up which dug the material and loaded it on cars to bring it to the site. At the site it was washed and screened and then dropped into storage bins holding about one day's supply.

Below the bins were mounted two mixers, only one being needed—the other as reserve in case of breakdown, in order not to interrupt the concreting. Sand and gravel were supplied to the mixer hoppers by a measuring car running past the bin spout and discharging directly into the hopper, while cement was brought from the cement storehouse alongside the bin structure. The mixers discharged into the hopper of a hoisting tower 110 ft. high alongside one end of the caisson.

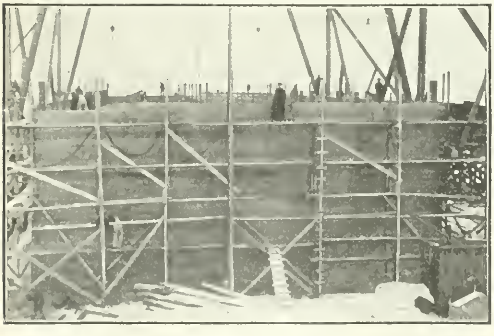


FIG. 4. CAISSON FRAMES ON GROUND BEFORE BEGINNING OF SINKING

Distribution from the tower was handled in a novel way. A low fixed tower on the center of the caisson carried a distributing box from which chutes running in two directions could be supplied. The last chute led to the top of a tremie hung from the boom of the derrick. By means of this tremie it was possible to control the flow of the concrete at will and hold the height of drop down as might be desired.

Concreting the Pumphouse Substructure

The seal course of concrete included the lowest set of strutting of the caisson. For the actual substructure concrete above this level it was important to leave no timber embedded in the concrete. This determined the order of operations in concreting.

The substructure concrete was put in in lifts corresponding to the height between sets of bracing struts and was in all cases so arranged as to leave the bracing struts exposed for removal. In this operation the concrete forming the walls of the inlet and discharge passages, etc., was not placed, to avoid having it cut up by the construction joints between successive lifts. The concreting in lifts comprised a skeleton of the substructure sufficient to form a body for bracing the caisson walls after removal of the timber strutting. In the spaces within this skeleton the finished concrete work of the passages was subsequently placed around forms.

Fig. 3 shows the series of lifts and how they were arranged in order to provide support for the caisson walls by concrete as close as possible to the struts to be removed. At the pump inlet and discharge openings there are only narrow ribs of concrete between the several openings or chambers, and, as the clear width across the openings is large, the framing at these points had to be designed carefully to transmit the wall pressure to the concrete.

The caisson was designed and sunk by the Jarrett-Chambers Co., Inc., of New York City, which is also constructing the discharge flume and the superstructure of the pump house.

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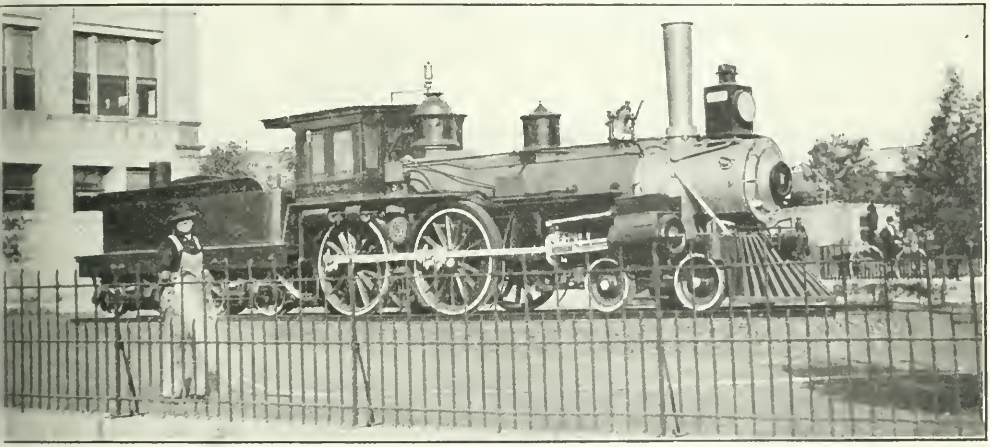
Riverfront Improvement in Des Moines, Iowa, is planned to include paving both banks of the river from Locust St. to the railway tracks with sheet asphalt, putting in 12-ft. cement walks on either side and installing electroliers along the walks. Harry B. Frase, superintendent of the Department of Parks and Public Property, states that present plans for riverfront improvement, other than the foregoing, are indefinite.

An 1857 Locomotive Parked

Locomotives as monuments of railway and locomotive history are not frequently seen. It is therefore of interest to note that locomotive No. 1 of the El Paso & Southwestern Railway System has been installed as a monument in the park adjacent to the railway company's office building at El Paso, Tex. It is shown in the accompanying view, but as originally built it had a short smokebox and "woodburner" smokestack (of inverted cone hape), instead of the extension front and straight stack dded later. The cab, bell, sandbox, dome, short wagontop boiler, side-rod ends and other features show decidedly old-fashioned characteristics.

This engine was built in 1857 by Breese & Kneeland, of Jersey City, N. J., for the Milwaukee & Prairie Duchesne Ry. Later it became the property of the Chicago, Milwaukee & St. Paul Ry. It was afterward purchased by he Arizona & Southeastern Ry., now a part of the El Paso & Southwestern System, and was in service on his road from 1888 till 1904. In 1909 it was installed in he park, as shown. It is interesting to note that the ractive power of this little 4:4:0 engine is 7,000 lb., hile that of the latest 2:8:2 freight locomotives on the ame road is 60,000 lb. Information has been furnished y J. L. Campbell, Engineer of Maintenance of Way, and . Paxton, Superintendent of Motive Power.



LOCOMOTIVE NO. 1 OF THE EL PASO & SOUTHWESTERN RY., IN SERVICE 1857 TO 1904

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What California Has Done with an $18,000,000 Road Fund

The $18,000,000 appropriated by the California State Iighway Act of 1909 for road improvement will be practically all expended during the current year. The unexended balance on Apr. 15, 1916, was $1,900,000, but early all this is needed to complete roads already under ontract. A new $15,000,000 bond issue is asked for by he State Highway Commission, of which Austin B. 'letcher is chief engineer.

The following statistics from the July issue of the *'alifornia Highway Bulletin* show what has been accomplished thus far with the original bond issue:

Miles of road surveyed		2,280
Miles of right-of-way secured		1,705
Acres of right-of-way secured		13,327
Miles of highway constructed:		
Oiled macadam	129	
Concrete pavement	933	
Asphalt	33	
Graded	395	
Total		1,490
Miles of roads paved by counties and taken over, improved and maintained by the state		108

11,750,000 cu.yd. earth and rock moved at average cost of 38c.
8,750,000 sq.yd. concrete pavement laid at average cost of 74½c.
1,000,000 cu.yd. concrete pavement laid at average cost of $6.64.
143 grade crossings eliminated.
200 mi., approximately, saved on the trunk lines.
443 bridges secured from counties of aggregate value of $3,450,000.

Eliminating advance surveys and materials on hand, out of every dollar expended 87½c. went directly into the roads in materials bought at "rock-bottom" prices and contracts let under keen competition.

The remaining 12½c. represents every other character of expenditure, including costly preliminary studies of mountain laterals and expensive aid given to many counties.

The Highway Act of 1909 called for the construction of nearly 2,900 mi. of road, an average allowance of approximately $6,200 per mi., including expenses of every nature. State highways in other states under comparable conditions have cost from $10,000 to $20,000 per mi. Hence it is not surprising that only about one-half of the projected mileage in California has been improved under the original bond issue.

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Renewal of the Missouri River Bridge of the Union Pacific R.R. between Council Bluffs, Iowa, and Omaha, Neb., is now under way. It includes renewing all the steel work, revising the foundations for the approach spans, and raising the grade about 2 ft. The main part of the bridge consists of four double-track through, pin-connected Pratt truss spans with curved top chords, each span being 246 ft. 3 in. long. These are over the main channel of the river. The east approach has one through riveted double-track lattice span of 120 ft. 9 in., three deck plate-girder spans of 66 ft. and one of 50 ft. The plate-girder spans are supported on steel bents. The west approach has two through riveted double-track lattice spans of 120 ft. 9 in. and 129 ft. 6 in., and two deck plate-girder spans of 67 ft. and 50 ft. The plate-girder spans and the west end of the longer truss span are supported on steel bents. The foundations for the approach spans are of concrete on piles cut off below low-water level. The bridge was built in 1872 and partly rebuilt in 1887. The American Bridge Co. has the contract for the new steel work and its erection. The work is under the direction of R. L. Huntley, Chief Engineer of the Union Pacific R.R.

Railway Improvements at Clinton, Iowa

Improvements on the Chicago & Northwestern Ry. at Clinton, Iowa, will provide better station facilities and reduce the blocking of street traffic by the trains and yard movements. The conditions are shown clearly in Fig. 2. From the west end of the Mississippi River bridge the line is now at the street level and has a descending grade for the greater part of the distance, rising then to the entrance of the freight yards.

The line will be raised so as to cross over 2nd St., which is to be depressed, as shown in Figs. 1 and 2. The bridge will be fan-shaped in plan and will carry eight tracks. Three streets near the new station will be closed, but a 60-ft. roadway parallel with the right-of-way will give improved means of access. Another street, at the entrance to the freight yard, will be closed also. Two street crossings will remain at grade, but they will be protected by gates and switchmen. The entrance to the freight yard, as shown on the plan, is shifted westward of the present position.

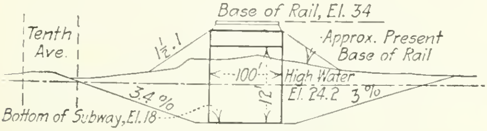

FIG. 1. CROSS-SECTION AT SECOND ST. SUBWAY; CLINTON, IOWA

The present passenger station is a frame structure south of the tracks, at the west side of 2nd Ave. The main part of the city is north of the tracks, and the new station will be on this side, at the end of 11th Ave. (closed), having a 60-ft. approach driveway connecting with adjacent streets. The station will be a one-story building having exterior walls of brick with stone trimmings and tile roof. A separate building will provide for the baggage and express business. There will be two platforms 880 ft. long. The one in front of the station will be 20 ft. wide, and the one between tracks will be 16 ft. wide. These will have shelter sheds of steel construction with composition roofing.

A new freight station, to be built at 3rd St. and 8th Ave., with driveway entrance on the latter, will have a brick building 40x270 ft. and will be approached by tracks extending through the team yard shown on the plan. This freight house is to be built in 1916, as it must be completed before the track changes necessary for the new passenger station can be made. It is planned to build the station in 1917 and the 2nd St. subway in 1918. The improvements have been designed under the direction of W. H. Finley, Chief Engineer of the Chicago & Northwestern Ry.

There are now two other railway stations: That of the Chicago, Burlington & Quincy R.R. and the Rock Island Lines is just south of the present Northwestern station; the Chicago, Milwaukee & St. Paul Ry. has a station farther east, on the river front. There is a movement to secure joint use of the new Northwestern station by all the railways. This plan is being supported by the Association of Commerce, the railway committee of which is headed by C. P. Chase, consulting engineer.

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Planning Problems of Cities in the Smaller Class*

By John Nolen†

This paper is to be devoted to the problems of cities with a population of approximately 100,000, or which will soon reach that size. The planning problems of the smaller cities are very much like those of the larger cities, except that the smaller cities have an opportunity to head off and avoid many of the evils resulting from the early lack of proper planning on the part of cities that are now large.

A notion prevails that comprehensive plans are needed only for large cities. The reverse of this is nearer the truth. In large cities the conditions are comparatively fixed and unyielding. Comprehensive planning, especially with our present legal limitations, can occupy only a limited field in larger places, relieving only the worst physical

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*Condensed from a paper before the City Planning Conference, Cleveland, Ohio, June, 1916. The paper is printed in full in "The City Plan" for June, 1916, the official organ of the National Conference on City Planning (19 Congress St., Boston, Mass.).

†Landscape Architect, Cambridge, Mass.

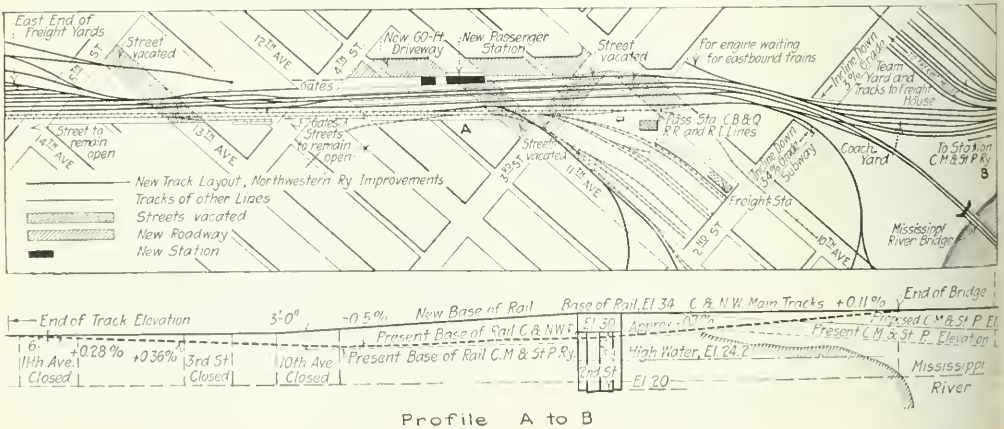

FIG. 2. PLAN AND PROFILE OF IMPROVEMENTS ON THE CHICAGO & NORTHWESTERN RY. AT CLINTON, IOWA

onditions. In the smaller cities streets can be widened, ransit systems properly outlined, building districts dened, park and recreation areas selected, public buildings rouped and a scheme of planning adopted which will have nity and character. All of these elements of a city plan, lmost indispensable sooner or later to the progressive ommunity, may be had in the small city with relative ase and at slight cost.

The safeguarding regulations which should be considred and, if approved, adopted by local authorities, are as llows:

1. The minimum width for main thoroughfares and the servation of land necessary for the same.

2. Provision for narrow streets and roadways of short ngth in many residential areas.

3. The establishment of building districts defining nes for factories, dwellings, etc., with regard to use, nd also the bulk (height and area) of buildings allowble.

4. Provision for some systematic setting aside of open aces for public use in connection with the extension of e town or city, just as streets are now usually set aside.

5. The approval of land subdivisions by local public ithorities.

In connection with these safeguarding regulations it ould be established that property would not be deemed be injuriously affected by reason of provisions which escribe the minimum space necessary around buildings, eir height, area or character, or which limit the number buildings to be erected in a given area. There should so be public power to purchase or expropriate land necesry for these wider public purposes, including, when derable, land within 200 ft. of the boundary lines of any reet, park or other public property.

The town or city should have all the power necessary make systematic local surveys and to provide a general wn or city plan, including the appropriation of the cessary funds, which in view of the fact that such surys are largely for the benefit of future generations ight, if it were deemed wise, be provided for by bond sues. While it should be noted here that more than e-half of what is important for towns and cities, escially the smaller ones, could be accomplished by regulaons involving practically no expense, nevertheless I beve that early planning, at least general planning, is ually important, and in order that the regulations alady referred to shall be wisely placed, a general plan sed upon a local survey should be prepared as early as acticable. One need, then, of the smaller cities is for me method that would bring action on the part of the wn or city early enough and of the right character so as avoid unnecessary waste and mistakes.

⁂

Cost Analysis of Asphaltic-Concrete Pavements

An accurate analysis of the cost of constructing 18,000 .yd. of asphaltic-concrete pavement, at Albany, Ore., is made by John R. Penland, City Engineer. The work is done under an unusual contract which gave the gineer access to all of the contractor's accounts. Hence e costs given are actual costs to the contractor and are t based on an inspector's estimates.

The pavement had a 1½-in. top and a 3½-in. asphalticncrete base, or a total of 5 in. Mr. Penland came to the conclusion that the actual material and labor costs should not exceed 68c. per sq.yd., and that with all general and overhead expenses and a reasonable profit this pavement should be laid at a contract price of $1 per sq.yd. A contract was finally let for the work in question at a price in excess of this figure, or $1.15 per sq.yd., but with the stipulation that Mr. Penland should have access to all the contractor's records and accounts, including his bank books and checks.

The mixture was a gravel asphaltic concrete. The top practically corresponded to the well-known Topeka specification, while the base was a coarser and dryer or more open mixture. The asphalt used was the California "D Grade," which is prepared at the refineries and is shipped in barrels for use without fluxing.

The mixing was done in an "Equitable" portable plant of 800 sq.yd. daily capacity, the heating drum being fired with crude oil, while the asphalt kettles were fired with wood and with staves from the asphalt barrels. The plant force in general consisted of nine men, and, with the exception of the foreman, were in the beginning unused to this class of work. The output of the plant, after the work had been organized, was about 800 sq.yd. of base and 1,200 sq.yd. of top, per day. In laying the pavement, the top and base were spread, raked and rolled separately.

The detailed costs of labor and material obtained by Mr. Penland fully confirmed his original estimates. The average for the entire job showed 28c. per sq.yd. for the 1½-in. top and 37c. for the 3½-in. base, a total of 65c. for the 5-in. pavement.

The detailed costs of the Albany work are available for a week's run in the middle of the job, after the labor had been broken in, and perhaps show more representative conditions than the cost on the entire job:

COSTS PER SQUARE YARD FOR ONE WEEK'S RUN; ALBANY, ORE., ASPHALT PAVING

		Cost		
Item	Unit Cost	Top, 1½ In.	Base, 3½ In.	Total, 5 In.
Gravel, per cu.yd.	$0.86	$0.013	$0.062	$0.075
Fine sand, per cu.yd.	1.50	.032	.026	.058
Coarse sand, per cu.yd.	1.80	.058	.024	.682
Asphalt, per ton	12.00	.089	.078	.167
Fuel oil, per bbl.	1.25	.008	.016	.024
Coal	....	.003	.005	.008
Wood, per cord	4.00	.002	.005	.007
Plant labor	....	.031	.052	.083
Street labor	....	.032	.044	.076
Teams	....	.008	.013	.021
Totals	....	$0.276	$0.325	$0.601
Amount laid (sq.yd.)		5,204	1,548	

In addition to the above, a contractor's costs would include plant charges, overhead and profit. The mixing plant used for the Albany work cost new about $6,000. The owner of this plant, after the completion of the job, offered to rent it to the city for 5c. per sq.yd. of pavement laid with it. While such a figure might represent a legitimate charge for a municipally owned plant, it would seem rather low for contract work, where ordinarily freight charges for shipping in a plant from outside would have to be met. A plant charge of 10c. would however cover almost any contingency of contract work. In addition to this, the charge for roller and for small tools would run about 5c. per sq.yd. To summarize, an equitable contract price for the conditions represented by the Albany, Ore., work would be as follows:

	Per Sq.Yd.
Labor and material (actual cost)	$0.65
Mixing plant (interest, depreciation and repairs)	.10
Roller and small tools	.05
Overhead (10%)	.08
Profit (10%)	.08
Total	$0.96

Copper-Sulphate Treatment of St. Paul Water-Supply

A successful campaign against tastes and odors due to organic growths in the water-supply of St. Paul, Minn., was conducted in 1915, along lines recommended the previous year by Allen Hazen, consulting engineer, New York City. The campaign was in direct charge of N. L. Huff, Professor of Botany, University of Minnesota, under G. O. House, general superintendent of the St. Paul Bureau of Water. The following information is taken from a paper by Professor Huff, read before the convention of the American Water-Works Association in New York City last June. (The paper appeared in the *Journal* of the Association for June and has also been reprinted for Professor Huff.)

The water-supply of St. Paul is taken from a series of lakes. A laboratory was established on the lower one and a careful study made of the organisms in the lake before and after treatment with copper sulphate. The lake as a whole was treated three times, at a cost of $180 for material and $17.50 for labor each time. Special treatment of troublesome coves and shallows was also made at slight expense. The result of the treatment was a material reduction in the number of complaints of bad taste or odor from consumers.

The paper describes all the governing conditions and gives the mode and results of the treatment in detail. In conclusion, after naming the various classes of green and blue algæ, diatoms and protozoa found in the water during the campaign, Professor Huff says:

> With conditions under which above treatments were made, a treatment of one part of copper sulphate in 10,000,000 parts of water remains effective for about five weeks, after which time the organisms present, or many of them at least, seem to find conditions favorable for their growth and reproduction, and if the treatment is not repeated at this time they may increase again with remarkable rapidity.
>
> Where quiet shallow bays afford breeding places for numerous organisms, or where any one or more organisms become abundant in small or limited areas, local treatment or the application of small quantities of copper sulphate to the particular spot where the trouble is originating, has been found very effective. If careful attention is given to such areas, and accumulations of organisms prevented here, the number of general treatments necessary to keep the lake clean for the entire season may be lowered and the total cost of treatments materially reduced.
>
> For treatment of very shallow bays, flat muddy shores and small ponds the use of a hand pump such as is used for spraying trees is a practicable and economical means of distributing copper sulphate. In addition to spreading the solution in places inaccessible for a boat, this method has the advantage of leaving the water unrolled and gives the organism the full effect of the copper, much of which might otherwise be absorbed by mud and organic matter stirred up by a boat in such places.

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K-Truss Bridge of Santa Fe Across Arkansas River

A bridge built recently by the Atchison, Topeka & Santa Fe Ry. has riveted trusses with K-system web instead of the usual subdivided panels. In each panel there are two diagonals, extending from the middle of one post to the top and bottom of the next post. This K-type of truss is used also in the Quebec Bridge.

The Santa Fe Ry. bridge was built rather as an experiment to determine whether the weight and cost of this design would be less than for the ordinary design. The details are found to be heavier than in the latter. The results indicate that the K-truss is not economical for spans as short as 230 ft., but would be decidedly economical for spans of 300 ft. and over.

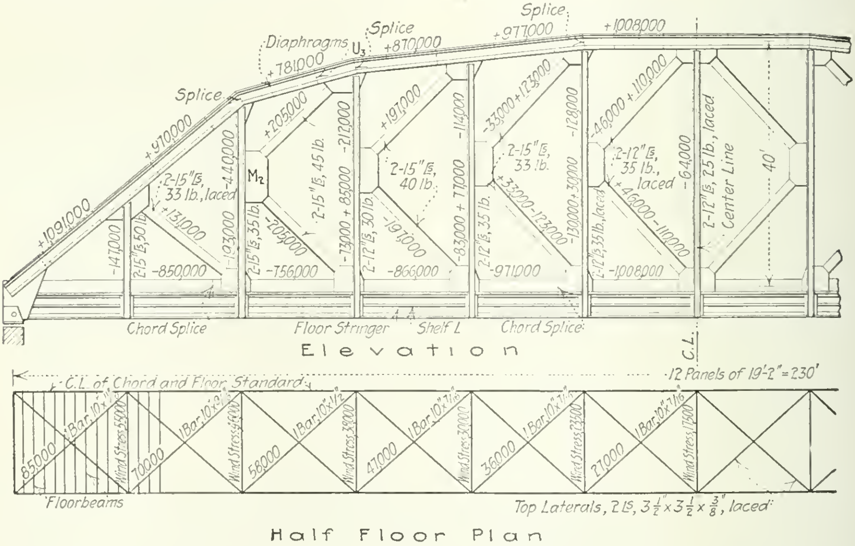

FIG. 1. GENERAL DESIGN OF K-TRUSS BRIDGE FOR THE ATCHISON, TOPEKA & SANTA FE RY.

The bridge crosses the Arkansas River at Pueblo, Colo. It is 230 ft. long c. to c. end bearings and has through trusses 40 ft. deep at the center, spaced 16 ft. (14 ft. clear between the trusses). The clearance height is 22 ft. 6 in. from base of rail to the sway-bracing struts.

The bridge is designed for the railway company's heavy-grade live-load, which is about equivalent to Cooper's E-65 loading. The axle load for the floor is 66,000 lb.

The heavy floor framing is assumed to take 25% of the lateral force. The assumed dead-load is 6,000 lb. per ft. of span, as follows: Steel, 3,950 lb.; timber deck, 270 lb.; ballast, 1,580 lb.; ties, 100 lb.; rails and fastenings, 100 lb. The shipping weight of the span was about 512 tons.

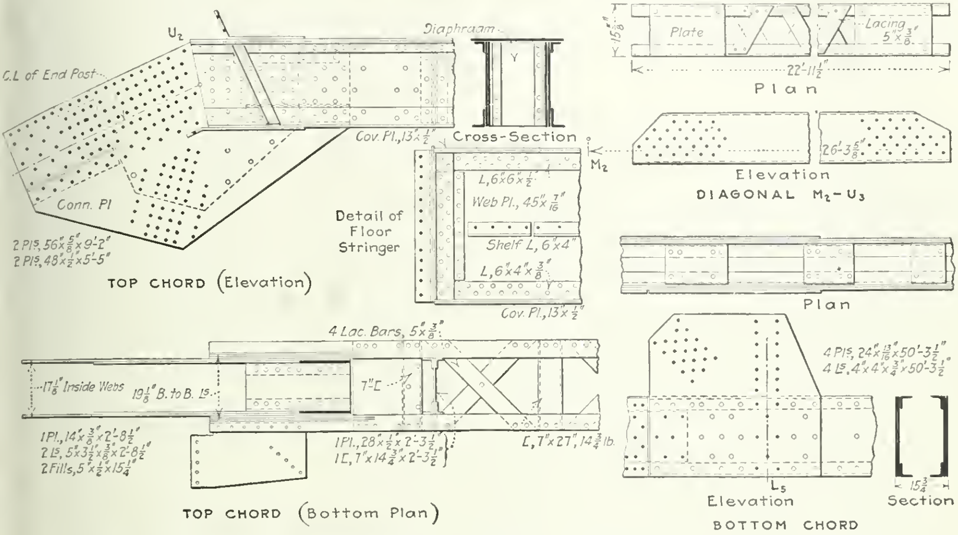

FIG. 2. DETAILS OF K-TRUSS BRIDGE ON ATCHISON, TOPEKA & SANTA FE RY. AT PUEBLO

The top chord is of box section, of very heavy construction It has two 26-in. web plates on each side (½ to ¾ in. thick), four outside flange angles 6x4x¾ in. and a ⅝-in. top cover plate 28 in. wide. Across the bottom flanges is a lacing of bars 5x⅝ in., with struts of 7-in. hannels between the lacing sets. The chord is stiffened by vertical diaphragms of ⅜-in. plates and four angles 3½x3½x⅜ in., there being two of these to each panel. The bottom chord is similar, except that it has the flange angles on the inside. It is composed of four 24-in. web plates (two on each side), ½ to $\frac{13}{16}$ in. thick, and four angles 4x4x¾ in., with top and bottom batten plates.

The posts and diagonals are pairs of 12-in. and 15-in. hannels, with flanges turned outward for the posts and nward for the diagonals. The channels are connected by batten plates and lacing bars 5x⅜ in. These bars (in the chords as well as the web members) are notable for their width (5 in.), which allows two rivets in each end. The connection plates are large and allow for ample riveting.

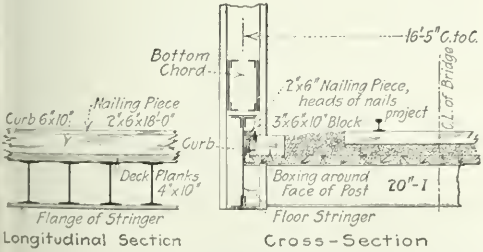

FIG. 3. SOLID-FLOOR CONSTRUCTION OF THE ARKANSAS RIVER BRIDGE

The top laterals are pairs of 3½x3½-in. angles, laced. The top struts are composed of four angles, with vertical lacing for the web. Beneath them is the sway bracing, with diagonals and bottom struts composed of pairs of angles 5x3½ in. The bottom lateral diagonals are 10-in. bars, $\frac{7}{16}$ to $\frac{11}{16}$ in. thick, riveted to the bottoms of the posts.

The ends have pin bearings in the shoes, and at the expansion end each shoe has a nest of nine segmental rollers 6x3 in., 4½ ft. long. Four tooth-bars projecting above and below the rollers engage pockets in the bridge plate and base plate, so that any movement of the bridge must operate the roller nests.

The structural material is openhearth steel of 55,000 to 65,000 lb. ultimate strength and an elastic limit of 55% of the ultimate strength. The rivets are ⅞ in., with $\frac{15}{16}$-in. open holes. Holes in the chord splices are reamed with the chord sections assembled in the shop, in order to secure fair holes. All the other work is punching and riveting without any reaming. A coat of raw linseed oil was given at the shop, and surfaces that would be inaccessible after assembling were given two coats of paint. After erection the steel was cleaned with wire brushes and scrapers and then given two coats of paint, as is general practice on this road.

Solid-Floor Construction

The floor system is of special interest, though it is not peculiar to this bridge, being the railway company's standard I-beam floor for ballasted-deck construction. There are no plate-girder floor-beams, as in ordinary construction, and the stringers—instead of being placed under the track—are placed directly under the bottom chords, being framed between the truss posts. These stringers are 45-in. plate girders, with $\frac{7}{16}$-in. webs, top flange angles 6x6x½ in. and bottom flange angles 6x4x⅜ in.

On the bottom flanges of the stringers rest transverse 20-in. I-beams, spaced 20 in. c. to c. These are secured by shelf angles 6x4 in., riveted to the stringer webs.

Upon the I-beams is a deck of longitudinal 4x10-in. creosoted planks, with a 6x10-in. curb on each side to retain the ballast. The curb is held by a flat nailing piece that bears against the web of the stringer and can be easily removed for inspection or painting of the steelwork. Boxing of 4x10-in. pieces keeps the ballast away from the truss posts. The ballast is about 7 in. deep under the ties.

The bridge was designed under the direction of A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe Ry. It was built by the American Bridge Co.

* * *

Exact Imitation Infringes Trade Rights

In a case before the Supreme Court of New York County, decided by Judge Shearn on June 20, where a competing manufacturer of a device made an exact copy of his competitor's production, his object being apparently to deceive a purchaser, the court ruled that such a proceeding was unfair competition and the plaintiff was entitled to a judgment and an accounting.

The plaintiff in the suit was the Diamond Expansion Bolt Co. and the defendant the United States Expansion Bolt Co. The plaintiff has built up in the last seventeen years a large business in the manufacture and sale of lag shields and anchors, and was the pioneer in introducing them to the trade. Other manufacturers entered the same field with widely different forms of shields and anchors. The lag shield designated as the "diamond" shield was put on the market by the plaintiff in 1910 and 1911. In 1913 the defendant placed upon the market a rival lag shield and anchor which to external appearance was a Chinese copy of the plaintiff's device but differed slightly from the plaintiff's in a hidden feature which was patented. In marketing this device the defendant widely advertised a cut of 25% in the prices maintained by the plaintiff, used underhand attempts to hire the plaintiff's important salesmen, and declared to the trade that its devices were identical with those of the plaintiff. The court in its decision said:

> It is, of course, true that where a design is not patented there is no exclusive legal right to its use per se, and apart from patent rights, one may copy with exactness that which another has produced without inflicting any legal injury, unless he attributes to that which he has made a false origin, by claiming it to be the manufacture of another. On the other hand, where an article of distinctive appearance has been on the market in that form for a long period and has been popularized and identified with its manufacturer through advertising and general use, its distinctive appearance gradually becomes as important a representation of its origin as its trademark.

The court ruled that from the evidence it was clear that the defendant, who made the Chinese copy of the plaintiff's devices, believed they would sell better if their appearance were identical with the form so popularized by the plaintiff. The court ruled that this constituted unfair competition and a judgment and accounting for the plaintiff was ordered.

* * *

Air-Diffuser Experiences with Activated-Sludge Tanks

SYNOPSIS—Differences of experience and opinion as to the use of porous-block and perforated-pipe diffusers for intimately mixing air and agitating sewage in activated-sludge tanks are expressed by engineers in charge of test and working plants at Milwaukee, Baltimore, Brooklyn, Cleveland, Urbana and Chicago.

In the design and operation of activated-sludge tanks questions that have received considerable attention and will probably be given much more are the possible clogging of the "filtros" or other porous blocks used for diffusing the air as it is forced into the bottom of the tank and up through the sewage, and the relative advantages of porous-block and perforated-pipe diffusers.

It is well known that in other mechanical operations where a large volume of air has to be forced through restricted passages the latter become clogged with dust and dirt and must be regularly cleaned or the flow of air will be interrupted; at least, this will happen unless the air is first washed or otherwise cleaned of dust. To what extent is this same trouble likely to arise in porous diffusers in activated-sludge tanks? In dealing with this general question in the discussion relating to experience at Milwaukee there appeared in *Engineering News* of Feb. 10, 1916, p. 263, in the course of some remarks by T. Chalkley Hatton, a statement that there was no trouble from clogging in the large tanks at the Milwaukee testing station. The air, however, is filtered through excelsior placed in the air-feed pipe. The experience at Milwaukee also showed that there was no trouble during nine months' operation from filtros block clogging from the sewage itself.

Subsequent to the appearance of the article on the Milwaukee plant, a member of the editorial staff of *Engineering News* visited the large Imhoff tank at Baltimore, where under the direction of Calvin W. Hendrick, Chief Engineer of Baltimore, and Leslie G. Frank, Sanitary Engineer, United States Public Health Service, one of the large new Imhoff tanks has been adapted to serve as an activated-sludge tank. The experiences at Baltimore being somewhat at variance with those at Milwaukee, it seemed desirable to appeal to the engineers who have been most intimately connected with activated-sludge work in this country, asking them to summarize their experiences with air distribution in its relation to clogging of porous distributors. The responses to this request have brought out some interesting facts regarding perforated-pipe as well as porous-block distributors. Below are printed staff notes on the Baltimore plant, kindly revised by Mr. Hendrick and supplemented by Mr. Frank, together with notes from various other localities and engineers.

Baltimore Notes: Revised by Mr. Hendrick

The air supply at Baltimore before passing to the blower is thoroughly washed to remove any dust it may contain. This washing is effected by passing the air through a 15-ft. length of a 12-in. cast-iron pipe set vertically. The ir enters at the bottom and passes upward through gravel ith an approximate diameter of ⅜ in. This gravel yer is supported 18 in. from the lower end of the pipe y a grid and extends to within 3 ft. of the top of the asher. A small stream of water is trickled through he gravel from the top and is taken off at the bottom by a oat-actuated valve. The air at Baltimore is compressed y a rotary compressor having an eccentric rotating piston hat requires a great deal of lubrication. Notwithstandng the thorongh washing that the air receives before going hrough the blower, there has been found on the inside of he porous blocks[1] a deposit of oily sludge. This, it is pposed, comes from the lubrication process already menoned. It is hoped that the oily deposit in the blocks n be avoided by substituting a rotary compressor of e gear type, or a high-pressure centrifugal blower neither of which requires internal lubrication), for the ind of blower referred to above.

Mr. Frank on Experience at Baltimore

The diffuser grid installed in the activated-sludge tank as first provided with carborundum disks, grit 120, the fluent air being washed as is described above. Two cts soon become evident—that an oily sludge accumuted on the bottom surfaces of the disks and that the r washer removed practically as much oil without the ater stream as with it. The whole gravel layer soon came heavily coated with an oil film, and this oil film as as good or probably better than a water film for the moval of dust and oil particles. Neither oil film nor ater film, however, removed the *oil vapor* that had en generated by the heat of compression, the air deten-n period in the washer being insufficient to effect its rendensation. This oil vapor, therefore, passed down into e manifold and condensed on the cold under-surfaces of e diffusers, gradually forming a sort of oily sludge comst with the particles of sludge that worked their way to the grid in times of shut-off. This oily sludge renred the carborundum disks almost impervious to air and used us to substitute filtros therefor. The same accumution of oily sludge has been observed on the underside the filtros plates, but owing to the greater porosity of is material the corresponding increase in resistance has t been so great as in the case of carborundum.

At present (Apr. 29) the air-compressor capacity is ing greatly increased by the installation of a Connerslle blower, and it is hoped that at the same time the oil fficulties will be obviated due to the fact that this type blower requires no internal lubrication, as in the case of e blower heretofore used.

Since the above was put in type, Mr. Hendricks inrms us under date of July 11 that a Connersville blower ith a capacity of 195 cu.ft. of fuel air per minute has st been installed and the porous area of the grill has en doubled. Experiments on this installation have just gan.

Milwaukee, Wis.: T. Chalkley Hatton*

As to the experience of Milwaukee I might repeat the atement in *Engineering News* of Feb. 10, 1916, in which said that no trouble from the clogging of the filtros ates had been so far experienced at the Milwaukee testing station—that is, clogging due to the passage of the air through the plate. We have occasional clogging on the top of the plate, owing to the very heavy sludge temporarily alighting thereon and not being lifted through the body of the liquor.

We think this is due to the character of our sewage in that it carries a great deal of waste, entrails from the packing-house district, small pieces of leather from the tanneries and large quantities of hair. All this becomes massed together. The specific gravity, being thus largely increased, overcomes the tendency of the air to keep such masses in constant suspension. We think much finer screens than we now use will largely overcome this difficulty.

The Connersville blower, which we are operating, was designed with a view of preventing any lubricating oil used in the blower from getting into the discharge pipe, and the wood wool placed compactly in the filter seems so far to have intercepted the dust carried by the air.

While we have not removed any plates that have been in operation more than two months, there is no visible evidence in the operation of our plant that these plates are not giving just as good diffusion as when they were installed. Two months after our new and large fill-and-draw tank was first placed in operation we did remove some of the plates from it and carefully examined them for porosity. We found that they were in the same condition in this respect as when they were first introduced.

From the notes furnished me of the Baltimore experience I should attribute the trouble to the lubricating oil from the compressor. This would not be entirely removed by the washing of the air. In fact, I do not place as much dependence upon the washing of the air as upon a good filter. Whether the wood wool is the best medium for this filter or not, I am not prepared to say, but so far it has been successful with us. It is cheap, easily examined, easily removed and replaced.

We are now experimenting with a diffuser made of basswood, cut at right angles to the grain. We have made several experiments on woods of different characters, but find basswood so far is the most reliable and gives the best diffusion with the least frictional loss. The air appears to be uniformly distributed in smaller bubbles than from the filtros plates, but whether the wooden disk will prove practical or not is a question yet to be determined.

We are trying 8x10-in. plates to determine among other things the total swelling of the wood, the uniformity of porosity during long-time service and the possibility of decomposition through aërobic action or through chemical action due to contact with the sewage. These, of course, are matters that can only be determined after considerable careful investigation.

Brooklyn, N. Y.: George T. Hammond*

The activated-sludge method of sewage treatment is so recent that it is not surprising if we have not yet learned the best technic of applying the principle in actual practice. The first experiments were made on a laboratory scale, or with apparatus designed for other methods of treatment, which could be modified for immediate use in temporary experimental plants. Resort to the actual trial of apparatus was the best, if not the only, way to gain essential working knowledge before serious problems in design could be undertaken: and indeed these trials and experiments are as yet unfinished, and it is still too early to anticipate their results.

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[1] Carborundum disks of 120 grit were first used, but the fferential pressure required to force the requisite amount air through rose so rapidly (from less than 1 to over 5 lb. r sq.in.) on account of clogging that filtros was substituted.

*Chief Engineer, Sewerage Commission, Milwaukee, Wis.

*Engineer of Design and in Charge of the Sewage Experimental Plant, Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.

It is scarcely a year since the first plant on a working scale was put into service. While we may not forecast results, it is quite safe to hazard the opinion that several years must elapse before sufficient data of a satisfactory kind will be secured to permit an adequate solution of some of the problems presented. Considering the short time that has elapsed, it is rather surprising how much progress has been made.

Air diffusion into the sewage has been attended with considerable trouble and affords one of the main problems involved in the application of the method.

The ideal air diffuser should give an easily controlled flow and volume of air, equally diffused to all portions of the tank, with bubbles of the "critical" size formed at the points of entrance. It should not tend to become clogged, or at least should not tend to unequal clogging. It should be readily cleaned in place without emptying the tank, or should be easily removable for replacement and for cleaning in case of clogging. It should show the minimum deterioration in service, and its cost should be reasonable.

The earliest aërator tanks of which the writer is informed employed grids of perforated pipe for this purpose. The experiments of Black and Phelps in Brooklyn were conducted with such grids, as was the continuous-flow aërating tank experimented with in 1914-15 at the same place. (See *Engineering News,* July 29, 1915.) These grids have uniformly given good service, if designed on correct principles, and have shown but little tendency to become clogged.

Porous material used to diffuse air has shown a tendency to progressive clogging. This may possibly be reduced to a minimum by various forms of air filters, placed in the supply line, which promise to render its use practicable. It has been employed because it gives a very fine bubble, and the entering bubbles are distributed over a wide surface. While clear and new, it gives the air diffused a higher efficiency than does the perforated grid. But in spite of every care this freedom of discharge and high efficiency seem not always to be maintained. From whatever reason, some of the porous plates come to pass the air less freely than others. Examination of a number of tanks supplied by air in this manner convinced the writer that there was in every instance a material variation in the diffusion of the air in different portions of the same tank. This was evidenced by violent local ebullitions and evident local streaming out of air, while other portions of the tank surface remained quiescent, or nearly so. Photographs taken of the surfaces of a number of these tanks sustain this observation.

It was also observed, where this phenomenon was seen, that for one or another assigned reason the aëration period had been, in all the cases observed, materially lengthened. This result was quite in accordance with the writer's own experience with the use of porous diffusers. We found that our disks clogged very unevenly and that the entire supply of air was discharged through the unclogged disk without showing any decrease in quantity by meter.

It seems obvious that the primary cause of this trouble is the fineness of the pore, or passage, through which the air is diffused. Even if all dust and other foreign material are excluded by means of air filters, various kinds of bacterial and other minute forms of life, etc., enter freely and may cause obstructing growths. The sewage directly over such plates may enter the pores and cause obstruction in various ways, among which may be mentioned deposits of mineral matters from solution. In short, there are many ways by which porous material can become clogged, even if the greatest care is taken to prevent it.

In view of the foregoing it seems desirable to find some other method of diffusion. Apparently the porous material answers only one of the above-mentioned ideal requirements of a distributor—that of giving a very fine size of air bubble.

Experiments have shown that the finer the bubble the more the pressure needed to distribute the compressed air and the greater the danger of clogging. The finer the bubble the greater its efficiency, but the more expensive the air. The tank efficiency is highest when its reliable average performance gives the effluent required at the least expense for air.

The experiments conducted in Milwaukee in 1915, reported by Mr. Hatton, seem to indicate that the porous material was rather the best for diffusing air, although he states that "there appeared to be little difference in the character of effluent obtained by the same volume of air, whether it was applied through an open jet or a filtros plate."

It seems to the writer, in view of this and his own experience, that the use of porous material for diffusion has largely grown out of theoretical rather than practical considerations and that further experimental work is very desirable. The useful age of service to be expected from a porous substance, it would seem, must be comparatively short, if we can depend upon our experience in other lines of work.

Our experience in Brooklyn has been in favor of the perforated grid, the pipes of which are placed not more than 12 in. apart and the perforation made of $\frac{1}{16}$ in. diameter, 6 in. c. to c. The grid in one tank aërator is still in service after over 2½ yr., during which time it has had no cleaning. The depth of sewage aërated is 22 ft., and the distribution is very good.

Another tank, in which distribution was provided by porous disks, was not so satisfactory on account of clogging. The phenomenon of clogging in this tank was rather interesting. Some of the disks clogged, while others did not. As a result, a greater volume of air entered through the unclogged disks, causing intense local surface ebullition and streaming out of air, while at other places the surface was quiescent. As there is always an excess margin of working pressure, increased volume of flow can readily occur through the unclogged diffusers; thus the entire metered flow of air will still continue to enter the tank, but it may not reach half of the sewage, and much of it escapes by streaming. Why employ the porous material, to obtain the most efficient size of bubble, in order to save a small per cent. of the air, if, as a result of the attempt, clogging or uneven distribution may occur and waste far more than could be saved by this means?

Unfortunately, there seems to be no satisfactory way to clean out the porous disks or plates, without removing them. This problem has been ingeniously handled at Baltimore, where the diffuser disks are mounted on a framework of pipes that may be closed like an umbrella and the entire mechanism withdrawn by a derrick. (See *Engineering News,* Apr. 27, 1916, p. 800.) This enables operator to remove and replace a disk at will: but ere the porous plates are built into the bottom of the k, as in some plants, it is too early to feel certain that y can be kept in good order. But as the surfaces of the inlets must be as nearly absolutely level with each other possible, it may be difficult to obtain this with a movable tributor.

In the design of a sewage-disposal plant refinements in rating parts are undesirable. The mechanism that ll give the most reliable average service will usually selected. For diffusing air in a tank filled with sewage writer's observation leads him, in the light of present owledge, to prefer the perforated-pipe grid, although it l not give the most efficient size of bubble.

The grid may be so designed that, if necessary, it can eive frequent flushings from the city water-supply, ich always has a greater head than the sewage in the k; and it can be provided with drains, so that it may be shed out with little trouble, without emptying the tank. uld the perforations become clogged with grease, the k may be emptied and steam or hot water discharged ough the grid. Possibly, further experiments may dify this opinion, which is offered by way of discussion experimental work still in progress.

The question has several times suggested itself to the ter, "Would it not be possible to get along with less by the use of mechanical agitation in the aëration ks?" It would seem that much of the air applied at sent is wasted, as it is only applied to produce agitation—a churning movement that seems to aid coalescence the finer particles of colloidal matter, and facilitates activation treatment. This has not been tried out so as the writer is aware, but various means suggest themes, such as paddles, screw propellers, movable air disutors designed to agitate the sewage and to diffuse air, of sewage discharged into the tank, if the sewage ers by pumping, etc. May not such a method greatly ease the effect of air, which could then enter by means rather coarse movable, or stationary, grid and be menically mixed with the sewage?

he importance of continuing our experimental work h the activated-sludge method of sewage treatment not be overstated, and every possible advantage should aken of constructive criticism, as well as experimental k.

ANITARY DISTRICT OF CHICAGO: LANGDON PEARSE*

Iy personal experience with small experimental units satisfactory, but in the plant put into operation by in January, comprising four units, with a capacity of 00 gal. per day on a 24-hr. period, we have had considle difficulty with the clogging of the plates. This apently has been caused by the sewage, which contains a d deal of paunch manure, straw, hair and other maal that will mat and clog. A recent examination of one k with a nominal inside dimension of plan of 6x23 ft., h a single row of filtros plates down the center, indis that all the plates have been broken. The breaks are arently due to downward pressure. The plates were ported on two sides only, in wooden boxes, lined with vanized iron, and were set in jointite. The use of wood bably caused the trouble, a more rigid frame being irable. The distribution in the tank was seriously inferred with, a considerable deposit of hair and coarse sludge being found underneath the plates, many of which were badly shattered. We are endeavoring to find the exact reason for this difficulty, although it appears to be due to clogging and the loading of the water on top. No provision was made for back-flushing by water. For various reasons the air pressure has been shut off from time to time. The air distribution has been remodeled, the boxes being stiffened, and an additional support placed so that all plates are supported on four sides. This has proved satisfactory.

The air at our testing station is furnished by a rotary blower of the Connersville type, working against a 6-lb. head, the depth of water being 10½ ft. over the plates. We have a muslin screen on the intake of the blower. So far as we can ascertain, there has been no difficulty on the underside of the plates from any oily deposits, there being no trace of oil in the air boxes underneath.

In order to cure certain difficulties in measuring the air with a venturi meter, a steel storage tank 5 ft. diameter, 5 ft. high, has been installed. This reduces the pulsating effect and forms a trap for oil or moisture.

Before our experiments are concluded, I hope to run comparative tests on two tanks with perforated pipes and two tanks with filtros plates. I believe that considerable thought is still required to determine the proper design for the air-distribution system in order to make it satisfactory at a minimum cost.

I believe that *Engineering News* will do well to impress upon its readers the importance of going slow in the adoption of activated-sludge plants without thorough consideration of all the elements involved, as I think most of us still agree that it is not a simple process to operate, but one whose entire limitations are not yet developed.

The cost problem is still in the air, particularly the cost of handling the sludge. Another warning should also be issued on the short-time tests lasting only two or three weeks, which are liable to give misleading results, as it takes several months in general to determine the efficiency and limitations of sewage-treatment methods definitely. We have noticed in our work that good results are obtained for the first three or four weeks, and then difficulties begin to develop that were not anticipated.

HOUSTON, TEX.: E. E. SANDS*

Our experiments were all conducted with that variety of filtros manufactured by the General Filtration Co. and known as Grade 5-1. The catalog published by the company states that where there is a net head of 2 in. of water the capacity of a filtros plate 1½ in. thick and 12 in. square is 360 cu.ft. of air per hour, or 6 cu.ft. per min., and that the porosity of this plate or the per cent. of voids is 37.56%. It is evident that the tests from which this table was prepared were made with dry air and under dry conditions. When a filtros plate becomes wet, the porosity is reduced and its resistance to the flow of air increases. Careful experiments were carried on with the filtros plate in tank No. 3. This plate was submerged to a depth of 7 ft. 6 in. The air as it entered the plate was measured through an orifice in a thin plate located in an enlarged section of the supply pipe. When the plate was new, 150 cu.ft. of air per hour (measured under a water pressure of 8 ft.) required a net head of 6 in. After the plate had been used for 30 days in a tank operated on the fill-and-draw plan, it was found that the same amount of air required a net head of 15 in.

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*Division Engineer, Sanitary District, Karpen Building, cago, Ill.

*City Engineer, Houston, Tex. The remarks here given are from Mr. Sands' "First Annual Report . . . on Sewage Disposal," dated Feb. 1, 1916.

After 40 days' use the following heads were required, the depth of sewage in the tank still being 90 in.:

Air in Cubic Feet per Hour (Measured Under Pressure)	Head of Water, Inches	
	Total	Net
50	102.2	10.5
75	102.22	12.22
100	104.1	14.0
125	105.82	15.82
150	107.53	17.53
175	109.20	19.20
200	111.10	21.10

Where the plate is in a fill-and-draw tank, every time the air is shut off a certain amount of sewage filters through the filtros plate back into the air pipe, and it is reasonable to assume that a small amount of sludge remains in the voids of the filtros plate and reduces its capacity.

Where a tank was used for a continuous flow, the resistance of the plate was not found to increase to any great extent, and it is believed that if a continuous-flow tank were supplied with filtered air the resistance of the filtros plates would remain nearly constant for any given climatic condition. It was observed, however, that the humidity of the atmosphere had a decided influence on the capacity of the plates. When the air was moisture-laden, the resistance of the plates was greatly increased. For this reason the use of a cheesecloth filter for the removal of dust from the air will give more satisfactory results than the use of an air washer. Such a filter will not remove as much dust as a washer, but a washer will cause an increase in humidity unless some cooling device is used.

Tank No. 3 was equipped for about 10 days with an aërator constructed of small brass tubing. This aërator consisted of a central head from which there radiated in a horizontal plane eight ⅛-in. brass tubes 6 in. long. An aërator constructed in this manner would work in a continuous-flow tank without any trouble, but when it was tried on a fill-and-draw tank it was found that the small tubes clogged up when the air was shut off and the sludge allowed to settle. As the water surface in the tank was lowered during the operation of drawing down the tank, the air held in the supply pipe between the valve and the aërator expanded and slowly escaped. Then when the tank was refilled, the sludge was forced into the aërator tubes and considerable difficulty was experienced in keeping this aërator cleaned out and in proper working condition.

All the mechanical difficulties of this could have been overcome without much trouble, but results of analyses made during the time this aërator was in use show a decided loss in efficiency. This is attributed to the fact that the air is not as finely divided by such an apparatus as it is by the filtros plate.

It is apparent that the operation of any large tank containing a great number of aërators requires careful consideration of the following conditions: When the air is turned on, a few aërators will handle a large quantity of air unless each aërator offers considerable resistance. This air will diminish the hydrostatic head over these aërators and consequently increase the effective head on the particular ones that start to work first. To eliminate this possibility it is necessary that each aërator shall contain sufficient resistance to prevent a few of them from discharging all the air that is intended to be discharged by the entire system. In other words, a certain resistance to the flow of air is absolutely necessary to insure a uniform distribution. Where the tank is 10 ft. in depth, this resistance should be such that a net head of at least 6 in. of water is required to discharge the amount of air that the aërating plate is designed to provide. If a type of aërator were used that did not require a 6-in. hydrostatic head to discharge the required amount of air, some other resistance would have to be used at each aërator; consequently the resistance offered by the filtros plate is of no disadvantage until it becomes greater than 6 in. It is believed that a proper filtros plate can be selected for any particular design that will afford the right resistance to insure uniform distribution, but it is necessary that air should be freed of all dust and that the tank should be worked as a continuous-flow tank or the resistance of the filtros plate will gradually increase with a resultant loss of power.

Armour & Co., Chicago: G. L. Noble*

The filtros plates that we had in our tank were admitted by the General Filtration Co. to be of uneven porosity, due to the manufacture by an outside kiln firm. This resulted in the very rapid clogging of the finer plates, and this method of distribution was abandoned.

Perforated pipes were promptly installed and have given good satisfaction. They are made of ¾-in. galvanized iron and perforated with $^1/_{25}$-in. holes, 2 in. apart and staggered. Cleaning is necessary only once in four months, and this cleaning can be accomplished in short order without interfering with the operation of the plant.

We have carefully studied all the data available for comparing these two methods and have yet to be convinced that a porous plate is preferable to perforated pipe, when the matter is considered from every viewpoint. We expect (July 3) to install perforated pipes in our larger experimental plants.

Cleveland, Ohio: R. Winthrop Pratt†

We have been running now (July 3) more than five months and as yet have noticed no trouble which might be due to clogging of filtros blocks.

We hope and believe that with our type of blower, containing as it does a water trap through which the air must go, there will be no serious trouble from dirt or dust in the air entering the activated-sludge tanks.

Illinois Water Survey: Edward Bartow‡

In our experiments, operating tanks on the fill-and-draw plan for about a year, we have experienced no trouble from clogging of the filtros plates. On the fill-and-draw plan, however, the pores are cleaned by downward flow of the water while the air is shut off during the settling period.

In our continuous-flow plant, about to be put in operation, we expect to filter the air through cheesecloth, and we have made arrangements so that the air may be shut off and water allowed to flow downward through the plates into a space from which it can be pumped. We can tell better after operating whether our precautions are satisfactory, but we do not anticipate any trouble from clogging of plates by impure air.

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*Engineer-in-Charge, Union Stockyards, Chicago, Ill.

†Consulting Engineer, Department of Public Service, Cleveland, Ohio.

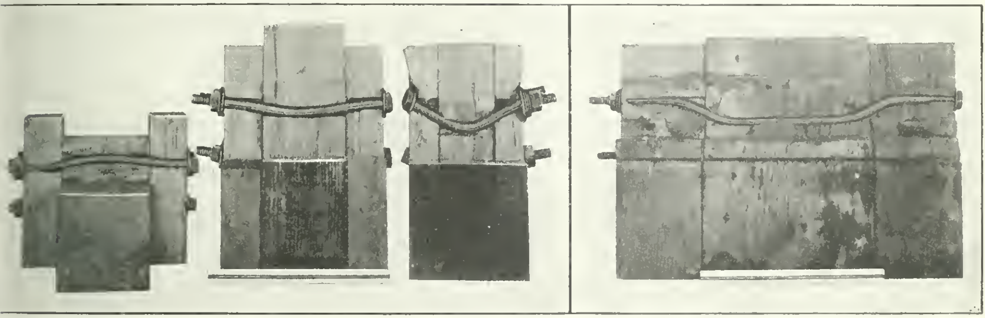
‡Director, State Water Survey, Urbana, Ill.

New Tests of Bolted Joints in Timber Framing

By H. D. Dewell*

SYNOPSIS—New tests on bolted joints in timber give a safe basis for design. Previous rules of handbooks are unreliable. A ⅞-in. bolt in double shear is good for 2,000 to 2,850 lb., depending on the thickness of the timber and pads; in single shear, half as much.

In an article entitled "Tests of Some Joints Used in eavy Timber Framing," *Engineering News*, Mar. 19 nd 26, 1914, the author discussed briefly the lack of efinite knowledge of the actual strength of bolted timber ints and the discrepancy between the sizes of bolts in ich connections, as computed by the accepted methods of sign, and those sizes commonly used by contractors and chitects. There were presented the results of some tests ade by E. E. Adams on 2-in. plank bolted with ½-in., -in. and ¾-in. bolts, and reference was made to other sts on bolted end joints of timber trusses. These are e only recorded tests of bolted joints which the author s been able to find.



Joint 11—Side bearing 2¾x6-in. pads on 6-in. timber; three ¾-in. bolts; maximum load, 35,000 lb.; deflection, 0.735 in.

Joint 6—End bearing 2⅞x8-in. pads on 6x8-in. timber; three ¾-in. bolts; maximum load, 36,250 lb.; deflection, 0.635 in.

Joint 3—End bearing 2x8-in. pads on 4x8-in. timber; three ¾-in. bolts; maximum load, 46,650 lb.; deflection, 1.95 in.

Joint 20—End bearing 6x10-in. pads on 12x10-in. timber; three ⅝-in. bolts; maximum load, 46,325 lb.

All of these joints show the pronounced bending of the bolts under compression of the timber.

FIG. 1. FOUR OF THE BOLTED JOINTS CUT OPEN AFTER TEST

The same article also described some tests by the thor to determine the lateral resistance of ¾x4½-in. g screws used to fasten 2-in. timber plates, as in column cing or bracing. Here again is a field in which no other sts have been recorded, to the author's knowledge.

A New Series of Tests

For fuller information a further series of tests was ade during 1915. This series comprised tests of 24 lted joints, 10 all-timber lagscrewed joints, 4 joints in hich a steel plate was lagged to timbers with ¾-in. and -in. lagscrews, and 13 tests made to determine the aring resistance of a round bolt against the ends and ross the fibers of Douglas fir. The joints were tested the Panama-Pacific International Exposition, in the alace of Machinery, on an exhibit testing machine of Tinius Olsen & Co., of Philadelphia. The machine is of 150,000 lb. capacity, with an attachment for making autographic records of the tests and a device for automatically balancing the arm by means of a sliding weight.

The tests on lagscrewed joints are dealt with in a subsequent article.

Present Methods of Designing Bolted Joints

One of the most difficult things an engineer has to contend with in timber design is the justification of the large size of bolts, when designed as pins, as compared with the sizes found in the designs made by many contractors and architects. In checking over many plans the author has found it to be a common practice to consider bolts in timber joints as equivalent to rivets in steel joints. Obviously, this practice is vitally wrong in principle. Shear usually governs the design of rivets or bolts in steel connections, but in timber joints the bolts will bend or the timber fail before the bolt will fail in shear.

Not alone are these high values used for bolts having all end bearing against the timber, but they are also used when the bolts have partial or entire bearing across the fibers of the timber. A common example of a connection in which the bolts bear across the fibers is that of an all-timber truss, where the web members consist, say, of 2-in. plank bolted to the chords. In such a case strict adherence to the method of designing the bolts as pins, with due allowance for bearing across the fibers, results in bolts of abnormal size, and the engineer is criticized for extravagance.

The rules given by text-books vary over a large range. As concerns designing bolts as rivets, Kidder ("Architects' and Builders' Pocket Book") disregards bending where the pieces joined are not more than 2 in. thick. W. J. Douglas (in Merriman's "American Civil Engineers' Pocket Book") disregards bending where the pieces are less than 3 in. thick. For computing bending in bolts, the rules given are as follows:

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*Civil Engineer, 58 Sutter St., San Francisco, Calif.

Considering a butt joint of two sticks 2L thick, spliced on each side by a pad L thick, through-bolted, the joint carrying a load 2P, of which half goes through each pad: Kidder gives the bending movement in the bolts as ¼PL; Jacoby ("Structural Details") gives it as ½PL, on the assumption of uniform pressure on the bolt; Howe ("Treatise on Wood Trusses") uses the same formula as Jacoby; W. J. Douglas uses the same formula as Kidder; Thayer ("Structural Design," Vol. I) recommends assuming uniform bolt pressure on such a length of bolt that the resulting bending in the bolt will just equal the flexural or shearing strength of the bolt. Not only the formulas but also the stresses used by these several authors differ.

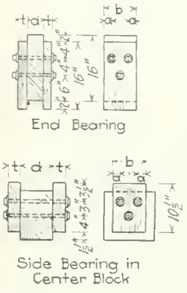

FIG. 2. DETAILS OF BOLTED TEST JOINTS

TABLE OF DIMENSIONS

	Joint	Bolts, In.	t In.	d In.	a In.	b In.
End Bearing	1	¾	2	4	2	8
	2	⅝	2	4	2	8
	3	¾	2	4	2	8
	4	¾	2¾	5¾	2	8
	5	⅝	2	4	2	8
	6	¾	2⅞	6	2	8
	10	¾	4	8	2	8
	14	⅝	3⅞	8	2	8
	15	⅝	3¾	8	2	8
	16	¾	3⅞	8	2	8
	18	¾	6	12	2	10
	19	⅝	6	12	2	10
	20	⅝	6	12	2	10
	21	⅞	6	12	2½	10
	22	1	6	12	2½	10
	23	1	6	12	2½	10
	24	¾	6	12	2½	10
	25	⅞	6	12	2½	10
	27	⅞	5⅞	12	2½	10
	28	⅞	5¾	12	2½	10
Side Bearing	11	¾	2¾	6	2	6
	12	¾	4	8	2	6
	13	¾	4	8	2	6
	26	¾	2⅞	6	2	6

Table 1 gives the working strengths of the joints as determined by the methods of Jacoby, Howe, Kidder, Merriman and Thayer, together with results deduced from the new tests. In the case of all the authorities the lowest and highest values are shown—that is, the values for joints with 2-in. and 2⅞-in. splice pads and those with 6-in. splice pads. This table emphasizes the wide variation in the prescribed practice of designing bolts.

The author maintains that the high values as given for joints with the thin plates, when based on the supposition of friction, cannot be sustained, as shrinkage of the timber will soon destroy the effect of friction.

Joints Tested After Loosening Nuts

Fig. 2 shows details of the joints tested. All had three bolts; 20 had the bolts bearing against the ends of the fibers, while 4 had the bolts bearing against the sides of the fibers of the main timber. The washers throughout were standard cut pressed-steel washers.

All joints were tested in compression. Before commencing the tests all nuts were loosened so that friction should not play a part in the results. This was to approximate the condition of a joint after shrinkage has taken place—a condition which actually exists in the majority of cases. An initial load of 1,000 lb. was first put on the joint, and the autograph set at 1,000 lb. load and zero deflection.

As to the propriety of loosening the nuts in the test specimens: The test conditions were considerably simplified by eliminating the influence of the washers; the action of the bolts was thus limited to bearing and bending, and a rational analysis of the results was made possible. But the practical side of the matter is even more important. Even with washers tight it is not probable that friction plays a very important part in the action of a bolted joint as ordinarily framed. The washers are usually of such a small size that when the nuts are tightened the washers sink into the timber instead of pulling the pieces of timber together. However, if comparatively large washers are used, considerable friction will certainly exist.

In addition, and much more important, the washers will exert a restraining moment on the bolt, tending to produce the condition in the bolt of a restrained beam, and the larger the washer the more effective is its action. However, unless the washers are at all times tightly drawn against the wood this action will not exist. Thus, if any appreciable shrinkage takes place, the washers will not bear tightly, and the bolt will deflect before the washer takes up.

In other words, the strengthening effect of the washers is not available at the working values of the joint where shrinkage can take place. And with green timber it does not take the sun long to shrink the timber, even in temporary construction, as contractors' falsework.

In joints 2 to 6 and 10 to 16 inclusive the slip of the side pieces over the center piece was measured by graduated cards tacked on the two lines of division of one face only. In joints 18 to 28 inclusive the slip was measured by means of two threads stretched across each face and passing over two graduated cards, one on the center of each exposed face of the center block.

The load-slip curves made by the pencil of the autograph show, in all cases but one, more deflection than those plotted from the direct readings. This is due to the fact that the autograph measures the total movement

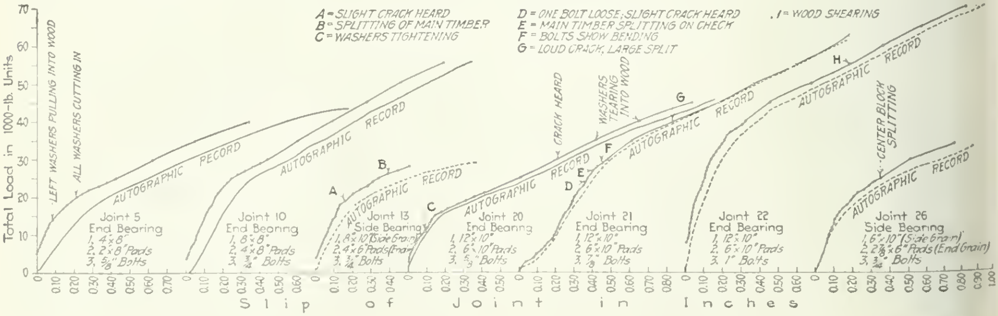

FIG. 3. TYPICAL LOAD-SLIP CURVES OF BOLTED JOINTS

TABLE 1. COMPARISON OF STRENGTH OF TEST JOINTS AT SAFE WORKING STRESSES

em	Autbority	2-In. Side Timbers 4-In. Center Timbers 3-⅝ In. B	3-¾ In. B	3-⅞ In. B	3-1 In. B	2⅞-In Side Timbers 5¾-In. Center Timbers 3-⅝ In. B	3-¾ In. B	3-⅞ In. B	3-1 In. B	6-In. Side Timbers 12-In. Center Timbers 3-⅝ In. B	3-¾ In. B	3-⅞ In. B	3-1 In. P
1	Merriman* (W. J. Douglas)	9,000	10,800	12,600	14,400	12,937	15,675	18,112	20,700	1,080	1,860	2,960	4,410
2	Howe†	1,793	3,100	4,920	7,350	1,248	2,160	3,420	5,110	598	1,030	1,640	2,450
3	Kidder‡	10,125	12,144	14,196	16,200	2,590	4,460	7,100	10,600	1,080	1,860	2,960	4,410
4	Thayer§	3,330	4,800	6,540	8,850	3,330	4,800	6,540	8,850	3,330	4,800	6,540	8,850
5	Jacoby‖	1,620	2,740	4,400	6,615	1,295	2,230	3,555	5,300	540	930	1,480	2,205
6	Test curves**	4,250	5,000			4,250	5,000			4,250	5,000	6,750	9,500
7	Test curves††	5,500	6,500			5,500	6,500			5,500	6,500	9,000	12,500
8	Formula	3,171‡‡	4,350‡‡	5,700‡‡	7,380‡‡	3,747‡‡	4,920‡‡	6,255‡‡	7,890‡‡	4,388	6,300	8,550	11,115
9	Proposed working values	4,800	5,250	6,150	7,050					4,350	6,300	8,550	11,115

* Bearing pressure 1,200 lb. per sq in , stress in bolts 22,500 lb. per sq.in. † Bearing pressure 650 lb. per sq.in , stress in bolts 25,000 lb. per sq.in. ‡ Bearing
essure 1,350 lb. per sq.in., stress in bolts 22,500 lb. per sq in. § Bearing pressure 1,250 lb per sq.in., stress in bolts 16,000 lb per sq in ‖ Bearing pressure
)80 lb. per sq.in., stress in bolts 22,500 lb. per sq in. ** Values = ½ loads when Δ = 0.0625 in. †† Values = loads when Δ = 0 025 in. ‡‡ Values for M
RPl, where R varies from ⅓ to $\frac{2}{27}$:

Values of t, for S = 16,000 lb. per sq.in., B = 1,300 lb. per sq.in., by formula $t = d\left(\frac{\pi S\ 27}{32B}\right)^{\frac{1}{2}}$ are: d = ⅝ in., t = 3.6 in., joint strength = 4,388 lb.; d = ¾ in.,
4.3 in., joint strength = 6,289 lb.; d = ⅞ in., t = 5.0 in., joint strength = 8,531 lb.; d = 1 in., t = 5.7 in., joint strength = 11,115 lb.

the head of the testing machine, and its curve includes ıy crushing of the timber. All the timbers were cut off a circular saw and the ends left unfinished, so that initial deflection resulted from crushing of the softer ɔers.

The ends of all joints were not exactly square. If dly out, they were shimmed with cards or thin metal ates. In all cases they came to full bearing upon the ɔplication of a few thousand pounds of load.

The instructions issued to the carpenters framing the ints were to make a good workmanlike job, all cuts to be ue and square and all bolts to be a driving fit. In the ·ts of joints 21 and 25 the deflections indicated the bolts ·re not a driving fit. Consequently, two additional nts were made and tested. Since the large initial flection noted in the previous joints did not materialize. is result justified the conclusion of loose bolts in the ginal joints.

Discussion of Tests

Table 2 gives a summary of the principal figures obned in the tests. The curves of the test results show a ɔre or less definite break at a load approximately oneird the ultimate strength. Specimen curves are given Fig. 3. Not all of the joints were tested to failure, the ıa being to carry the test well past the break in the rve. By the aid of the autograph this point could be termined as the test proceeded. In some of the joints this break is very marked, and the portion of the curve below is practically a straight line.

BLE 2. SUMMARY OF TEST RESULTS ON BOLTED JOINTS, 1915 TESTS

int o.	Number and Size of Bolts No.	In.	Thickness of Side Pcs., In.	Center Piece, In.	Load at Apparent Yield Pt.[6] Lb.	Load at Slip of $\frac{1}{16}$ In., Lb.	Final Load[3] Lb.	Final Slip, In.	Remarks
1	3	¾	2	4	[1]	[1]	42,000	2 00	No slips
2	3	¾	2	4	16,000	6,500	41,000	1 85	Measured
3	3	¾	2	4	12,500	7,000	45,000	1 95	
4	3	¾	2⅞	5¾	11,000	8,000	45,000	1 15	
5	3	¾	2	4	13,000	5,000	43,500	1 68	
6	3	¾	2⅞	6	10,000	6,500	36,250	0 64	
0	3	¾	4	8	15,000	6,000	55,000	1.39	
1	3	¾	2⅞	6	11,000	7,500	35,000	0 73	Ultimate
2	3	¾	4	8	14,000	10,500	23,000	0 53	
3	3	¾	4	8	15,000	10,500	29,000	0 52	Ultimate
t	3	⅞	3¾	8	13,000	7,000	27,000	0 72	
5	3	⅞	3¾	8	13,000	6,500	20,000	0 47	
6	3	¾	3¾	8	15,000	4,000	28,000	0 58	
8	3	¾	6	12	13,000	7,000	60,000	1 64	
9	3	⅞	6	12	14,000	7,500	30,000	0 83	
20	3	⅞	6	12	15,000	9,500	46,000	1 64	
1	3	⅞	6	12	18,000	3,500	63,000	1 78	
2	3	1	6	12	26,000	20,000	70,000	1 53	
3	3	1	6	12	27,000	16,500	75,000	1 78	
4	3	¾	6	12	16,000	10,500	45,000	1 28	
5	3	⅞	6	12	23,000	2,000	60,000	1 46	
6	3	¾	2⅞	6	15,000	8,000	34,000	0 63	Ultimate
7	3	¾	5¾	12	22,000	12,500	60,000	1 54	
8	3	¾	5¾	12	21,000	13,500	60,000	1 26	

No slips except the final made on Joint No. 1.
In Joints 1 to 16 direct readings were made on one side of joint only, and bably direct-reading curves do not indicate true slips of joints In these joints ·e is a large difference between direct-reading curves and autographic curves.
The final loads are not necessarily ultimate loads.
Bolts bearing across the fibers of the center timber
Large initial deflection, probably due to loose fit of the bolts in the timber.
The average slip of the joints at the loads under the heading "Load at parent Yield Point" was 0 12 in. Using the formula developed in the text, the flexural stress in the bolts for this load is approximately 35,000 lb. per sq.in.

The load at this break was, for most joints, taken a the "apparent yield point" of Table 2. Where a curve had no well-defined break, the J. B. Johnson method of finding a point having 50% greater value of deformation than the initial was employed to find the apparent elastic limit.

That practical use may be made of the results of the tests, it at once becomes imperative to determine what point on the curves shall be considered the critical point—that is, the critical load on which to base the factor of safety and the working load. In this respect the ultimate load the joint will carry is of small moment, since the slip is so great. The loads at first appreciable slip might be taken as the critical point and the working load based on this value. This would be on the safe side, but it seems extravagant to use a working load of only one-tenth the ultimate strength.

In the case of nailed joints it has been found that the elastic limit of the joint corresponds to a slip of about $\frac{1}{16}$ in. or $^{5}/_{64}$ in., and the working loads are taken at one-third to three-fifths of the loads corresponding to this slip.[1] Would it not be reasonable then to establish in the case of the bolted joints a working load of 50% of the load corresponding to a slip of $\frac{1}{16}$ in., or possibly a working load corresponding to a slip of 0.03 in.?

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[1] Three sets of tests on the strength of nailed joints when subjected to lateral forces are on record. The first set was made by Walker and Cross in 1897 at the University of Minnesota. The results are published in the "Journal" of the Association of Engineering Societies, Vol. 19, December, 1897, by A. W. Muenster. The second set was made by Darrow and Buchanan at Purdue University in 1898-99 and presented to the Indiana Engineering Society by Prof. W. K. Hatt, being published in the 1900 "Proceedings" of that society. An abstract and review of both these sets of tests are given in Jacoby's "Structural Details." The third series of sets was made in 1907 by Morgan and Marish at the Iowa State College, and the results were recorded by M. I. Evinger in Bulletin 2, Vol. IV, of the engineering experiment station of the Iowa State College, under the title of "Holding Power of Nails in Single Shear."

From these tests it was found that the elastic limit of the joints corresponded to a slip of about $\frac{1}{16}$ in. The first and second series of tests showed this elastic limit to be at a load approximately 16 times the penny designation of the nail, or E.L. = 16 D. The load at the elastic limit of the joints in the tests of Darrow and Buchanan was found to be approximately 29 D, or almost twice that of the other two tests.

Professor Hatt recommends a working load of about ⅙ the ultimate, or ⅓ the elastic limit, W.L. = 9.5 D, while Mr. Muenster advocates a working value of 60% of the elastic limit.

The foregoing tests comprise joints of white pine, spruce, yellow pine and oak. It was found that while the different timbers give varying results, in accordance with their different strengths to resist compression against the ends of the fibers, the variation is not in direct proportion to these values. It was also found that changing the direction of the cleats in the joints so that the bearing of the nails was across the fibers apparently made no difference in the strength of the joint.

The author has studied the discussions and records of the tests on nailed joints as given in detail in the original papers, and is convinced of the truth of the following conjectures:

1. The erratic load-deflection curves are largely the result of the rough methods used in determining the slips, the true average slip of the joint apparently not having been found

2. The lack of agreement between the ratio of the strengths of two similar joints of different timbers and the ratio of the unit compression strengths of the respective timbers was to have been expected, since the resistance of timber to the pressure of a metal cylinder in a tight-fitting hole is not the same as where such pressure is applied on a flat surface.

In order to study the tests more fully several of the joints were cut open (Fig. 1 reproduces four of them).

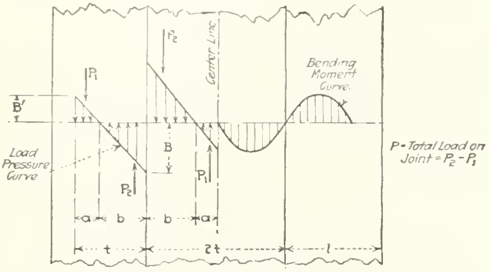


FIG. 4. DIAGRAM OF BOLT PRESSURES AND MOMENTS

These joints exhibit some exceedingly interesting features. It is evident that the bolts acted as restrained beams with reflex bending, the two points of contraflexure being on the contact surfaces of the main timber and side pieces. This condition of restraint was furnished in two ways—first, by the distribution of loading and, second, by the action of the washers.

From a study of the condition of the bolts after bending, the following theory of the distribution of load on the bolts is proposed:

Let

S = Maximum allowable flexural stress in the bolt;
B = Maximum allowable bearing stress against the ends of fibers of timber;
d = Width of timber and splice pads;
$2t$ = Thickness of main timber;
a, b, B', P_1, P_2 as shown.

It will be assumed that the distribution of load on the bolt, as shown in Fig. 4, is triangular, concentrated near the contact surfaces and of such arrangement as to produce the condition of a restrained beam with point of contraflexure at each contact surface. In order to conform to these conditions, b must equal $2a$; then $B' = \frac{1}{2} B$.

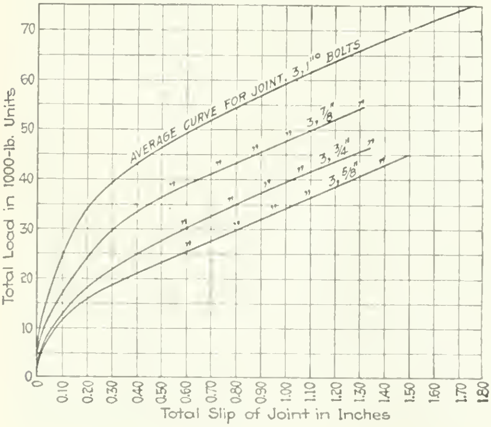
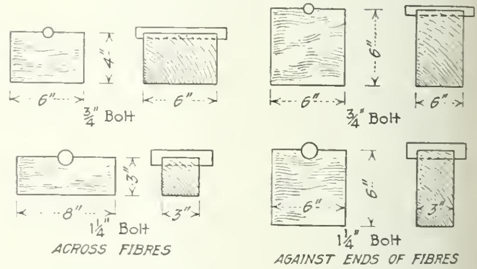


FIG. 5. PROPOSED AVERAGE LOAD-SLIP CURVES FOR FOUR SIZES OF BOLT

The distribution of bending moment will be as shown, there being two equal maximum moments, of amount $M = {}^{2}/_{27}\, Pt$, where $t = a + b$, and of course t must be not greater than l.

Under the assumption that beyond a certain minimum value of t, or thickness of side piece, the strength of the joint is independent of the length of bolt required, it is possible to find the length t such that the moment resulting from the load on this length of bolt will just equal the flexural strength of the bolt.

With the safe stresses for flexure of bolts and bearing for the timber, the strength of the bolts is easily determined; and for all thicknesses of side pieces in excess of the limiting value t the strength will be constant. For thicknesses of side pieces under t the safe strength of the bolts will be a question of bearing against the timber (assuming the pressure distribution to remain constant) with a resultant decrease in the strength of the joint. The results of the tests do not bear out this assumption. It is believed that in joints where the thickness of side timbers is less than the limiting value t, the pressure-distribution diagram, while holding to the general triangular shape, changes in its relative dimensions a and b, within the limits where $a = 0$ and $a = 1/3$. Further, it is held that the ratio of a to l is always such that the resulting bending moment on the bolt bears the same relation to the capacity of the bolt in bending as the maximum intensity of pressure on the timber bears to the resistance of the timber in bearing.



ACROSS FIBRES

AGAINST ENDS OF FIBRES

FIG. 6. DETAILS OF BOLT-BEARING TEST PIECES

Following out these assumptions, the strengths of the test joints with 2-in., 2⅞-in. and 6-in. side timbers have been calculated, using 16,000 lb. per sq.in. as the flexural stress in the bolts and 1,300 lb. per sq.in. as the limiting pressure on the timber. The results are entered in item 5 of Table 1, and are seen to coincide approximately with the values taken from the test curves as shown in item 6.

A careful study of the different curves has led to the conclusion that for all the test joints having the same diameter of bolts—except joints 11, 12, 13 and 26, in which the bolts bear across the fibers of the center timber—the load-slip curve is practically a constant. Expressed in another way: For the limits of the tests the strength of the joints with ⅝-in. and ¾-in. bolts is nearly independent of the thickness of timber.

Fig. 5 shows curves representing the relation between deformation and stress for each size of bolt.

SIDE-BEARING JOINTS AS STRONG AS END-BEARING

For those joints where the bolts have bearing across the grain of the center timber (joints 11, 12, 13 and 26) the stress-deformation curves appear to coincide with those for end-bearing joints up to loads of about 30,000

, or 5,000 lb. per bolt. For working loads, therefore, the sistance of these joints is apparently as great as those ving all end bearing.

The author has been unable to find any treatment of e subject of the pressure of a bolt against the fibers and ross the fibers of timber which would explain the rela-ely large strength of the test joints having cross-bear-g on the timber.

Where a cylindrical pin bears across the fibers of timber a closely fitting hole, as occurs in the case of a bolt with driving fit, it is unquestionably true that the various fferential surfaces of the timber along the perimeter of e hole exert pressures against the pin and that these essures bear some relation to the safe compressive resist-ce of timber surfaces inclined to the direction of the ers. Consequently, the total pressure exerted by the nber on the pin may be taken at a value greater than at obtained by multiplying the diametral section of the ı by the safe compressive strength of the timber in ›ss-bearing.

A tentative theoretical consideration of this problem ıds the author to believe that the unit stress for the erage pressure on the diametral section of the pin, in le bearing, may be taken as high as 800 lb. per sq.in. milarly, for bearing against the ends of the fibers of timber a diametral pressure of 1,300 lb. is allowable, the ordinary end-bearing and side-bearing strengths timber (on *plane* surfaces) are 1,800 and 300 lb. re-ctively. The formula derived is $p = \frac{2}{3} S' + \frac{1}{3} S''$, ere S' and S'' are the ordinary bearing strengths and s the allowable pressure of a pin in the direction of S'.

TESTS OF BOLTS IN BEARING ON WOOD

In an effort to determine the relative resistance of bolts ıring against and across the fibers of timber a number small blocks was made with half-holes and was tested h with a short piece of bolt having a tight fit in the e, as per detail Fig. 6. The results were somewhat appointing. While the stress-deformation curves for two sizes of bolts bearing across the fibers are practi-ly constant, there is a wide variation in the curves for l bearing, although the ultimate strengths are practi-ly the same. It should be stated that the blocks with $1\frac{1}{4}$-in. bolts were much better specimens, both in pect to quality of timber and grade of workmanship, n those with the $\frac{3}{4}$-in. holes, the latter having untrue l cuts. However, all uneven blocks were shimmed up, l it is not likely that the difference in strength shown s due altogether either to quality of timber or to work-nship (Fig. 7.)

On the basis of a limiting joint-deformation of 0.03 in. safe bearing pressures are seen to be, in the case of $_{1}$-in. bolts, 2,000 lb. per sq.in. along the grain and 5 lb. per sq.in. across the grain. For the $\frac{3}{4}$-in. bolts corresponding values are 1,500 lb. and 900 lb. per in.

CONCLUSIONS

The author believes that the following conclusions and ommendations for working data, made from a careful dy of the tests, are justifiable and reasonably conserva-e.

1. For bolts with driving fit in the timbers the strength the joint is practically independent of the thickness of side pieces, when this thickness exceeds the limiting ue "*t*."

2. While the ultimate strength of the joints whose bolts have cross-bearing in the main timber is far below that of the all-end-bearing joints, the stiffness of such joints up to the break in the curve is practically the same.

3. The safe loads for bolts in joints like those described, having all end bearing, may be taken as per Table 3. These values correspond fairly well to one-half the loads for $\frac{1}{16}$-in. slip. These working loads are consistent with the results of tests on nailed joints.

4. For the allowable pin pressure it is proposed that for Douglas fir and similiar timbers 800 lb. per sq.in. be used for cross-bearing and 1,300 lb. per sq.in. for end bearing.

5. For connections in which the bolts are in single shear only, as in the case of two timbers bolted together, it is recommended that the value of the bolts be taken at one half the values given in Table 3.

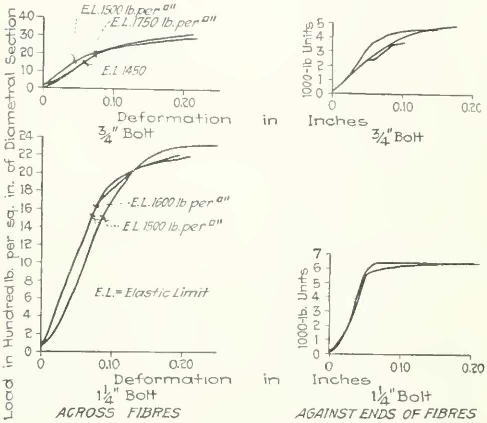


FIG. 7. LOAD-DEFORMATION CURVES FOR BEARING TESTS

6. For connections in which the bolts bear across the fibers of the timber, it is recommended that the values of the bolts be taken at six-tenths the values given for all end bearing.

TABLE 3. WORKING STRENGTH OF ONE BOLT IN TIMBER JOINT (BOLT IN DOUBLE SHEAR)

For Joints Similar to Test Joints, with Bolts Bearing Against End of Grain

Size of Bolt, In.	Thickness of Side Pieces and One-Half Thickness of Center Timber 2 In.	3 In.	4 In.	6 In.
$\frac{5}{8}$	1,057	1,275	1,460	1,460
$\frac{3}{4}$	1,450	1,665	1,980	2,100
$\frac{7}{8}$	1,900	2,130	2,450	2,850
1	2,460	2,664	2,960	3,705

These values are for double shear. For single shear take one-half the tabular values.

7. The working values recommended are for Douglas fir. For other timbers these values are to be multiplied by the factors following:

Long-leaf yellow pine	1.05
White pine	.78
Norway pine	.65
White oak	.78

8. All working values herein given are for timber in a dry condition, as for use in the interior of buildings.

Purchase of the Garbage-Reduction Works of the Genesee Reduction Co. is proposed by the City of Rochester, N. Y., the plant to be taken over on Jan. 1, 1917. The price would be fixed by a commission of three, chosen in the usual manner. Herbert W. Pierce is commissioner of public works and Edwin A. Fisher is consulting city engineer.

Engineering Literature

Eleven Worthy Volumes

The International Engineering Congress held last September at San Francisco was made possible through a guarantee fund provided by five great national engineering societies. Although the international feature was unfortunately curtailed, the congress was a success, as is attested by the high character of the eleven volumes of "Transactions" now published. These volumes are being distributed to advance subscribers, and only a few copies may be had by anyone else. In fact, Vol. III, "Municipal Engineering," and Vol. V, on "The Materials of Engineering Construction," are already out of print, while of Vol. IV, "Railways and Railway Engineering," and Vol. VIII, "Mining Engineering," only ten copies each remain. Of Vol. II, "Waterways and Irrigation," however, which was without doubt one of the most valuable and important sections of the congress, about 90 copies are still available. (Address International Engineering Congress, Foxcroft Building, San Francisco, Cal.; $5 per volume in paper, or $5.50 in cloth.)

It is only giving credit where credit is due to say that the success of the Engineering Congress and the value of its "Transactions" as a contribution to technical literature are the result, first of all, of the untiring energy of San Francisco engineers, who bore the prime responsibility. To Prof. W. F. Durand, Chairman of the congress, and W. A. Cattell, Secretary and Treasurer, the thanks of the profession are certainly due for the efficient manner in which they have carried out their tasks.

REVIEWS AND NOTES

New Ideas in Teaching Text on Elementary Hydraulics

Reviewed by Robert E. Horton*

HYDRAULICS—By R. L. Daugherty, Assistant Professor of Hydraulics, Sibley College, Cornell University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 267; 243 illustrations. $2.50 net.

This work is intended primarily as a textbook for use in engineering schools, where the time that may be devoted to hydraulics proper, aside from its applications, is rather limited. The subject matter has accordingly been thoroughly generalized. Few working data are given. Those which do appear in the book include coefficients for orifices of certain forms, coefficients of roughness and values of *C* in Kutter's formula. These are evidently intended as a basis for the solution of illustrative examples. The book wisely was not intended to be a working treatise for engineers, for in fact it is becoming increasingly difficult to incorporate in one book both a good practical treatise and a satisfactory teaching text. However, the simplicity and clearness of the author's statements of essential facts and principles of hydraulics are such that the book might well be read by many practicing engineers who have more or less hydraulic work to do, but have not specialized in this subject.

Many short demonstrations involving simple methods in integral calculus are given, but aside from these the text could all be readily understood by a student of high-school grade. It is not to be expected that such a course would prepare the student for active practical work; rather it should serve to pave the way for more advanced courses in special subjects. At the same time the author seems happily to have included a number of matters that the beginner in hydraulics needs to know early in his studies, but which are seldom explained even in more complete treatises.

Piezometers and differential gages are clearly and simply described. Pressure on curved surfaces—a subject often slighted in textbooks because it does not lend itself readily to elegance of mathematical treatment—is simply and quite fully treated.

The utility and limitations of the Kutter formula are well covered in a manner that rings true to the working engineer. There are many such practical subjects in hydraulics which for one reason or another get scant treatment in most engineering courses. When the graduate snubs up against one of these subjects in practice, he is likely to feel that there has been a serious gap somewhere in his training. This little book seems to go as far toward bridging these chasms as an elementary text can.

The author starts out with the dictum that students should get a better grasp on hydraulic phenomena as physical processes than they ordinarily obtain. In this the reviewer fully concurs. Unfortunately the physics of hydraulic phenomena, in the broader sense, seem to belong to the more advanced rather than to the elementary aspect of the subject. The beginner cannot be expected to grasp the physical intricacies of fluid friction, for example, as set forth by De Villamil. The book begins with a table of notation, which will add greatly to its value to the student after his course is finished, since he may pick up the text at almost any point and read it intelligently without searching for the meaning of symbols.

There are many halftone illustrations of hydraulic works, probably intended to convey to the student an impression of the practical and physical meaning of the subjects treated. This object would probably be better attained by the use of lantern slides in the lecture room. To the reviewer the pictures seem rather out of place. First, they afford an excuse—too often sought—for dilettante discussion among students in lieu of hard study; second, students should not need pleasing pictorial bait to induce them to study.

The descriptive chapters in relation to turbines and centrifugal pumps are popular in form and expression, capable of being readily understood by anyone. Some of the statements are, however, somewhat incomplete and a ittle unsatisfactory. For example, the reasons for the use of the simple inward-flow Francis-type turbine in ome cases and inward-, downward- and outward-flow runners in other cases are not adequately set forth. The author virtually repeats a statement from his earlier 'Hydraulic Turbines,' that "modern inward-flow turbines are commonly known as Francis turbines in honor of James B. Francis, who built the first successful one in 849."

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*Consulting Hydraulic Engineer, 57 North Pine Ave., Albany, N. Y

Inasmuch as there has been considerable dispute regarding the relative merits and efficiencies of turbines of European and American designs, it would appear desirable that the facts regarding the development of the so-alled Francis-type turbine should have been set forth omewhat more fully. In the first place, the inward-flow urbine in a commercially successful and fairly efficient orm was invented and patented by Samuel B. Howd, of Geneva, N. Y. James B. Francis, as clearly set forth n his book, "Lowell Hydraulic Experiments," pages 1-62, credits Howd with the invention of the "center ent" waterwheel and adds:

> In the design of the Boott wheel, the author has so modified he form and arrangement of the whole as to produce a wheel essentially different from the Howd wheel as above escribed, although it may possibly be technically covered by he patent for that wheel.

So far as the reviewer knows, the term "Francis turine" was first applied to what are more properly known n Europe as "mixed-flow turbines." Such wheels had een imported to France and Germany from America; nd the Germans had learned the trick of modifying by alculation the design of the wheels so as to produce ariation in speed and power, results which had in general only been obtained in this country by practical exeriments. The wheel, which came to be known abroad s the Francis turbine, bore much less resemblance to he wheel made by Francis than did the Howd turbine. t was a pretty close copy of a design made by John B. McCormick.

Later, when the demand arose for specially designed urbines for use in America, European designers were enerally called upon, there being no turbine designers hen in this country. Their early designs for mixed-flow urbines consisted here, as abroad, in modification of methods of calculation of a fundamental form of runner, which was developed not by calculation at all, but purely y experiment; and since the turbine runners in this way ad been misnamed Francis runners abroad, the misnomer was brought back to America.

Of course it is not to be expected in so brief a text that ll such matters of detail will be fully entered into. However, the object of a textbook, it seems to be the reviewer, s that the student shall have a means of acquiring the pirit as well as the letter of the science, and this often nvolves somewhat more careful phraseology than seems o have been utilized in some of the more descriptive portions of this book. The author's plan is good, and it s to be hoped these few defects of execution will in another edition be carefully removed to perfect the work.

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Watson's Concrete Bridges

GENERAL SPECIFICATIONS FOR CONCRETE BRIDGES—By Wilbur J. Watson, M. Am. Soc. C E. Third Edition. New York: McGraw-Hill Book Co. Paper; 8x11 in.; pp. 70; illustrated. $1 net.

The third edition of Wilbur J. Watson's "General Specifications for Concrete Bridges" brings that work up to January, 1916. It concludes some radical changes in the requirements, particularly as regards the quality of materials. Sections on surface finish and waterproofing have been completely rewritten.

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Principles of Depreciation

PRINCIPLES OF DEPRECIATION—By Earl A. Saliers, Ph. D., Instructor in Accounting and Investments, Yale University. New York: Ronald Press Co. Cloth; 6x9 in.; pp. 200; illustrated. $2.50 postpaid.

The many engineers in this country who have valuation work on their hands will find much to interest and enlighten them in Dr. Saliers' little treatise. Its value to them, first, will be its insistence on a sharp distinction between capital and revenue—matters of economics and accounting in which the engineer's training is limited. Its second value will be the closer acquaintance it will give with some of the existing methods of finding depreciation, besides the familiar straight-line and sinking-fund schemes.

The work starts out with a description of the use of capital in industrial plants and of the sacrifice of investment by wear and obsolescence. The general discussion is visualized by application to a hydro-electric plant. Then follows a description of the "plant ledger"—a double-entry account-book showing additions to physical plant, retirals and wastage from depreciation. After this is a further accounting phase of the general subject—a discussion of "funds" and "reserves," the distinction between which too few engineers seem to carry. A short chapter treats "depreciation and efficiency" relations, but meaning "effectiveness" rather than the engineer's "efficiency." This ends Part I, on theory.

The rest of the book is called "Part II—Practical Applications," though to the engineer it is all theory, the difference being in regard to extent of detail. This part opens up with a very good story of the growth of depreciation accounting in utility and general industrial accounting—in the one case as stimulated by commission regulation and in the other by the Federal income-tax act. Finally, there are chapters showing various schemes for computing depreciation—straight-line, reducing-balance, sinking-fund, annuity, equal-annual-payment, unit cost, inspection. The mathematical formulas going with certain of these are worked out in considerable detail.

The book has obvious merit to a high degree, and it is no detraction to state, as should be said, that the text does not go deep enough for immediate practical engineering utilization. Perhaps that is inherently impossible, but only a few steps more would have accomplished it. For examples of shortcomings: There is not a satisfactory discussion for the engineer of the ultimate nature of the elements of depreciation—wear- or weather-deterioration, service-antiquation, efficiency- or output-obsolescence, etc. Yet these are matters which at times become very important in the scrutiny of depreciation, value and rates. Further, there is no development of nomenclature to differentiate between depreciation, the wasting of assets; "depreciation," the wastage indemnity; and the several other special meanings that have become hitched to the term to make confusion confounded. The educated searcher can find an indication that the author realizes the difference between sinking-fund handling of depreciation compensation and the idea of immediate direct repayment of lost assets; but the uninstructed engineer will not be properly illuminated on this matter, which is assuming greater importance all the while.

One of the most interesting parts of the work lies in the presentation of the "unit-cost" plan of computing depreciation. This scheme attempts to take into account the effect of decreased efficiency and output in such a way that the unit cost of product is the same for the old as for the new machine. This scheme, however, neglects the factor of interest and thereby under-rates the value of the old machine. The author would have made a useful contribution had he extended (as since has been done) the equal-annual-payment plan to cover this most general case.

Urgent Irrigation Problems

IRRIGATION IN THE UNITED STATES: A Discussion of Its Legal, Economic and Financial Aspects—By Ray Palmer Teele, Irrigation Economist, Office of Public Roads and Rural Engineering, United States Department of Agriculture. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. ix + 253. $1.50 net.

IRRIGATION MANAGEMENT: The Operation, Maintenance and Betterment of Works for Bringing Water to Agricultural Lands—By Frederick Haynes Newell, Professor of Civil Engineering, University of Illinois; former Director, United States Reclamation Service. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. xi + 306; illustrated. $2 net.

Of the two books named above, the first reviews the history and status of irrigation in the United States and suggests possible means of putting irrigation on a sound economic basis, and the second book is primarily concerned with the management of going projects.

At least half of Mr. Teele's volume deals with irrigation investments and other financial questions. He concludes, broadly, that irrigation in the United States has thus far been an economic failure, whether under strictly private enterprise, local irrigation districts, the Carey Act or the United States Reclamation Service Act. Notwithstanding lack of returns on the heavy investments already made, a large increase of capital is needed. In short, the author says, the Federal Government, the states and districts, perhaps acting together, may have to finance the irrigation farmer for years before he can pay for land and water and put his land on a paying basis. Mr. Teele even goes so far as to suggest that the irrigator be "carried" by the equivalent of some form of general taxation for the sake of the good that will result to him, his locality, his state and the United States. Less radical measures are suggested, however, as capable of bringing some advance.

Mr. Newell's "Irrigation Management" is the first comprehensive attempt to compass that subject as it exists today. Although based largely on the author's extensive and intensive experience as Director of the United States Reclamation Service, the volume is sufficiently comprehensive to serve as a guide to the management of works small or large, under private, district, state or Federal ownership. Many of the historical, legal and economic phases of irrigation covered in Mr. Teele's book are considered by Mr. Newell also, but naturally from a different viewpoint. Other aspects of Mr. Newell's many-sided subject are physical conditions, the human element, methods of applying water and of operation generally, schedules and records, finances, crops, cattle, markets and rural credit.

The author makes clear that on the projects the irrigation manager has as large and varied a task as the manager of good-sized lighting or railway properties. The importance of the engineer and engineering services are recognized without being idolized. Business ability, knowledge of men, tact—in short, all that goes to make up the capable administrator—are given due weight.

The volume cannot fail to make its impress on the future of irrigation management in America—and for that matter on good management generally. It is fortunate indeed that Mr. Newell gave the public the benefit of his wide experience while it was fresh in his mind just after leaving the Reclamation Service.

Railroad Valuation and Rates

RAILROAD VALUATION AND RATES—By Mark Wymond. Chicago (Rand-McNally Building): Wymond & Clark. Cloth; 5x8 in.; pp. 339; illustrated. $1.50.

Mr. Wymond has combined in this volume virtually three books on railroad subjects none too intimately related—except that the persons interested in railway valuation are pretty generally concerned in railway rates. The volume well demonstrates the gulf between valuation and rates in railroad practice, cost of service entering into rates only in a minor way compared with the use of this principle in other utility fields.

The author evidently is largely in sympathy with railroad men in his views of finance, valuation and rate making. Therefore, this book may be taken as a statement of the railway position in these matters. Indeed it has been unofficially reported that the book is indorsed by the Railway Presidents Conference—the organization that is representing the railroads of the country in matters relating to the Interstate Commerce Commission's valuation program.

While the book exhibits some of the idiosyncrasies that railroad men as a group possess in regard to matters of valuation and rates compared with other utility men, the volume will be welcomed for its candid and quiet statements. Evidently the author has endeavored to preserve a judicial and thoughtful presentation of his subject. The general discussions are enriched and exemplified by data apparently derived from the author's many years of experience in railroad circles.

He starts off with the history of steam railroading in this country and describes the early rates and financing. The next section is devoted to "Promotion." In this appear such topics as the cost of delays before a railroad begins to pay, the cost of the early work, real estate, options, franchises, damages, etc. A third section is on "Construction-Reconstruction," showing the cost of work on some of the earlier lines, the continual additions to first cost, the meager early earnings, and the necessity of eventual reconstruction of the roads to reduce operating expenses. Under "Capitalization" such matters are discussed as stocks, bonds, state aid, railroad combinations, inter-company securities, holding companies, bond readjustments, reorganizations, commissions and discounts, etc.

After these matters are dismissed, valuation proper is taken up, first by discussing the purpose of valuations in general and of the Interstate Commerce Commission's valuation in particular. Various suggestions are offered as to what the Interstate Commerce Commission should consider in such matters as original cost, cost of reproduction, overhead charges, engineering, contingencies, interest during construction, reproduction less depreciation, appreciion, depreciation, obsolescence, inadequacy, unit prices, nd values, excess cost of acquiring land, intangible lues, good-will, early deficit, development cost, etc.

Under "Rates" the author presents a "cost-of-service" inciple but apparently means thereby only that the tal revenues should more than meet the total expenses. ome actual figures are introduced to show American st experience. The effect of traffic and topography on tes is described in connection with cost of service. Ter- inal expense is discussed and the apportionment of rious expenses between the several classes of traffic.

When it comes to the actual detail scrutiny of rates to found on American roads, the author shows the neces- ty of working more on the principle of value of service an cost, on account of the utter complexity of railway te schedules and the infinite number of services insep- ably intermingled. The practice of the Interstate Com- erce Commission is shown typically by reference to par- ular districts and by the discussion of such effects as ter transportation, preservation of natural advantages, mpetition of lines, long-and-short-haul provisions, etc.

There are some arguments that all readers may not cept. Among them are such debatable points as good- ill (p. 199); it is held that even a shipper having no oice of roads has the option of going into his business staying out of it, his decision being based on railway tes and services, so that there is an element of good-will such traffic.

Again, on pp. 209 and 211, the author upholds the ntention of railroad men that all the component parts a railroad may and do depreciate, but that the railroad nnot suffer depreciation. On p. 266 and following, the mparisons made with rates for electric current are akened by attempting to show that the lower cost of l-day power over short-hour current is due to the value the service. Value of service enters some electricity tes for commercial establishments, where competition ith steam power has to be met, but in the majority of ses the cost of 24-hr. service is so much lower than the ort-hour service that cost may be said to determine the te. Again, on p. 269, in discussing value of service by e analogy of taxation, the author states that the owner a \$20,000 building on a 50-ft. front gets no more rvice for his taxes than the owner of a \$3,000 building the same frontage—obviously neglecting such funda- ental functions of tax-supported government as police d fire protection which are properly measured by the lue of the investment protected.

In making the unqualified statement (p. 260) that st of service is a limiting factor in all rates below which rate can go if it does not cover the actual out-of-pocket pense, the author seems to neglect branch lines that re operated at an appreciable loss in order that the rofits may be secured on the main line. These last few aragraphs disclose the comparative triviality of the riticisms that can be made—except as to the treatment of epreciation already noted.

Some Elevator History

LEVATORS: A Practical Treatise on the Development and Design of Hand, Belt, Steam, Hydraulic and Electric Elevators—By John H. Jallings, Mechanical Engineer and Elevator Expert with Karstner & Hecht Co., Chicago. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 217; 172 illustrations. \$1.50.

In writing this book the author has taken pains to resent in considerable detail the history of American elevators and he shows some interesting types—like the steam lifts—now practically unused. The first part of the book confines itself to hand elevators. Then come belt-power machines and a chapter on worm gearing, which has been important in the development of power lifts. A few pages are given up to steam types and the several hydraulic elevators. A final section presents the subject of electric hoisting and control equipment.

Steel-Framed Mill Buildings

Reviewed by Clyde T. Morris*

THE PRACTICAL DESIGN OF STEEL-FRAMED SHEDS—By Albert S. Spencer. New York: D. Van Nostrand Co. Cloth; 6x10 in.; pp. xv + 163; 13 folding plates. \$3.50 net.

The preface states:

> The object of this book is that of providing for the student and the designer a guide to the practical design of shed framework and foundations. . . . The author has presumed of the reader an intimate knowledge of the theory of structures and of practical designing.

The theoretical treatment, as indicated in the preface, is very limited. There is a short discussion of wind pressures to be used in designing and of the various assumptions made as to the degree of fixity existing at the tops and bases of the "side stanchions," or columns, as they are known in America.

Four types of "sheds" (mill buildings) are considered, divided according to the degree of fixity of the ends of the columns and the presence or absence of "side stays" (knee braces). Standard tables of stresses and sizes are given for various spans and heights for three of these types, both for roofs covered with corrugated sheets and for slate roofs. The pitch of the sheeted roofs is 21½° and of the slate roofs 30°. All of the trusses are of the Fink or the modified Fink type. At the end of the book a number of plates are given showing typical stress diagrams and standard methods of framing.

Chapter VII, on "External Coverings," and Chapter VIII, on "Gutters, Pipes, Ventilation, Doors, Windows and Skylights," give standard British practice in these matters.

The book might be of value as a handbook in the drafting rooms of structural companies in England, but will probably find a very limited use in this country, as the standards used do not fit American practice.

A Book on Scaffolding

SAFETY ENGINEERING APPLIED TO SCAFFOLDS—The Travelers Insurance Co., Hartford, Conn. Cloth; 6x9 in.; pp. vi + 354; 127 illustrations. \$3.

The first chapter of this book on a rarely discussed subject seeks to establish the reality of the scaffold hazard. Those who follow building construction will need only to read this chapter heading and turn to the next. Here scaffolds are considered generally—pole, outrigger, ladder, suspended, chimney stagings, and even falsework. Following this are a number of sections dealing exhaustively with the characteristics, special hazards and the good features of various designs of scaffolding.

The masons' horse is widely used in the construction of buildings, both on the inside and the outside of the wall, and it is a prolific source of accident. A scaffold consisting of horses and planks is a loose device that when built for high work is none too stable. Section 9 treats of this arrangement, giving a sketch of a well-designed horse. When horses are set tier upon tier it is advisable to brace the temporary structure. When this type of scaffolding reaches 6 or 8 tiers—a dangerous and ill-advised practice, by the way—it is recommended that every horse be nailed to the planks it supports and to those upon which it rests.

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*Professor of Structural Engineering, Ohio State University, Columbus, Ohio.

"Structures Similar to Scaffolds" is the title of Section 12. It touches upon such subjects as sidewalk protection, material hoists, arch centers and other falsework.

The section following carries the sober heading General Counsel, and men in the building trades who are responsible for the safety of others would do well to at least endeavor to assimilate some of the wise advice offered here. Unquestionably every building superintendent should possess a copy of this eminently practical book, and in not a few cases it would be a downright economy for his company to purchase it and present it to him.

Valuation for Rate-Making

Reviewed by Leonard Metcalf*

VALUE FOR RATE-MAKING—By Henry Floy, Fel. Am. Inst. E. E., M. Am. Soc. C. E., Consulting Engineer. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 322; illustrated. $4 net.

Only those familiar with the subject can have a just appreciation of the tremendous amount of labor which has entered into the writing of this book. It is clearly a composite work embodying, as the author frankly states in his preface, much matter originally prepared by him in discussing technical papers upon "Valuation" and "Rating" and in assisting in the writing of legal briefs in public-utility cases covering a wide field. It is the work of an alert and studious mind which has had the benefit of broad practical experience and contact with some of the ablest lawyers and jurists in this country. The arrangement of the matter is logical, the discussion lucid, and the legal citations are apt and up to date.

The author opens with an introduction covering a discussion of the basis for rates, right or regulation, development of law and a quotation of the Federal Valuation Act. Chapter II is given over to definitions.

In Chapter III the fundamentals of valuation are admirably presented, particular attention being called to the unfairness and illegality of attempting to apply *ex post facto* rulings to utility regulation; and to the general tendency to ignore the fact that newly organized utilities originated under present-day regulation cannot be treated the same as long-established utilities which have been created and operated without much restriction as to their profits and rate of return. The author recognizes the trend of public service commission rulings toward investment cost as a fair measure of value and control, giving an assured return commensurate with the nature of the guarantee, though "such basis is not sanctioned by the United States Courts," which have in a long line of decisions adhered to present value and a variable rate of return commensurate with the risks of the business. The discussion of the difference between the competitive and noncompetitive utility is well presented, and the popular agency theory is thoroughly exploded. The necessity for establishing rates for periods rather than annually, on account of the impracticability of repeatedly raising and lowering the rates to closely follow the value of or the investment in the property, is recognized by the author.

Chapter IV, upon "Fair Value for Rate Making," covers the general principles involved, discussion upon the distinction between investment cost and present value, fair rate and an excellent presentation of the necessity for recognizing and encouraging in some practical way efficiency in operation—perhaps the most difficult problem facing regulating bodies. The valuation of the service is briefly touched upon, but no specific suggestions are made as to methods for its determination. A striking example of the failure of the regulating body to recognize the value of this most important element, as well as the cost and effect of good organization, business acumen and efficiency in rendering service, is cited in the familiar Wells-Fargo decision of the California Railroad Commission.

In Chapter V the details of the cost of reproduction are intelligently discussed, though the subject of used and unused property or property to be included in the rating base, was overlooked.

Chapter VI covers Land, Paving and Water Rights. The discussion as to the latter is particularly timely. Though brief, it is significant. The author recognizes the growing importance of the doctrine of beneficial use and that history, in the proper treatment of water rights, is in the making. The present situation of the doctrine of State vs. Federal ownership and control of waters within its own bounds, now pending before the United States Supreme Court, is well outlined.

Chapter VII follows with a good discussion upon Franchises, Working Capital and Bond Discounts.

Chapter VIII, upon "Going Value," is perhaps the best summing up of the subject which has yet appeared. The author's analysis of Justice Day's (United States Supreme Court) dicta upon "Going Value" in the Des Moines Gas Co. case is as convincing as it is fearless but courteous, and his analysis of the historic attempt of the New York Public Service Commission, First District, to practically exclude going value from the rating base is clear, cogent and significant.

Chapter IX is devoted to the subject of "Depreciation" and contains a forceful argument for a consideration of the property as an operating entity and not as an aggregation of detached and perishable structures. The essential difference between the problem of dealing with the property having structures, for the most part of very long life, as the gravity water-works, and those of comparatively short life, as the railroad, might have been somewhat more clearly drawn, and the reader's mind might have been better prepared for the subject had his attention been called at the outset to the basic difference in principle involved in the two theories of depreciation accounting—the first, on the "service basis," in which depreciation is in general not taken care of until it has actually accrued; the second, the "condition theory," in which the ultimate effect of depreciation is anticipated, consideration being given not only to the effect of wear and tear, but to the often greater effect of mere lapse of time, with resulting shortening of useful-life period of the property.

The book is a most important and timely contribution to the subject of "Valuation for Rate-Making" and will l found of marked service to engineers and lawyers, and ıers having to do with such problems.

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*Consulting Engineer; Metcalf & Eddy, 14 Beacon St., Boston, Mass.

The untimely death of the author, recently noted in *ıgineering News,* is a distinct loss to the profession.

Occurrence and Use of Coal

ıAL: ITS ECONOMICAL AND SMOKELESS COMBUSTION—By James F. Cosgrove. Philadelphia, Penn. (357 West Duval St., Germantown): Technical-Book Publishing Co. Cloth; 6x9 in.; pp. 273; 33 illustrations. $3.

Mr. Cosgrove has prepared a descriptive discussion of e geology and chemistry of coal, and of the physics and gineering of fuel combustion, in a plain and readable shion that ought to make the fundamental information idily available for businessmen, factory managers, civil gineers, contractors, and all others not specially trained power generation processes. How comparatively small volume is really essential to treat adequately many imrtant engineering topics is thus again exemplified.

The author first discusses the classification of coal acrding to its carbon and hydrogen contents. Then he ves a classification with descriptive comment according the more familiar grouping as bituminous, anthracite, mianthracite, semibituminous, coking, and noncoking, nite, peat, etc. After this there is a further classificaon of coals for their use—domestic service, stationary ating and power plants, locomotive boilers, steamship rvice, smithing, coke making, gas making, cement rning and metallurgical processes. After this is a apter on composition, and then one on the effects of e, weathering, spontaneous combustion, etc.

The clinkering of coal ash in its relations to the coal be selected for various services forms one of the importt sections of the book. After this, and before the rther discussion of combustion, etc., is taken up, there a section of some fifty pages on the geology of American al fields. Noteworthy among the discussions in the reaining part of the book are those on the purchase of al taking into account heat value and impurities, and prevention of smoke; a useful appendix gives the alyses of 319 American coals from scattered localities.

Theory of Cost of Service for Railway Rates

AILWAY MONOPOLY AND RATE REGULATION—By Robert James McFall, Sometime Fellow in Economics in Columbia University and Instructor in Economics in the University of Minnesota. ["Studies in History, Economics and Public Law," edited by the Faculty of Political Science of Columbia University. Whole No. 164.] New York: Columbia University; Longmans, Green & Co. Paper; 6x10 in.; pp. 223.

Professor McFall has given here a careful exposition the economic basis for the present-day principle of rvice cost applied to adjustment of railway rates. His ındamental thesis is not, as many would suppose, that tailed tariffs should follow closely the costs of particlar service, but that the rate system as a whole must be ual to the cost of service—including therein the "fair turn on fair value." He would adjust particular riffs more or less in accordance with the ability of a ven traffic to develop under certain rates, the starting oint being the aggregate of closely assignable items.

In the course of his argument the author shows that ilway monopoly—the combination of control and nance—is a social advantage compared with unrericted competition. The evils pointed out are unnecesry maintenance of price and restriction of service. It is urged that railroad regulation be aimed at securing the maximum service rather than letting companies secure maximum possible profit, and at keeping rates down as far as the desired service permits. Such an end the author believes is as much as could be looked for with either government ownership or unrestricted competition.

Principles of Cost Accounting

Reviewed by R. R. Potter*

PRINCIPLES AND PRACTICE OF COST ACCOUNTING, For Accountants, Manufacturers, Mechanical Engineers, Teachers and Students—By Frederick H. Baugh. Baltimore (P. O. Box 682), Md.: The Author. Cloth; 6x9 in.; pp. xi + 194. $3.

While the title page of this book describes it as being for accountants, engineers, teachers and students, it appears to be written quite decidedly from the standpoint of the accountant. Engineers will find it rather a dry volume, unless indeed they should find themselves in a situation where some definite knowledge of cost accounting was required. In such a case, since the book is very compact, it should prove useful to engineers as a reference work.

The author describes a system of cost accounting which, he states, calls for little if any addition to the books which a corporation should ordinarily possess. He shows a dozen or so forms for the analysis of costs, indicating the way in which the information can be usefully summarized. These forms are given chiefly in the last two chapters, which illustrate briefly the system explained by the author in its application to departmental cost keeping and process cost keeping respectively.

Forms such as would be used for payroll analysis, production orders, requisitions, material transfers, etc., are purposely omitted. The author states that such forms are rarely of any practical value except to the business for which they were especially planned and that when one knows what data are needed the required forms are easily prepared. This policy certainly has the desirable result of making the book exceptionally concise. The same general idea is followed in the text, where a little too great care is taken not to describe the accounting system for, or even to mention, any particular line of manufacture. This certainly does not make the book any more interesting reading; and while it may for some reasons be an excellent plan, it introduces an element of vagueness and necessitates more than ordinary effort at concentration on the part of the reader.

Hill's Public Health Revised

THE NEW PUBLIC HEALTH—By Hibbert Winslow Hill, Director, Institute of Public Health, and Medical Officer of Health of London, Canada; Professor of Public Health, Western University. New York: The Macmillan Co. Cloth; 5x8 in.; pp. 206. $1.25.

Dr. Hill has revised and extended the valuable series of syndicated articles that he wrote some five years ago and that were subsequently published in book form. (Noticed in *Engineering News,* Mar. 19, 1911.) The new publishers have greatly improved the typography and general makeup of the book.

It seems hardly necessary to state in these columns that the new public health deals primarily with the infected and infective person and the earliest possible control of discharges from him and leaves garbarge, ashes, plumbing and the like to others, all of which is clearly and forcibly explained by the author. The book contains many practical suggestions for health-protective work.

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*Assistant Manager, Blood Bros. Machine Co., Allegan, Mich.

Electric Pole and Tower Lines

POLE AND TOWER LINES, for Electric Power Transmission—By R. D. Coombs, M. Am. Soc. C. E. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 272; 162 illustrations. $2.50 net.

Mr. Coombs is known as an earnest advocate of departmentizing the work of a power company's engineering staff to the extent that the electrical engineers should not design the transmission lines as structures, and he cannot be charged with trying to educate electrical men into that field of applied mechanics. But nevertheless his book will be particularly useful to the many electrical engineers who cannot have civil-engineering associates to work out these problems for them. Moreover, with the good fundamental education which every successful electrical man must have had, there is no reason why a close approach to safe and economical transmission lines should not be promoted. But it will be necessary for such a man to have other books on structural design, for the author does not give an exposition of the general theory and practice of that subject.

The book opens up with introductory notes, drawn from experience, on economic grade of construction, life of materials, necessary clearances, factors of safety, fields for various types of supports, etc. The details of design begin with a discussion of loading. The author would neglect accidental loads—like falling objects—and he would advocate a single ice and wind load as applicable generally the country over, modified up or down, no doubt, as judgment dictates for a few localities. A reasonable sleet load is taken as ½ in. of ice all around a wire; the suggested wind load is 13 lb. per sq.ft. of projected area for flat surfaces and 8 lb. for the projected area of wire and ice coat.

In designing the wire and cable spans the parabolic formula is substituted for the true catenary, it being argued that the computed results are closer to actual than the actual stringing is to the designed. At this point in the book, tables and curves of wire and span data are inserted.

There are very interesting and suggestive chapters on the design of wood-pole, steel-pole, steel-tower and reinforced-concrete-pole lines. There is not presented in these sections, as already intimated, a complete procedure for design, but rather a chain of discourses on departures from ordinary structural designing—covering such topics as maximum stress and weakest sections in wood poles, flat and angle lacing for poles and towers, connections, wide-base structures, flexible frames, etc. A notable addition is the tabulated data on about fifty wood- and ninety steel-supported lines.

Summed up, the author's recommendation seems to be to use combined ice and wind loads with very moderate broken-wire conditions, to avoid excessive l/r values and thin sections, and to use rather low factors of safety. In fact, he specifically argues against high factors of safety designed to protect against the ignorance of the designer.

There is a good chapter on foundations, although it might have been appreciably enriched by reprinting constructions shown a year ago in an extended topical discussion before the American Institute of Electrical Engineers. Toward the end of the book are assembled a miscellaneous selection of practical matters all of great importance and well presented—protective coatings, tie wires, proper insulator and pin types, arm braces, guys, anchors, erection practices and costs, accident prevention, etc. A valuable feature is the large number of specifications inserted at various parts of the text.

Electric Railway Practice

ELECTRIC RAILWAY ENGINEERING—By C. Francis Harding, Fel. Am. Inst. E. E., Professor of Electrical Engineering, Director of Electrical Laboratories, and Dressel D Ewing, M. Am. Inst. E. E., Assistant Professor of Electrical Engineering, Purdue University. Second edition fully revised, enlarged and reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 416; 190 illustrations. $3 net.

The appearance of the second edition of Professor Harding's work on electric-railway engineering for advanced students reminds teachers of the discussions on the appearance of the first edition as to whether the strictly theoretical and somewhat academic procedures should be exclusively presented to budding minds, or whether it might not be assumed that the students had been earlier acquainted with such procedures and could be introduced to various practical short cuts that were in common use, especially in preliminary work. The author employed the second plan.

Comparison of the first and second editions shows the addition of one new chapter—on locomotive train haulage—and the general insertion all through of such new matter as brings the text up to date. The book is of service not only to teachers and students, but to utility executives and casual readers who desire to inform themselves on the engineering steps in establishing an electric railway in operating shape.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ADVISORY PAMPHLET ON CAMP SANITATION AND HOUSING—By J. J. Rosenthal. San Francisco, Calif. (525 Market St.): Commission of Immigration and Housing of California. Fourth revised edition. Paper; 6x9 in.; pp 56; illustrated.

ANNUAL REPORT ON THE MINERAL PRODUCTION OF CANADA, 1914—Ottawa, Ont.: Mines Branch, Department of Mines of Canada. Paper; 7x10 in.; pp. 362.

BRIDGE ENGINEERING—By J. A. L. Waddell, M. Am. Soc C. E., Senior Partner of Waddell & Son, Consulting Engineers, Kansas City, Mo. In Two Volumes. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. lxxv + 2,177; profusely illustrated. $10.

COAL MINERS' POCKETBOOK: Formerly the "Coal and Metal Miners' Pocketbook"—Principles, Rules, Formulas and Tables. Eleventh edition, revised, enlarged and entirely reset. New York: McGraw-Hill Book Co. Flexible leather; 4x7 in.; pp. xxv + 1,172; illustrated. $4 net.

COMMISSION ON BUILDING DISTRICTS AND RESTRICTIONS (OF NEW YORK CITY): Final Report, June 2, 1916—New York (Municipal Building): Committee on the City Plan, Board of Estimate and Apportionment. Paper; 7x10 in.; pp. 100; illustrated.

Acting under a 1914 amendment to the charter of New York City, the Board of Estimate appointed the Commission named above, which had been preceded by a Heights of Buildings Commission. After two years' work the new Commission submitted a tentative report, accompanied by a series of maps. These maps showed numerous geographical divisions of the city divided into "use" districts, the latter including residence business, unrestricted and undetermined sections for each division. After public hearings on the tentative scheme, the resent report was formulated. It includes a resolution, with xplanatory diagrams, establishing "use districts" and regulating the height of buildings.

COMPREHENSIVE PLAN OF INSURANCE AND ANNUITIES FOR COLLEGE TEACHERS—By Henry S. Pritchett, President of the Carnegie Foundation. New York (576 Fifth Ave.): The Carnegie Foundation for the Advancement of Science. Bulletin No. 9. Paper; 7x10 in.; pp. 67.

OMPREHENSIVE PLAN OF NEWARK—Newark, N. J.: Office of the City Plan Commission; Harland Bartholomew, Secretary. Paper; 6x9 in.; pp. 180; illustrated.

One of the best-considered and most business-like citylan reports so far published. It is the result of more than hree years' study, under the immediate direction of Harland artholomew, Engineer and Secretary to the Commission, with eorge B. Ford and E. P. Goodrich as expert advisers. The our main topics are: Streets and Transportation; Recreation nd Civic Beauty; Housing and Public Control of Private evelopment; Planning the Greater City and a Program for uture Work.

ONNECTICUT STATE PUBLIC UTILITIES COMMISSION: Fourth Annual Report, including the Financial Reports of All Public Service Companies for the Year Ending June 30, 1915, with Statistical Tables Relating Thereto. Hartford, Conn.: Henry F. Billings, Secretary. Cloth; 6x9 in.; pp. 688.

OPPER SULPHATE TREATMENT OF ST. PAUL, MINNESOTA, WATER-SUPPLY—By Prof. N. L. Huff, Department of Botany, University of Minnesota, with Introduction by Garrett O. House, General Superintendent. Bureau of Water, St. Paul, Minn. [Reprinted from the "Journal" of the American Water-Works Association, Vol. 3, No. 2, June, 1916.] Paper; 6x9 in ; pp. 581-621; illustrated.

EPARTMENT OF PUBLIC WORKS, NEW SOUTH WALES: Report for the Year Ended June 30, 1915—Sydney, N. S. W., Australia. Paper; 8x13 in.; pp. 145; illustrated. 7/6.

ISCUSSION OF POWER ESTIMATES FROM STREAM FLOW AND RAINFALL DATA—By Clemens Herschel. [Reprinted from the "Journal" of the Boston Society of Civil Engineers, Vol. 3, No. 6, June, 1916.] Paper; 6x9 in.; pp. 303-313; illustrated.

OREIGN COMMERCE AND NAVIGATION OF THE UNITED STATES: Report for Year Ending June 30, 1915—Washington, D. C.: Bureau of Foreign and Domestic Commerce. Cloth; 9x12 in.; pp. 928. $1 a copy; from Superintendent of Documents, Washington, D. C.

EOLOGIC ATLAS, UNITED STATES GEOLOGICAL SURVEY —Washington, D. C. Paper; 18x20 in.; illustrated.

Folio No. 199, Silver City, N. M.—By Sidney Paige. Pp. 19. Folio No. 201, Minneapolis-St. Paul, Minn.—By Frederick W. Sardeson. Pp. 14.

NDUSTRIAL ACCIDENT PREVENTION—Albany, N. Y.: New York State Department of Labor, Bureau of Statistics and Information. Special Bulletin No. 77. Paper; 6x9 in.; pp. 54; illustrated.

NDUSTRIAL PREPAREDNESS—By C. E. Knoeppel, Author of "Maximum Production in Shop and Foundry" and "Installing Efficiency Methods." New York: The Engineering Magazine Co. [Industrial Management Library.] Cloth; 5x8 in.; pp. viii + 145. $1.

HE INFLAMMABILITY OF ILLINOIS COAL DUSTS—By J K. Clement and L. A. Scholl, Jr. Washington, D. C.: United States Bureau of Mines. Bulletin 102. Paper; 6x9 in.; pp. 74; illustrated.

NTERIM REPORT: STATISTICAL EXAMINATION OF CERTAIN GENERAL CONDITIONS OF TRANSPORTATION BEARING ON THE ECONOMIC PROBLEM OF THE PROPOSED GEORGIAN BAY CANAL—By W. Sanford Evans, Chairman, Georgian Bay Canal Commission, Ottawa, Canada. Paper; 7x10 in.; pp. 150; illustrated.

NTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION: Proceedings of Convention Held at Philadelphia, Aug. 17-19, 1915. Lima, Ohio: A. L. Woodworth, Secretary and Treasurer. Cloth; 6x9 in.; pp. 226; illustrated.

ANUAL OF AMERICAN STEEL AND WIRE COMPANY'S PROCESS OF WATER PURIFICATION WITH SULPHATE OF IRON—208 South La Salle St., Chicago, Ill. Paper; 6x9 in.; pp. 152; illustrated.

Although designed primarily to promote the use of sulhate of iron in water treatment, this pamphlet contains a onsiderable amount of information on water treatment in eneral, many pages of tables and numerous illustrations of ltration plants.

ASSACHUSETTS STATE BOARD OF HEALTH: Annual Report for the Fiscal Year Ended Nov. 30, 1914—Boston, Mass. Cloth; 6x9 in.; pp. 781.

ECHANICAL ENGINEERS' HANDBOOK: Based on the Huette and Prepared by a Staff of Specialists—Lionel S. Marks, Editor-in-Chief, Professor of Mechanical Engineering, Harvard University and Massachusetts Institute of Technology. New York: McGraw-Hill Book Co. Flexible leather; 4x7 in.; pp. xxiii + 1,779; illustrated. $5 net.

HE METALLURGY OF STEEL—By F. W. Harbord, Assoc. R. S. M., F. I. C., formerly Consulting Metallurgical and Analytical Chemist to the Indian Government, Royal Indian Engineering College, Coopers Hill; and J. W. Hall, Assoc. M. Inst. C. E., Consulting Engineer, Birmingham. (In two parts.) Vol. I, Metallurgy. By F. W. Harbord. Vol. II, Mechanical Treatment. By J. W. Hall. Fifth edition, enlarged and revised. Philadelphia: J. B. Lippincott Co. [Griffin's Metallurgical Series.] Cloth; 6x9 in.; pp. xvi + 522 and xviii + 411; 54 folding plates, comprising 115 figures, over 500 illustrations in text and nearly 80 photomicrographs of steel sections. $12.50.

HIO STATE BOARD OF HEALTH: Annual Report for the Year Ending Dec. 31, 1914. Columbus, Ohio: E. F. McCampbell, M. D., Secretary and Executive Officer. Paper; 6x9 in.; pp. 894

HE PLANNING OF THE MODERN CITY: A Review of the Principles Governing City Planning—By Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment of New York City. New York. John Wiley & Sons. Cloth; 6x9 in.; pp. xv + 423; 62 text illustrations and 87 plates. $3.50 net.

THE POLLUTION OF NEW YORK HARBOR AND ITS REMEDY—By Kenneth Allen, Engineer of Sewage Disposal, Board of Estimate and Apportionment of New York City. [Reprinted from Proceedings of the Connecticut Society of Civil Engineers for 1916.] Paper; 6x9 in.; pp. 28-48; illustrated.

POWER TRANSMISSION BY LEATHER BELTING—By Robert Thurston Kent, Jun. Am Soc. M. E., Consulting Engineer. New York: John Wiley & Sons. [Wiley Engineering Series.] Cloth; 5x8 in.; pp. vi + 114; 31 illustrations. $1.25 net.

PRACTICAL COST KEEPING FOR CONTRACTORS: A Book Giving a System of Accurate Cost Keeping and the Methods Used for Adapting It to All Classes of Construction Work—By Frank R. Walker, Author of "The Building Estimator's Reference Book." Chicago (30 North Michigan Ave.): The Author. Cloth; 4x7 in.; pp. 273; 159 illustrations. $2.

THE PREDETERMINATION OF TRUE COSTS AND RELATIVELY TRUE SELLING PRICES—By Frederic A. Parkhurst, M. E., Organizing Engineer. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. viii + 96; 30 illustrations. $1.25 net.

PRINCIPLES OF ELECTRICAL DESIGN: D. C. and A. C. Generators—By Alfred Still, Fel. Am. Inst. E. E., Professor of Electrical Design, Purdue University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 365; 146 illustrations. $3 net.

PROCEEDINGS OF THE FIRST INTERNATIONAL ROAD CONGRESS Held Under the Auspices of the Worcester Chamber of Commerce, Dec. 14-17, 1915. Worcester, Mass.: William J. Conlon, General Secretary, Worcester Chamber of Commerce. Paper; 7x10 in.; pp. 112. 50c.

PUBLIC SERVICE COMMISSION, SECOND DISTRICT, STATE OF NEW YORK: Annual Report for Year Ended Dec. 31, 1915. Vol. I.—Albany, N. Y. Cloth; 6x9 in.; pp. 1,114.

PUBLIC UTILITIES COMMISSION OF MAINE: Annual Report for Year Ending Oct. 31, 1915. Vol. II, Relating to Topgraphy, Geology and Water Resources—Augusta, Maine. Cloth; 6x9 in.; pp. 146; illustrated.

EL SISTEMA DE ALCANTARILLADO Y PAVIMENTACION DE LA CIUDAD DE LA HABANA—Por Luis Morales y Pedroso, Ingeniero Civil, S. S. C. I., Ingeniero Jefe del Negociado de Suministro de Agua, Cloacas e Ingenieria Municipal de la Secretaria de Obras Publicas, Designado por el Gobierno Miembro de la Comision Nombrada para Investigar el Cumplimiento del Contrato por el Cual se Ejecutaron Las Obras. [Revista de la Sociedad Cubana de Ingenieros de parte de los numeros 2, 3 y 4 del Vol. VIII.] Havana, Cuba: The Society. Paper; 7x10 in.; pp. 353; illustrated. $1.

STRENGTH AND OTHER PROPERTIES OF CONCRETES AS AFFECTED BY MATERIALS AND METHODS OF PREPARATION—By R. J. Wig, Engineer Physicist; G. M. Williams, Assistant Engineer Physicist, and E. R. Gates, Assistant Physicist. Washington, D. C.: United States Bureau of Standards. Technologic Paper No. 58. Paper; 7x10 in.; pp. 172; illustrated.

THE STRENGTH AND STIFFNESS OF STEEL UNDER BIAXIAL LOADING—By Albert J. Becker. Urbana, Ill.: University of Illinois. Engineering Experiment Station Bulletin No. 85. Paper; 6x9 in.; pp. 65; illustrated. 35c.

TESTS OF REINFORCED-CONCRETE FLAT-SLAB STRUCTURES—By Arthur N. Talbot, Professor of Municipal and Sanitary Engineering and in Charge of Theoretical and Applied Mechanics, and Willis A. Slater, Research Assistant Professor of Applied Mechanics. Urbana, Ill.: University of Illinois. Bulletin No. 84, Engineering Experiment Station. Paper; 6x9 in ; pp. 128; illustrated. 65c.

TESTS OF THREE LARGE-SIZED REINFORCED-CONCRETE SLABS UNDER CONCENTRATED LOADING—By A. T. Goldbeck, Engineer of Tests, and E. B. Smith, Associate Mechanical Engineer, Office of Public Roads and Rural Engineering. [Reprinted from Journal of Agricultural Research, Vol. VI, No. 6, Department of Agriculture, Washington, D. C., May 8, 1916.] Paper; 7x10 in.; pp. 205-234; illustrated.

THE THEORY AND PRACTICE OF MODERN FRAMED STRUCTURES Designed for the Use of Schools and for Engineers in Professional Practice—By the Late J. B. Johnson, C. E., C. W. Bryan, C. E., Chief Engineer of the American Bridge Co., and F. E. Turneaure, C. E., Dean of the College of Mechanics and Engineering, University of Wisconsin. (In three parts.) Part III, Design. Ninth edition, rewritten by F. E. Turneaure and W. S. Kinne, Associate Professor of Structural Engineering, University of Wisconsin. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xii + 486; illustrated. $1 net.

THE TREND OF MODERN WATER PURIFICATION METHODS—By C. Arthur Brown, Chief Engineer, Engineering Bureau-Water Purification, American Steel and Wire Co. [Paper for Convention of Southwestern Water-Works Association held at Waco, Tex., May 8-10, 1916.] Dallas, Tex.: The American Steel and Wire Association of Texas. Paper; 5x7 in ; pp. 41

TRIANGULATION IN CALIFORNIA, 1913-1915—Washington, D. C.: United States Geological Survey. Bulletin 644-C. Paper; 6x9 in.; pp. 25-81

WATER-SUPPLY PAPERS, UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in ; illustrated.

No. 374, Ground Water in the Hartford, Stamford, Salisbury, Willimantic and Saybrook Areas, Connecticut—By Herbert E. Gregory and Arthur J. Ellis Pp. 150. No. 383, Surface Water-Supply of the United States, 1914; Part III, Ohio River Basin. Pp. 121. No. 398, Ground Water in San Joaquin Valley, California By W. C. Mendenhall, R. B. Dole and Herman Stabler. Pp. 310

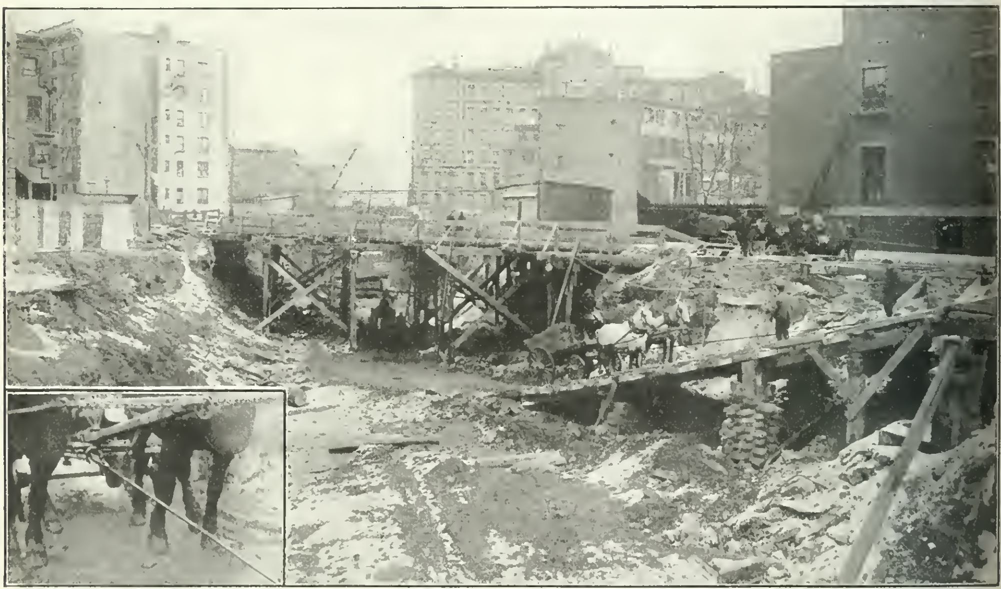
Field and Office

Snatching Wagons Out of Pits

By James F. Fouhy*

Pulling wagons to the street level, by means of a line to a snatchblock and thence to an engine usually saves horses and time. This was the method employed by the Degnon Contracting Co. and the United States Realty and Improvement Co. in excavating Routes 4 and 38 of the Seventh Ave. Subway, New York City. The view is of the operation at Charles St., and shows the timber incline up which the dump wagons were hauled. The electric hoist is shown on the side of the cut. Mucking is done by a steam shovel, working on the farther side of the temporary wooden crossing.

The snatch line is attached to the hound on the wagon and runs to a block anchored to a deadman located a few feet beyond the top of the incline. The height above ground at which the snatchblock was attached was found to be of considerable importance, especially on 15 to 20% grades. With the block two or three feet above the surface the forward end of the pole and the harness rose, making it very difficult to manage the horses. A block lying on the ground gave the best results. At first the cable was hitched to the front end of the pole, but after several poles had been pulled out and some had been broken the change was made.



SNATCHING A WAGON OUT OF A NEW YORK SUBWAY EXCAVATION
Small insert shows that rope was attached to hound of wagon

This method allows the wagon to take any position transversely on the runway, a great advantage in shovel work. Another advantage not possessed by the barney method (described in *Engineering News* of Nov. 4, 1915) consists in the assistance given to a wagon on its down trip, at which time the cable is attached to the rear end. Prior to using this method an extra team—and sometimes two extras—were used to snatch wagons to the street level.

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Keeping Progress Record of a Tunnel Repair Job

Reinforcing the Radebaugh tunnel on the Pennsylvania R.R. at Greensburg, Penn., was such an extensive performance that special effort was required to keep a full record of the progress made. At first this was not attempted, but in view of the various requests for reports received by the construction office, the desirability of a comprehensive system of daily record was apparent. The form devised for this work is illustrated herewith.

To understand the progress sheet, a brief description of the methods used to reinforce this tunnel is necessary. For some years there had been occasional falls of portions of the brick lining of the tunnel. These accidents resulted from the fact that part of the tunnel had been built on a coal vein, the result being a settlement of the structure. To correct this last September two workg headings were driven parallel to the tunnel and along le of the springline. From these headings the excavaon over the arch was accomplished. The headings rminated at an old shaft 850 ft. from the portal. oncrete was blown in over the arch and finally the orking drifts were filled with concrete, by the pneumatic ethod.

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*Assistant Engineer, Public Service Commission, First District, New York.

Each morning entries are made on the progress sheet vering the work of the preceding 24 hr. The figures r the first three columns represent the work accomished on the day just passed and are obtained by measement every morning. Column 5 headed "Open xcavation" represents that part of the tunnel that has en uncovered, which part is usually timbered and ready r the concrete relining. To obtain this figure add the Ground Uncovered This Day" (Col. 2) to the open cavation of the "Previous Report" (Col. 5), subtractg from this sum the part concreted "This Day" (Col. .

PROGRESS SHEET OF RADEBAUGH TUNNEL-REPAIR JOB

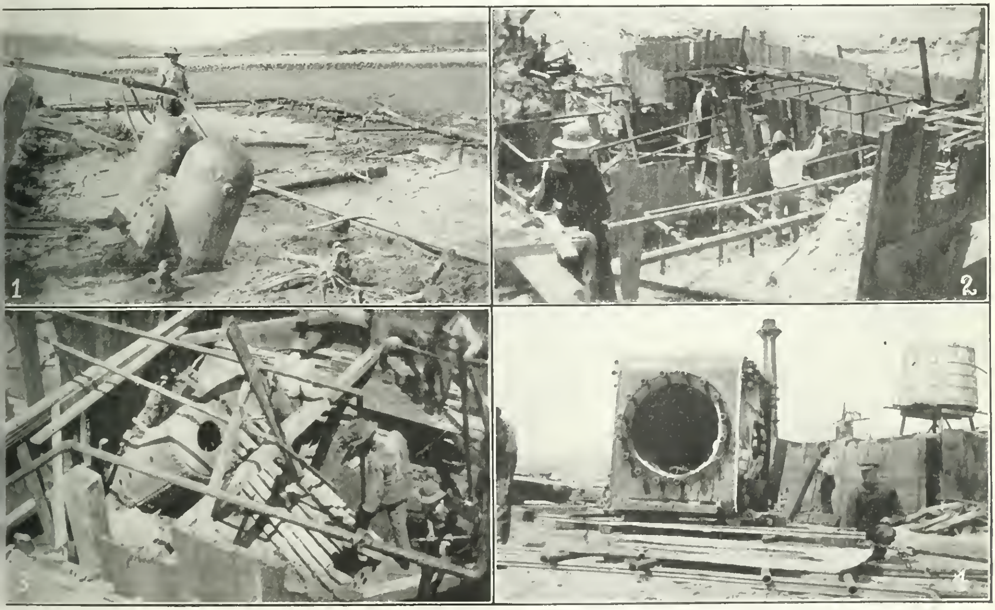
ate	This Day			Previous Report			Total to Date			Remaining Excavation	Remaining Concreting	Concreting North Drift		Concreting South Drift		Concreting Over Arch	
	Ground Uncovered	Timbered	Concreted	Open Excavation	Timbered	Concreted	Open Excavation	Timbered	Concreted			This Report	Total to Date	This Report	Total to Date	This Report	Total Remaining
ay 31	...	.	....	..	.	.	340	750	430	80	420	... .	320	. ...	340	....	
ne 1	10	15	8	334	750	430	342	765	438	70	412	30	350	20	360	....	.
ne 2	8	6	12	330	765	438	338	771	450	62	400	28	378	12	372	....	.

The column, "Timbered" to date, is obtained by adding l. 3 to Col. 6. The figure representing that part of e tunnel concreted to date is obtained in a similar nner. The data for the remaining columns are deterned in like fashion.

Salvaging a Flooded Pumping Plant in California

By Roy A. Silent*

Southern California was visited by severe rainstorms in January, 1916. On the San Luis Rey River in San Diego County the flood damage was exceptionally severe, practically all the bridges being washed away. The pumping plant of the Oceanside Mutual Water Co. was 200 yd. south of the river and about 3 mi. above the mouth. The soil was typical "sandy bottom" land overgrown with willows. The machinery was housed in a reinforced-concrete building 70x40 ft. in plan. The main pumping unit consisted of an Allis-Chalmers horizontal Corliss cross-compound high-duty pumping engine of 2,600,000 gal. per 24 hr. This engine obtained water from a sump and delivered it through a 16-in. force main against a total head of 215 ft. The weight of the unit, with foundation, was in excess of 335,000 lb. Water was extracted from the wells and delivered to the sump by means of an 8-in. centrifugal pump belted to a 35-hp. Ames high-speed engine weighing 5,650 lb. Steam was furnished by two 103-hp. Sterling boilers. The stack



FIGS. 1 TO 4. VIEWS OF SALVAGING OPERATIONS AT OCEANSIDE MUTUAL WATER CO., FOLLOWING JANUARY FLOOD IN CALIFORNIA

ig. 1—General view before salvaging began. Fig. 2—Sheeted excavations around boilers. Fig. 3—Excavation around No. 1 boiler. Fig. 4—Moving low-pressure cylinder to higher ground; weight, 6,500 lb.

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*With J. B. Lippincott, 1134 Central Building, Los Angeles.

was made of riveted steel and rose 50 ft. above the engine-room floor.

It was impossible to find firm bearing when the plant was erected, as the well logs showed that the underlying quicksand extended down 100 ft. Accordingly, the foundations were mushroomed out and were extended below the level of the groundwater, which stood about 6 ft. under the engine-room floor.

At the time of the heavy storm of Jan. 17 the plant was not damaged, but the river changed its course sufficiently to reduce the distance between the living stream and the pumphouse one-half. On the night of Jan 27, in spite of all efforts to save it, the building was completely demolished by the river, which further changed its course so that the main channel was flowing directly over the former site of the plant, leaving a cut bank 4 ft. high, 200 ft. to the south. When the river had subsided to some extent, it was diverted by an earth and brush levee to a point 150 ft. north of the building.

Salvaging work was undertaken on Mar. 1 by the Bent Construction Co., the work being directed by the engineering offices of J. B. Lippincott, both firms having their home offices in Los Angeles. (See Fig. 1 for the general condition of the plant at the time of the arrival of the salvaging equipment.) The water plane stood at the ground surface, and the quicksand was so treacherous that it was necessary to construct a roadway of crossties from the top of the bank to the plant in order to place the pumps and boiler properly. It was also necessary to construct 150 ft. of levee in order to protect the equipment, as the surface of the sand was but 2 in. above the level of the river. As further protection, an earth levee 3 ft. high was thrown up entirely around the workings.

The method of unwatering was devised by the contractor, who does not care to have the details of the operation made public. A row of sheetpiling was installed around the excavation on the exposed sides. It was made up of 2x6-in. t.-and-g. Oregon-pine planks 10 ft. long, surfaced on one side. These were sharpened and jetted their full length into the sand. Progress was much hampered by underlying brush and débris. In some places it was impossible to get the piling down at all. The cost of this work was $0.625 per lin.ft. for the driving alone, with labor at $2.25 for a 9-hr. day.

Condition of the Flooded Machinery

The main engine was found to be practically intact and the damage purely nominal. The entire mass had sunk about 7 ft. below its former level and was tilted at an angle of 40° with the horizontal. It was necessary to lower the water plane approximately 12 ft. in order to remove the condenser and air pump, which formed the lowest elements of the main engine. The machine was dismantled piece by piece, the heaviest being the low-pressure cylinder, which weighed over 6,000 lb. The separate pieces were lifted with chain-blocks suspended from a heavy horse supported by tie cribbing. In some cases it was necessary to lift with jacks. When the various portions were raised clear of the foundations, a runway of cribbing was constructed and they were moved from the excavation on rollers. The accompanying views show this work in progress.

Moving to solid ground was accomplished by means of a sled or stoneboat. The heavier pieces were moved on rollers. These were supported by a movable track laid and taken up behind as the moving progressed. Pulling was done by a team of horses working with double blocks attached to successive snubbing posts. In this manner pieces weighing 5,000 and 6,000 lb. were moved 300 ft. up a 6% grade in 20 min.

The progress of the excavation was greatly impeded by the presence of brush and of structural steel formerly composing the roof trusses. In some instances trees 8 and 10 in. in diameter were encountered. An attempt was made to locate by jet the Ames engine and centrifugal pump; but the method was not satisfactory, as portions of the concrete building and structural steel were encountered, making recognition of the machines impossible. Accordingly, the entire area of their supposed position was excavated to a depth of 8 ft., but nothing of interest was uncovered. This area was explored with a 14-ft. jet. Hard material was encountered 22 ft. below the normal water surface; but whether this was structural steel or the machines sought could not be determined.

The former location of the boilers was excavated to a depth of 8 ft. and upon investigation with the jet showed no results at 22 ft. An area 200 ft. square was then marked off in 5-ft. squares below the former site of the boilers, and systematic soundings with the jet were made at the corner of each. One of the drums was located 55 ft. out of position and 8 ft. below the surface of the sand.

A crib was constructed of sheetpiling inclosing the boiler, which proved to be lying on its side, having toppled into the river. The violence of the flood was shown by the fact that the brickwork was entirely washed away. The cast-iron front was located 7 ft. from the main portion of the boiler, and the whole area was interlaced with the structural steel used to support the stack and upper drums. It was necessary to cut several of these steel beams in order to sink the crib. As fast as the tubes were uncovered, they were cut loose and removed, a Lagonda cutter being used. The bottom of the lowest drum of the first boiler was found to be 16 ft. below the water surface and 20 ft. below the former floor level of the plant.

On the removal of No. 1 boiler, boiler No. 2 was found lying partly beneath it. A second crib was then constructed to inclose it. In this case the boiler was on its side as before, but with the manholes down, which necessitated the cutting of the tubes from the outside. This was done with ripping chisels, the work being accomplished under extreme difficulties, as much of the cutting had to be done under sand and water. Difficulty was experienced with the water, as the brush and other small débris clogged the pumps, making it necessary to stop and clean them several times a day. At these times the water would rise at the rate of 6 to 8 ft. per hr. To excavate the No. 2 boiler, it was necessary to lower the water plane 26 ft. below the surface of the river, or 30 ft. below the former elevation of the engine-room floor.

At the bottom of the excavation trees were encountered, which showed that the scour must have extended to a depth of at least 35 ft. below the former surface of the ground; which fact partly explains the failure of many of the bridges and other structures supported on piling in southern California. A penetration of 35 ft as hitherto been considered adequate in many cases.

As fast as the various pieces of machinery were re-oved, they were taken in hand immediately and cleaned, rst with scrubbing brushes and water under pressure nd then with distillate, emery cloth and rotten stone. t was found that an exposure to the air of even a half-our allowed rust and corrosion to set in to such an xtent that heroic measures were necessary to prevent rious damage. All of the boiler parts and much of the ast iron were painted, as soon as cleaned and dried, ith linseed oil and graphite. The bright parts were ickly coated with heavy grease.

The salvaged machinery has been removed to a new cation, where it is proposed to reërect the plant as soon conditions warrant it. The salvaging operation was n economic success, the cost of the salvaging being pproximately 25% of the value of the salvaged materials.

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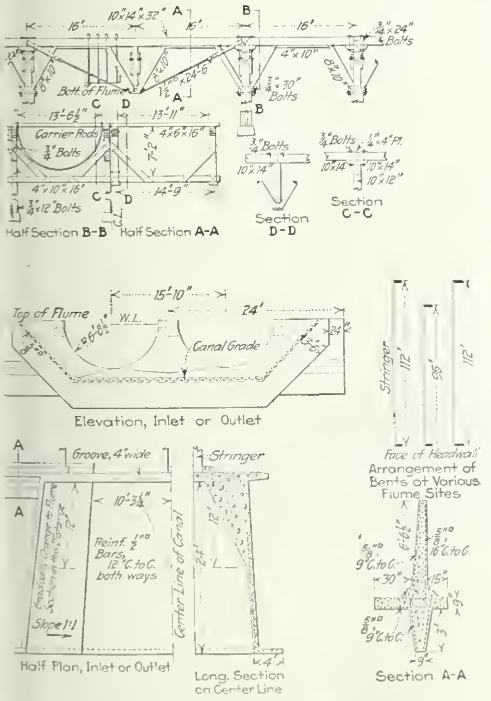
Very Large Metal Flumes

The views shown herewith illustrate what is prob-bly one of the largest metal flumes yet constructed. The iameter of each flume is 13 ft. 6½ in., and the two gether carry the main canal of the Grand Valley Proj-t of the United States Reclamation Service. Three vin flumes of this size are used on this project. The etails are shown by Fig. 1.

The trestle is constructed of separate bents and string-rs for each flume. The posts are 10x12 in. and the ringers 10x14 in., 32 ft. long, trussed in the center shown. The entrance to the two flumes is a specially designed concrete structure for reducing the loss of head to a minimum. The three flumes are 144, 160 and 144 ft. (single) in length, and cost $7,507, $8,809 and $11,883 respectively, including excavation, approaches, trestle, concrete, paving, etc. J. H. Miner is Project Manager. The flumes are of the Hess type, made by the R. Hardesty Manufacturing Co., Denver, Colo.



IG. 1 DETAILS OF 12 FT. 6½ IN. TWIN HESS FLUMES; GRAND VALLEY RECLAMATION PROJECT

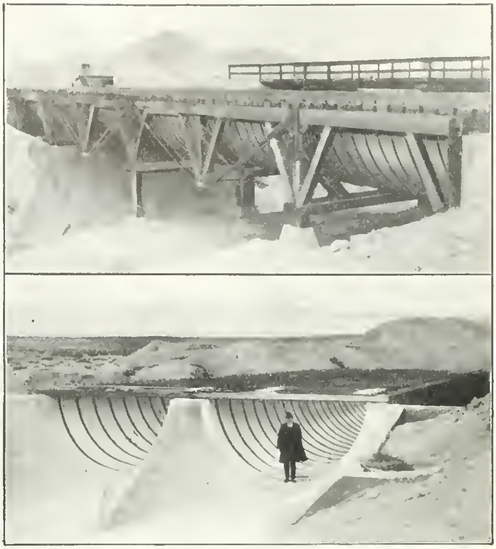


FIG. 2. FLUMES 13 FT. 6½ IN. IN DIAMETER; MAIN CANAL, GRAND VALLEY PROJECT

⁂

Illinois Road Specifications

Specifications for highway construction just issued by the Illinois State Highway Department are based upon the opinions and experience of engineers outside of the department as well as upon those of the state engineers. Drafts of the specifications as originally prepared by the engineers in the department were submitted to a number of engineers, contractors and material supply men, who were requested to examine them critically. The specifications were then revised and improved in accordance with many of the criticisms and suggestions offered.

The specifications include the following types of construction: Monolithic brick road; brick with sand-cement bed; concrete road; bituminous concrete; bituminous macadam; waterbound macadam; gravel roads and earth roads. There are also included specifications for the oiling of earth roads and the oils to be used for such work. The specifications were prepared and revised under the direction of William W. Marr, Chief State Highway Engineer.

⁂

Durax Granite-Block Pavement is being laid on the southerly half of the Brooklyn-Brighton viaduct at Cleveland, Ohio. The blocks are 4-in cubes laid in sand-cement 1 : 3. As much as is laid during the day is flooded in the evening. The next day that which has been flooded the night before is grouted 1 : 1. The contract price is $2.50 per sq.yd., which includes all labor and material. The blocks cost $6.50 a ton at the quarries of the Harris Granite Quarries at Salisbury, N. C. Freight brings the cost f.o.b. Cleveland to $9.10 per ton, which will lay not less than 6½ sq.yd.

Furniture Layout Increases Designing Efficiency

Efficiency in designing may be appreciably promoted by the furniture and layout of the drafting room, according to the experience of W. W. Horner, Engineer in charge of design of sewers and pavements, St. Louis, Mo. The accompanying view, Fig. 1, shows how the designers' and draftsmen's tables are arranged parallel and opposite the desks where the computers and estimate makers work. The aim is to coöperate with the least possible lost motion and confusion. Fig. 2 shows one of the computer's desks, which have served their purpose admirably. It is a standard bookkeepers' oak desk, such as may be purchased of any commercial furniture dealer, but with the legs shortened to accommodate a person seated. The ample drawer room will be appreciated by all designers. The views are taken in the St. Louis City Hall, Department of Public Works.

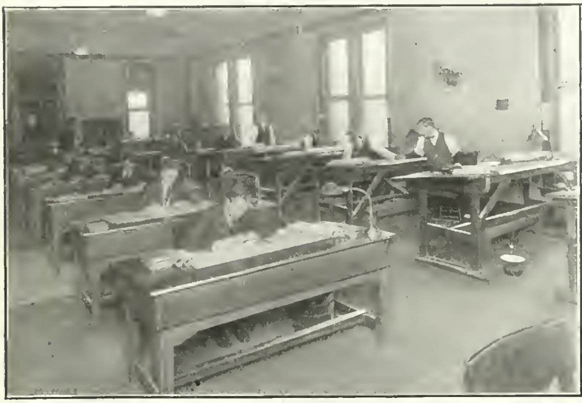


FIG. 1. DRAFTING ROOM, SEWERS AND PAVEMENTS, CITY HALL, ST. LOUIS, MO.

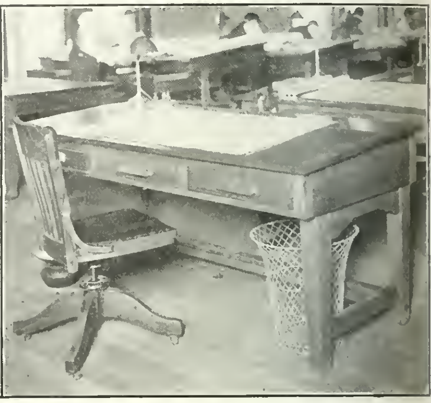


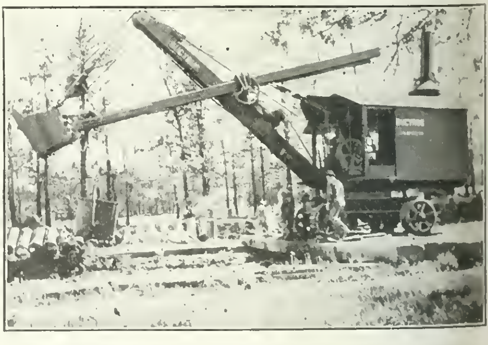
FIG. 2. COMPUTER'S AND ESTIMATOR'S DESK

NOTES

Mixing Cement with Skim Milk—An item has been given wide publicity, to the effect that the inflammability of shingle roofs will be greatly retarded if they are given a coating of paste made by mixing skim milk and portland cement. It is doubtful whether any coating of this sort spread upon a shingle roof in sufficient thickness to materially affect its resistance to fire would not soon crack off by the gradual exposure and weathering of the shingles. It is a fact, however, that a very cheap cold-water paint for farm buildings and similar purposes can be made by mixing lime and portland cement with skim milk instead of water. The basis of the commercial cold-water paints is casein, which is substantially skim milk with the water removed. The main advantage of the casein appears to be that it holds the moisture until the cement has time to set, whereas a mixture of cement and lime with water, spread out in a thin coat with a brush, will dry before the cement has time to set. Ernest McCullough of Chicago informs us that concerns in Iowa have been putting cement paints on the market for a number of years, made up with skim milk according to a formula given by Mr. McCullough in an address in Minneapolis some ten years ago and the addition of some dyes or pigments to give a desired color.

Contractors' Stern-Wheel Gasoline Barge—With 26 dipper dredges excavating 625 mi. of ditch in the Little River Drainage District, Missouri, extensive use is made of small gasoline stern-wheel towboats for distributing coal and supplies. One of these boats which are built on the work by the different contractors, is described by P. J. O'Connell, General Superintendent of the Canal Construction Co., Memphis, Tenn. The hull is an open flat-bottom scow 36x8½ ft. on top, 3 ft. 2 in. deep. The frames have 6x6-in. posts and sills, spaced 25 in. c. to c., upon which is spiked the planking. The wheelshaft is carried by the projecting ends of long timbers, o wheel-arms, bolted to the tops of the frames. There ar from 6 to 12 blades, according to the size of the boat. Light posts support a roof and hinged side panels, while at the forward end are a pilot house and an engine room. Some of the boats, however, have simply an awning roof of plank or corrugated iron, with the engine placed at any convenient point on the floor. The steering wheel and engine-control levers can be either at the bow or at the stern. Mr. O'Connell's boat has an 8-hp. gasoline engine of the ordinary single-cylinder horizontal type, with chain drive to a countershaft from which there is a chain drive to a sprocket wheel on the wheelshaft. It can make a speed of 3 mi. per hr. when towing a barge loaded with 50 tons of coal.

Sewer Trenching with a small revolving steam shovel, working from a platform of 12x12's over the trench, was done with apparent efficiency and economy on a recent job in St. Paul, Minn. The outfit is shown in the accompanying view. Only six men composed the construction crew. The 12x12's were laid on planks on either side of the trench. All the excavation was done with the aid of the steam shovel For finishing the grade and bailing out water a cylindrical bucket was attached to the dipper arm. This was filled with a shovel by a man in the trench, who also did the pipe laying The trench contractors were Siems-Carey Co. & Helmers, St. Paul


SMALL REVOLVING SHOVEL SEWER TRENCHING, ST. PAUL

Editorials

Railway Rates That Help Cities at Expense of the Country

The authorities of the State of New Jersey have rought before the Interstate Commerce Commission a uit that raises questions of greater social and economic nportance than any railway-rate case before that body n many years. The suit is brought to compel the railays reaching New York from the West to charge a wer rate on freight to or from the cities on the New ersey side of the Hudson River than the charge to or om New York itself.

The issue is this: The present system of railway rates based primarily upon distance. It harks back to the me when the railway was the competitor of the stage-ach. The cost of hauling over the road was then the ain expense in transportation, and the cost of handng at terminals was trifling. The last half-century has volutionized these conditions. The cost of hauling affic over the road has been reduced to a mere trifle, hile the cost of handling in the terminals of great cities s been multiplied many fold.

Everyone recognizes that transportation rates should be sed on the cost of service plus a fair profit to the transortation company; but the present railway rates entirely nore the high cost of terminal handling in large cities. reight rates on a carload of goods hauled between Chigo and a factory located in Newark, Paterson, Jersey ity or Hoboken are the same as if the freight had to be ghtered across the Hudson River to or from a factory n Manhattan Island or in Brooklyn. Since railway ates must on the whole be sufficient to pay all the operting expenses, fixed charges and profits of the railways, follows that the merchants and manufacturers of Jery City, Hoboken and Newark are actually paying in eir freight rates part of the cost of carrying goods for eir competitors located on the eastern side of the Hudson River.

The average cost of transferring freight by lighters cross the North River to New York City was estimated y an able expert six years ago at 80c. per ton. It is oubtless much higher now—because of the increase in bor and material prices in that time. There must be dded to this expense the cost of the switching moveents on the New Jersey side of the river to sort the ars for placing on the car floats. It is probably safe o say that it costs the railways that cross New Jersey rom $1 to $1.20 per ton more to handle freight to and rom New York or Brooklyn than it does to handle the ame freight to or from a private siding of a manuacturing plant located in Newark or Paterson. Yet on oods shipped a hundred miles or more westward the Newark shipper must pay the same rate as the New York shipper.

It has long been recognized that for the economical andling of Western freight at the port of New York he transfer should be made directly between cars and cean steamers on the New Jersey side of the North River. The cost in rehandling, trucking, switching, etc., where steamships land at the crowded wharves of Manhattan and Long Island, before a consignment of goods is started on its railway journey westward constitutes a tax on business that is felt by industries scattered all over the United States. But so long as the present artificial railway rates prevail, shippers would have no object in directing their traffic through a New Jersey terminal if one were built.

In other words, the present rate structure perpetuates an expensive method of doing business involving an expenditure of many million dollars annually, which is added to the price of a thousand commodities distributed to many millions of consumers.

There has already been from other causes a great development of manufacturing industry in that part of New Jersey within a radius of twenty miles from New York. The high cost of land in Manhattan and Brooklyn, the congestion of street traffic, with the heavy cost of cartage, have already driven most of the heavy manufacturing industries out of New York City to locations in New Jersey. There is no reason whatever why these hundreds of manufacturing concerns and the hundreds of others which are certain to locate there during the next dozen or twenty years should not be granted railway rates corresponding to their advantageous location instead of being burdened as they now are with a rate based on the cost of transferring all freight across the Hudson River.

It need hardly be said that this suit will be bitterly contested. New York City interests will fight any proposition that might encourage the transfer of commerce and industry to the New Jersey side of the river. The owners of real estate in every city constitute the most influential interest; and there is no city where population is so congested and land values so high that the real-estate interests will not exert all their influence to favor anything that promises to force land prices still higher.

New York at present stands committed to a gigantic real-estate speculation in building up a great ocean-freight terminal at Jamaica Bay, in the eastern part of Brooklyn. The cost of transferring freight between this Jamaica Bay terminal and the railway lines west of the Hudson would be as great as the cost of hauling it hundreds of miles on its journey westward.

Doubtless the New York situation is the most flagrant case of discrimination to be found anywhere due to the ignoring of terminal costs in fixing railway rates; but the principle involved is of great importance to the country as a whole. There is no doubt whatever that the present system of railway freight rates, which takes no separate account of terminal costs, is a powerful economic force in stimulating the congestion of manufacturing, commerce and population in great cities and handicapping the business of the country towns and the smaller cities.

It is doubtless little realized, even by engineers, how great the disparity has become between the cost of hand ing freight over a railway when once started on its journey and the cost of handling it in crowded city terminals. In *Engineering News* of Mar. 3, 1910, there were presented a detailed analysis and figures comparing the average cost of road haulage with the cost of handling freight at the terminals of New York City and Philadelphia. It may be of interest to repeat here some of the figures given in that article.

An estimate was made of the average cost of handling a ton of merchandise freight between a warehouse in Philadelphia and a store in New York City. The total terminal expenses at the two ends of the route were found to be $3.65, whereas the total cost of hauling the ton of freight over the ninety miles of railway between the two cities after it was once started on its journey was only 27c. In other words, on that class of freight, handled between these crowded city terminals, *the cost of hauling over the road was only one-fourteenth as much as the terminal cost.*

A second comparison was made of the average cost of handling through merchandise freight between Chicago and New York City. It was there shown that, according to the best figures obtainable, it costs the railways about as much to handle this freight in the terminals at each end as it does to haul it the entire thousand miles between the two cities.

It is especially important to remember that while the tendency of modern transportation methods is toward a steady reduction in the cost of haulage over the road, the terminal expenses, on the other hand, are all the time increasing, and increasing especially fast in the larger cities. The land in large cities used for switching yards, team tracks and freighthouses is steadily rising in value. The bigger a freightyard grows, the longer is the distance cars have to be moved in it in sorting and making up trains. The bigger a freight warehouse becomes, the longer the distance the trucks have to travel in handling incoming and outgoing freight.

It is probably not often realized that in the development of our present-day railway transportation system the engineer is dealing with problems wholly without precedent. The world has never before seen cities of such vast size; never before has the problem arisen of furnishing economic transportation to such huge aggregations of people.

How much farther can we proceed in our concentration of population? The railways have spent many hundreds of millions to create their present city-terminal facilities. How vast must be their expenditure if switching yards and freighthouses must again be radically enlarged on land purchased in congested districts? There is little doubt that one of the greatest factors in the high cost of living is that so large a proportion of the population is crowded on high-priced lands.

The freight congestion of the past six months has been a great object lesson, showing how small is the safety factor of capacity in our great city railway terminals. It is there that the congestion has been concentrated. There has been no difficulty in moving trains over the road, even on the lines where freight embargoes have been most frequent. The difficulty has been in sorting the cars in the crowded yards when they arrived at their destination.

The expense that railways and shippers have incurred during the past nine months because of the congestion of railway traffic must amount to many million dollars. That a vast investment must be made by the railways in enlarging city-terminal facilities is beyond question. It is time to take a long look ahead and see what can be done now to reduce the need of this in the future.

It would be of enormous advantage to the railways to stimulate the growth of industry and traffic at the smaller cities, where their terminal expenses are small and their profits are correspondingly large. The railways could do this in no other way so certainly as by radically revising their rates so that the shipper in the great cities will have to pay the cost of the service rendered him.

It would be of vast advantage to the country, also, to have some check applied to the congestion of population, with all the social and economic problems connected therewith. The figures previously given as to the relative cost of road haulage and city-terminal costs give some idea of how radical the change would be if railway rates were revised to correspond to the cost of service.

It is, however, beyond expectation that any such revolutionary change will be made save by slow degrees. The advocates of such a change would be opposed by the city real-estate interests the country over. A great majority of present shippers now located in the cities would of course join in opposition. The railways also, from pure conservatism, would doubtless oppose so sweeping a reform, although nothing can be clearer to traffic experts than that the present plan of practically ignoring cost of service in fixing rates is pernicious in principle and distributes the transportation tax most unfairly.

Manifestly, a long process of public education must precede the needed reform, and it is to be hoped that the suit brought by New Jersey may be a first step in this process.

Co-operation Saves Pavements

Much has been written about the vicissitudes city pavements undergo because of constant openings to get at subsurface pipes, conduits, etc. Paving engineers lament the necessity of these openings, and many cities have passed stringent ordinances setting a definite time of from one to five years during which a new pavement must not be disturbed except for emergency work. But Chicago appears to be one of the first, if not the first, city to meet the problem in a rational way.

In Chicago there is an organization known as the Board of Underground Work of Public Utilities, the purpose and labors of which are apparently little known to municipal and public utility officers generally. It is not a new thing, for it has had five or six years' successful operation to prove its worth.

This board of Underground Work of Public Utilities is an association of the Board of Local Improvements, the Chicago Postal Pneumatic Tube Co., the Chicago Telephone Co., the City Electrical Department, the City Press Association, the City Water Department, the Chicago Surface Lines, the Commonwealth Edison Co., the Peoples Gas Light and Coke Co., the Postal Telegraph Cable Co., the Sanitary District of Chicago and the Western Union Telegraph Co. In short, the association comprises all the public utility interests of the city sharing in the use of the streets. These interests are represented in e Board by their chief engineers or other officials. The ard has a salaried secretary whose office is in the ty Hall adjacent to the offices of the Board of Local nprovements.

The object and work of this Board is to save the city vements from avoidable openings. The secretary of e board is constantly on the job to find out when and ere new pavements are to be laid. He then brings to e attention of the interested public utilities any changes their subsurface structures which are necessary or derable before the new pavement is laid. He keeps posted whether or not these changes have been made before ving operations begin. In short, he is the go-between which results are accomplished without the usual govnmental and bureaucratic red tape and misunderstandgs. The secretary has no authority to order work done, r does he devise ways and means to do it. That is the rk of the responsible bureau or corporation officials.

Aside from eliminating red tape by means of the cretary, the regular meetings of the Board and the timate association and acquaintance of the public utility ads with one another has worked wonders in bringing out a better understanding of the objects to be attained d in bringing about a really hearty coöperation between at were, and in many cities still are, warring interests.

* * *

he Old Battle Between Stone Masonry and Concrete

Engineers whose memory extends back over a period of enty years or more will readily recall the strong ejudice that for many years retarded the use of conete in the United States. French engineers built notle structures of *béton*, as they called it, in the early 's, but all through the '90's American engineers, parularly those of the older generation, were doubtful of e reliability of concrete and hesitated to risk their putations by building concrete structures.

One of the most prominent among the opponents of ncrete was the late William H. Brown, for many years e Chief Engineer of the Pennsylvania R.R.; and one his remarks with reference to concrete gained wide blicity. He declared that for his part he could not e the advantage of breaking stone up into little pieces r the sake of sticking it together again with cement. s long as he remained at the head of the Pennsylvania's gineering department, that company consistently oided the use of concrete except for footing courses.

Under Mr. Brown the policy was inaugurated of building stone arches in place of metal or wooden structures moderate span all along the main line of the Pennsylvania R.R., as well as on other divisions of heavy traffic. robably few will be found to question the soundness this policy, and it is altogether likely that most of ese bridges will be in sound condition and amply strong r the loads imposed upon them a century after their mpletion.

There are, however, exceptions, and it is of interest to cord that extensive repairs became necessary last ring to one of these stone-arch bridges built no longer o than 1899. The bridge in question is a five-span one arch, crossing the Little Juniata River in the pruce Creek Narrows east of Tyrone, Penn. The arch on a very sharp skew and is of the ribbed type. Longidinal cracks developed on the under side of these ribbed arches, indicating that the outer rings had separated from the body of the arch, and it was deemed necessary to adopt means for bonding the arch longitudinally and preventing further separation.

In order to do this without interrupting traffic, long yellow-pine timbers were placed under the ties, enabling pits to be excavated in the filling on top of the arches without interfering with the stability of the track. In this way the arches were exposed, and holes were drilled in the backs of the arch stones. Iron rods were inserted in these holes in such a manner as thoroughly to bond the arch together and draw the separated rings back into place. After these bonding rods were placed, they were embedded in concrete, which at the same time of course further secured the arch rings. According to a detailed report of the work in a local paper, about four months' time was consumed in making these repairs, and there were used in the work 56 timber stringers, 12x18 in. by 46 ft.; 1,685 cu.yd. of filling on top of the arch was excavated; 2,110 bonding holes were drilled in the arches, each $1\frac{3}{4}$ in. in diameter and 8 in. deep. It will be evident from the foregoing that the structure as now repaired has a very substantial reinforced-concrete mat on top of the stones arches, and is without question a much stronger and more secure structure than when originally built.

It might be a reasonable conclusion to draw from this experience that for arches built on a very sharp skew a good concrete structure is more reliable than cut stone. It would not be safe, however, to draw any such conclusion as regards the relative merits of concrete and stone masonry as applied to structures generally. No engineer doubts nowadays, of course, that a concrete-arch structure properly designed and properly built is safe, reliable and permanent. There is some danger, however, that with the great popularity and extensive use of concrete the merits of cut-stone masonry and its advantages in certain locations are in danger of being overlooked. There are certain economic advantages in breaking stone into little pieces and sticking them together again with cement which were not appreciated by Mr. Brown and others who held similar views twenty-five years ago. On the other hand, in localities where good dimension stone, readily cut, is easily obtainable, the masonry arch should find a place, and its design and construction ought not to become a lost art.

* * *

Another Public Health School

The recent announcement of the establishment of a School of Hygiene and Public Health at Johns Hopkins University, Baltimore, by the Rockefeller Foundation, is an act as well designed as anything can be "to promote the well-being of mankind throughout the world"—the motto and the grand object of the Foundation.

Strange to say, none of the justly commendatory press comments on the establishment of this school mention the fact that a number of schools of public health are already in existence and doing good work in the United States. Stranger still, the press announcement given out by the Rockefeller Foundation was silent on this point, although it distinctly said:

> There are many medical colleges in the United States which train men for a career in curative medicine, but the facilities for those desiring to devote themselves to preventive medicines and the promotion of public health are yet inadequate.

It would have been only fair to recognize the existence of a number of schools of public health and to have stated that there seemed to be plenty of room for another. Failure to do this may be passed over as an indication that neither the publicity bureau of the Rockefeller Institute nor the daily press wished to detract from the news interest of its story by acknowledging that it was not announcing something unique in the annals of the United States.

Turning now to another phase of the announcement, or rather to the foreshadowed character of the school itself, it is a pleasure to recognize that instruction in sanitary engineering is prominently featured and that attention is to be given to social science and its relation to public health. It is notable that the announcement states that on its teaching side the school "will be designed primarily to benefit those who plan to give their lives to the administration of scientific sanitation." Stress is rightly put upon instruction in sanitation rather than in medicine. Certainly from the administrative point of view, public-health work is sanitary rather than medical in character. But is not too much emphasis being laid upon instruction in both medicine and engineering by most of the schools of public health today?

Under the present precarious tenure of municipal office it may be necessary for the health officer to be able to turn either to medical or engineering practice for a living at any time. This necessity ought not to continue long. When it ceases and when the hundreds of municipalities of the country realize the value of the services of trained health officers and are willing to employ them and keep them during good behavior and efficient service, then certainly there should be a new sort of public-health school which would cut out a considerable part of the instruction in both medicine and engineering that now seems to be deemed necessary. Health officers may then best be trained broadly in the fundamentals of public health and sanitation, sociology, law, vital statistics and especially in administration. They can and will then call to their aid, as needed, specialists in medicine, in sanitary engineering, bacteriology, chemistry and other sciences, instead of taking a specialist in one of these fields for a health officer or for material to be put through a school of public health.

Low Bids for Another East River Tunnel

The low bids received by the New York Public Service Commission last week for two subway tunnels to be driven under the East River, from 60th St. in the Borough of Manhattan, to the Queensboro Bridge Plaza in Long Island City, about 1½ mi., are especially noteworthy in view of the troubles which have been met in previous East River tunnel driving. Most engineers around New York are familiar with the accidents and delays that have been met with in the construction of the ten tunnels which have already been driven under that river. It is safe to say that nowhere else in the world is there another body of water under which tunnels have been driven with such extraordinary difficulty and danger. The most recent and most spectacular difficult tunnel driving under the East River was the new gas tunnel at 132nd St. which was fully described in *Engineering News* last fall. This is a deep tunnel in rock, 250 ft. below the surface of the water.

The tunnels to be driven at 60th St. will be as near the river bottom as practicable to reduce the total rise and fall. A mile farther south are the two old Steinway tunnels, which were taken over and put in operation by the city as part of the underground rapid-transit system a year ago. It is of interest to note that the corporations which built the Steinway tunnel claimed to have expended about ten million dollars on their construction, whereas they were turned over to the city at about three million dollars.

A short distance farther south are the four tunnels which carry the lines of the Long Island R.R. under the river to the Pennsylvania station at Seventh Ave. These tunnels were built under the direction of the late Alfred Noble, as engineer, with the Pearson Co. as contractor. Many will recall the huge fountains of escaping compressed air that arose from the surface of the river over the tunnel headings for months while this work was going on. Similar, if not worse, difficulties were experienced in driving the pair of tunnels across the river from the Battery which are used by the present subway trains. Indeed some of the ground through which these tunnels pass is so soft that for years after the tunnels were opened, there was agitation from time to time over reports that the tunnel structure was becoming displaced in the silt.

For the four tubes a short distance above the Battery tunnels which will form the downtown crossover connections of the new subway system and which are now under construction, the bid price was in the neighborhood of $13,000,000, a very much greater price per track, it will be seen, than the low bids now made for the 60th St. tunnels. Various difficulties have been experienced on these downtown tunnels since work was started there, but probably no more than was expected by the contractors when they prepared their bids.

Possibly one explanation of the low bids on the 60th St. tunnels is the expectation that tunneling conditions there will be more favorable than at other points on the river. As the tunnel crosses directly under Blackwell's Island, it will be in solid rock, presumably, for a considerable part of its length. It is fair to assume, also, that the channels on either side of the island, which are subject to perpetual tidal scour, will contain less of soft silt than the wider stretches on the river below.

There will be, however, on each of the 60th St. tunnels, presumably, at least four points where a change from earth to rock will have to be made, with all the difficulties that involves. Furthermore, as the East River gas tunnel experience shows, the rock in that vicinity is very far from reliable for tunneling work. The high prices of labor and materials now current make the low bids for the East River tunnel the more remarkable.

Finally it must be noted that not one contractor but several were of the opinion that the 60th St. tunnels could be built at a low price and backed their opinion with their bids. When the petition was presented a year ago to have the uptown subway connection made across the river by a tunnel instead of by strengthening the Queensboro cantilever bridge to carry additional loads, the Degnon-McLean Co. offered to build the tunnel for not to exceed $4,500,000, if given a chance to bid. When it came to actual bidding, however, this company bid more than a quarter of a million dollars below its guarantee, and one other bidder went lower still.

Letters to the Editor

Montreal Centrifugal Pump

Sir—In commenting upon your discussion of the ently published test of a De Laval steam-turbine- iven centrifugal pump at the Montreal Pumping Sta- n, F. W. Dean, in your issue of June 8, makes several estionable assertions. He says: "I think that every ort should be made in such matters to see that pump- g engine guarantees are based upon the performance of e main engine, unmixed, so to speak, with auxiliaries." What the purchaser generally desires is the most onomical plant, which should govern the kind of iarantees to be drawn. Other things being equal, in a am-driven plant, is not that prime mover, or combina- n of prime mover and auxiliaries, the best that will oduce the highest overall duty; that is, the most foot- unds of work from a given amount of heat? If the cle of operations can be improved by designing the paratus to work in conjunction with auxiliaries, why ould it not be done and why should not the auxiliaries included in the guarantees and in the acceptance test? Mr. Dean further says: "It has been my custom, and should always be the custom, to base the performance on the steam used by the engine itself, as a measure of e merits of the engine and means of comparison with her engines." The test conducted by the Montreal ater-Works engineers, however, was not intended to easure the efficiency of an engine. Its purpose was ther to determine the duty of a complete outfit, as easured by its ability to utilize heat in raising water. was agreed with the builder therefore that the net nount of heat received from the boilers would be used calculating the duty as explained in the report of e acceptance test that was supplied to the *Engineering ews.*

The fact that the quantity of heat was defined terms of 1,000 lb. of steam at a stated temperature nd pressure, produced from cold feed water of a certain mperature, rather than in millions of B.t.u., does not lter the situation.

The weight of steam entering a turbine is not of self a suitable measure of duty in a pumping plant ordinarily designed. For example, a perfect engine, xpanding adiabatically from 150 lb. gage to 28 in. acuum, would develop 224 million foot-pounds per illion B.t.u. received from the boiler, or 252 million ot-pounds per 1,000 lb. of steam. On the other hand, n engine working on an isodiabatic cycle in which artly expanded steam is employed to heat the feed water p to boiler temperature, to which the use of an exhaust team feed-water heater is an approximation, would have duty of 250 million foot-pounds per million B.t.u., ut of only 314 million foot-pounds per 1,000 lb. of steam ntering the engine. The reheating engine draws more team from the boiler, but some of its heat is put back, that actually less heat is required from the fire, and ss fuel is burned.

GEORGE H. GIBSON.

Tribune Building, New York City, June 15, 1916.

Sir—I have been greatly interested in the article and the subsequent discussions concerning the Montreal centrifugal pump. I believe, however, that the published letters create an erroneous impression, when they appear, as they do, by themselves and are read by engineers who have not seen the original article that appeared in *Engineering News* of April 27.

The article that has received so much adverse comment does not appear to be misleading in the slightest degree, for it distinctly warns the reader that heat returned by the feed-water heaters is credited in the duty figures, and this is certainly as it should be, for the ultimate economy of any heat unit is measured by the conservation of the heat supplied it: and conversely, the extravagance of any unit is measured by the total heat actually extracted from the system. The time is passing when engineers are content in getting only the highest mechanical results from steam, then letting all the heat that cannot be converted into mechanical energy go to waste in the condenser. If the American Society of Mechanical Engineers' Test Code discourages anything that conserves the heat of a system, it would seem that it should be revised. Further, engineers are more interested in the ultimate steam consumption of a system than they are in the consumption of a particular part that obtains its greater economy partly at the expense of some other unit of the system, such as the boilers.

If the steam turbine lends itself to the further use of partly expanded steam in feed-water heaters better than does the reciprocating engine, it certainly should not be barred from enjoying this inherent advantage by an arbitrary test code.

With reference to the editorial in *Engineering News* of May 18, entitled "Triple Expansion Still Ahead," I think that the editor has presented the case in an improper light. The duty claimed for the Montreal unit is 168.3 million foot-pounds per thousand pounds of steam at 140 lb. pressure and 100° F. superheat. This certainly is not, by any manner of figuring, equivalent to 168 million foot-pounds per million B.t.u. as stated in the editorial and no such figure was claimed nor could any one infer from the original report that such was the case. The figure of 134 million foot-pounds per million B.t.u. actually extracted from the system gives the correct measure of the economy of the Montreal installation, and represents what any other unit would have to meet in order to equal this ultimate economy. If, in a comparison between steam turbine and reciprocating units, credit for heat returned to the system is not allowed the turbine unit, it is manifestly unfair to the turbine, not to charge against the reciprocating unit the additional work put on the boilers, by evaporating from a colder feed temperature.

As stated in the foregoing, the published letters, appearing by themselves, prejudice the reader. For instance, F. W. Dean's letter of June 8, relates a case of a reciprocating unit where credit was wanted for the steam used in the cylinder jackets. This illustration is particularly unfortunate and far from comparable with the case under discussion. Here, we are asked to credit a machine with heat actually extracted from the system in obtaining its economy and the casual reader at once infers that some similarly unwarranted credits are claimed by the Montreal unit, whereas, in the case under discussion, the turbine is charged with absolutely all the heat that it removed from the system.

The steam turbine has brought with it new ways of arriving at better efficiency and these better efficiencies cannot always be determined in the old ways, and the old ways of expressing economies are often extremely misleading. There are many cases where a straight high-pressure condensing machine is absolutely extravagant when compared with the bleeder turbine, although the steam consumption of a bleeder turbine in pounds per kilowatt-hour is ridiculously high when compared with the condensing machine. How, then, are we to express the economies in such instances? Not by steam rates, for they are misleading. The logical way, to my mind, is to base all duty statements on the actual heat removed from the system, for manifestly any heat that remains in the system is not consumed. This will eliminate, to a degree, such variables as steam pressures and superheat that make the usual duty records hard to compare unless all the data are available.

In the case of the Montreal unit, the above method was used to a certain degree and adds another precedent for the newer and more exact method of determining duty; and instead of causing so much adverse criticism it should be considered as the forerunner of more modern methods that are bound to supersede the antiquated methods now in vogue. R. A. BURFORD, JR.

131 State St., Boston, Mass., July 1, 1916.

[What we have criticized is not any improvement in pumping equipment or test methods, nor any contract basis found desirable by builder or purchaser. What we did mildly censure was the statement that the duty of the Montreal pump was 168.3 million foot-pounds per 1,000 lb. of steam, when that rating did not correspond to the widely accepted meaning given by the test-report code of the American Society of Mechanical Engineers—even though to that figure was appended an explanation (sure to be omitted sooner or later by some one) of the difference in meaning. The advances in overall efficiency of large turbine-driven centrifugal water-works pumps are each and all matters of unusual interest and importance; the greater this interest the greater is the need for announcing the accomplishment in unmistakable terms. No matter what tests are agreed upon between builder and purchaser, in an important case data should also be sought that will permit full comparison with earlier machines.—Editor.]

Creeping and Heaving of Concrete Road Slabs

Sir—I have just read with much interest the editorial on the creeping and heaving of concrete road slabs in the issue of June 22, p. 1192, in which suggestions are requested from engineers who have worked in the field of concrete-road construction.

The four cardinal faults of concrete roads have been in nearly all cases traced to (1) poor drainage of subgrade, (2) porosity of the concrete, (3) non-uniform abrasive value in the wearing surface, (4) improper curing.

Overcoming the first fault is elementary. If the subgrade is permitted to become saturated with water, it will heave and swell in both northern and southern climates, this being especially true if the subgrade was over-rolled or over-compressed when dry. A subgrade can be over-rolled as easily as under-rolled, and to prevent over-rolling I recommend a 6- or 7-ton roller.

The porosity of the concrete is one big obstacle to overcome in a concrete pavement. Get the concrete as dense as possible, for the absorption of moisture swells the concrete and sets up internal stresses that are very damaging, causing it to crack and disintegrate. The concrete should be laid too dry rather than too wet. It should come from the mixer in a quaking homogeneous mass. If the mix is too wet, the water will soon drain down into the subgrade and take a large portion of the cement with it.

In almost every case, the parting of the two slabs of concrete is not due to subgrade faults, but to the absorption of moisture in the slab, which causes the concrete to swell. Should this state be followed by a few hot days, the slabs would dry out and contract, leaving a slight open joint between slabs. This crack or joint will at once be filled with dust, sweepings or other incompressible material. This intermittent swelling and contracting, followed each time by the entrance of foreign matter, will gradually increase the width of the joint or crack and force the slabs out of place. By this is not meant that no pavement creeps on subgrade, but that in most instances the separation of the concrete slabs is due to expansion and contraction and not to creeping.

Regarding the non-uniformity of the wearing surface, it is certainly the better part of wisdom to get as dense and rich a mixture of stone and mortar as possible in the top surface, which will not only improve the wearing quality of the pavement, but to a large extent form a water-tight covering. This can be done by a more thorough floating and tamping, and it is a point of such tremendous value that too much stress cannot be laid on it in all concrete-road specifications.

FRANK W. SAMPSON.

Katonah, N. Y., July 10, 1916.

NOTES AND QUERIES

Aërial Tramways on the Los Angeles Aqueduct—The use of aërial tramways in the construction of the aqueduct for Los Angeles, Calif., was described in "Engineering News" of June 29. It should have been stated that two of the three tramways were built by the American Steel and Wire Co., of New York, N. Y., and the third by the A. Leschen & Sons Rope Co. of St. Louis, Mo.

The Article on Steel and Wood Water Mains at Butte, Mont., published on p. 1108 of our issue of June 8, stated that the first wood stave pipe line laid in Butte which was of redwood pipe, was put down in 1892 and was still in good condition, and that over 40 mi. of continuous stave wood pipe had been laid since that time. It might have been inferred from the wording of the article that all this wood pipe was of redwood. We are informed, however, that two of these wood conduits are of fir staves, one of them laid many years ago and the other about three years ago.

New Facts About Materials and Methods of Test

Some of the papers and discussions relating to prop- ties and tests of materials read at the Annual Meeting ' the American Society for Testing Materials were pre- nted in these columns last week. Below are given hers of practical interest.

Two Ways of Testing Cloth

The existence of two quite different methods of testing oth in tension was emphasized by the Textile Fabrics ommittee in recommending one method for belting fab- cs and another for tire fabrics. Fig. 1, from a short per by W. S. Lewis, gives the essentials of the respec- ve test pieces.

For the "strip" test the cloth is raveled to 1-in. width id the test thus made on a definite thread-width. For e "grab" test a wider strip is used, but the jaws that ip it are only 1 in. wide. Mr. Lewis gave a long table test results on wool and cotton fabric, showing that the ab method indicated up to 127% greater strength than e strip method.

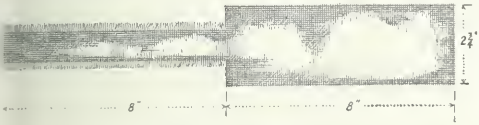


FIG. 1. SPECIMENS FOR TESTING CLOTH

Left—Strip test Right—Grab test

E. D. Walen discussed the actions of the two test pieces iring test. Fig. 2 represents the behavior of the threads ar failure. In the strip test some of the outer threads ll away and do not get tension enough to break. In e grab test a larger width of cloth than the jaw width rticipates in the resistance.

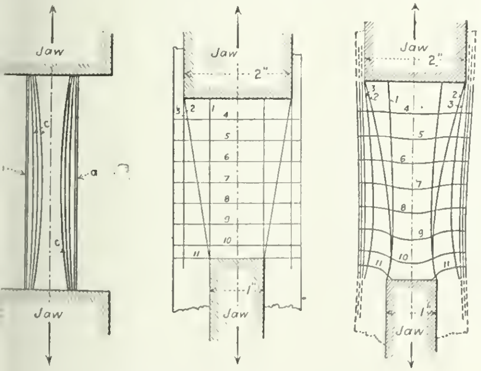


FIG. 2. RESULTS OF CLOTH TESTING

Left—Strip test specimen before breaking. Middle—Grab st specimen before testing. Right—Grab test specimen just fore breaking

If either test is a true measure of strength of the ma- rial, it should for varying width show proportionally ried strength. Tests bearing on this point yielded the rves reproduced in Fig. 2. These show that the strip test follows a straight-line law, while the grab test follows a curve.

Variations from the linear law, occurring in duck fabrics, were discussed by John Lind and E. D. Walen. Corrections must be introduced to allow for the number of unbroken threads in wide test pieces—the number being constant after a certain minimum width—and for the greater coöperation of the whole test piece in very narrow widths, when the pull is able to straighten out the thread.

Testing Refractory Firebrick

C. E. Nesbit and M. L. Bell submitted practical methods for testing refractory firebrick. They consider that, to be of greatest benefit, the tests should be such that they may be readily made on the finished brick, and their investigation, which is reported in the paper, was to develop tests that would imitate service conditions and give information from which the quality of the brick could be determined. The method for making the tests, written in the form of a specification, is appended to the paper. It is stated that the methods described are primarily intended for testing brick about an iron and steel plant, but it is believed that they can be easily modified to fit the requirements of brick in other industries.

Wear Tests on Concrete

Acting on the premise that wearing resistance is a function of hardness, toughness, brittleness, etc., Prof. D. A. Abrams, of Lewis Institute, Chicago, has been experimenting on the wear of concrete blocks placed around the perimeter of the Talbot-Jones rattler, in which fixed brick are subjected to battering action. Test blocks 8 in. square and 5 in. in thickness are arranged around the drum of the rattler and subjected to the abrasive action of a charge of 200 lb. of cast-iron spheres. About 200 blocks have been tested with helpful results. Professor Abrams considers that all things are favorable to this method of test and thinks that it may prove of considerable value in studying the relative merits of different aggregates, mixes, consistencies, time of mixing, surface treatment, etc., on the wearing resistance of concrete, particularly in relation to the construction of floors.

In discussion George P. Hemstreet (Hastings Paving Co.) said that a device similar to that described had been in use for ten years in the asphalt block industry and had yielded most excellent results.

Strength of Clamp Splices in Reinforcement

The strength of reinforcement-bar splices made with U-clamps was reported by E. L. Lasier. Mr. Lasier made a number of tests of three types of reinforcement splices—namely, lap splices not embedded in concrete, butt splices not embedded in concrete, and lap splices embedded in concrete, 1-in. square cold-twisted reinforcing rods being used. The lap splices consisted of two bars overlapping each other 17 in. and 21 in., with the ends clamped with U-clamps. The butt splices consisted of two rods butt-ended and overlapped with another bar extending 17 in. in one case and 21 in. in the other on both rods, clamped thereto with the regular U-clamp. It was found that the 4-in. difference in length of lap tested had apparently no effect on the strength of the splice, that the clamp lap splices when they were not embedded in the concrete sustained a slightly greater load before the first slip and a larger maximum load than the clamp butt splices: that the splices consisting of two bars of opposite twist probably sustain a greater load before first slip and a larger maximum load than do splices in which the bars have a like twist: that lap splices are stronger than butt splices; that the clamp lap splices embedded in concrete undoubtedly can safely withstand a unit load equal to the unit stress in steel reinforcement.

Emulsification Value of Lubricating Oil

P. H. Conradson described a simple test method for comparing oils as to their power to separate out from a water emulsion, or demulsify. A 250-c.c. graduated glass cylinder, about $1\frac{7}{16}$ in. in diameter, is charged with 20 c.c. of distilled water and 100 c.c. of oil. Then steam is passed through to churn it, for 10 min., and the cylinder is kept 1 hr. in a water bath at 130° F. At the end of this time the graduations permit reading off the volume of separated water, the volume of emulsion and the volume of separated oil (on top). The amount of water in the separated oil is also determined.

W. H. Herschel proposed a somewhat different method. He takes 20 c.c. of oil and 40 c.c. of water and, after heating them to 130° F., stirs them with a $3\frac{1}{2}\text{x}\frac{7}{8}\text{x}\frac{1}{32}$-in. metal paddle at 1,500 r.p.m. for 5 min. The mixture then stands at 130° F., and the rate of settling in cubic centimeters per hour is measured. The best transformer, dynamo and turbine oils settle out in a minute or less. The General Supply Committee of the Government specifies for turbine and spindle oils a demulsibility of at least 300 by Herschel's test, meaning that the entire 20 c.c. must separate out within 4 min.

Proposed Specification for Concrete Aggregate

Realizing that the current specifications for concrete aggregate are anything but satisfactory, Cloyd M. Chapman, of Westinghouse Church Kerr & Co., proposes a new form of specification which he thinks may satisfy the first requirement of an acceptable specification—namely, that it should insure the production of suitable concrete if the aggregates are properly used. But it does not, he thinks, satisfy the second requirement, which is that the specifications should permit the use of materials found in the vicinity of the work, if such materials are capable of producing concrete of the required quality. He suggests that instead of specifying that a concrete aggregate, particularly sand, be of a certain fixed minimum standard of quality, which may not be obtained in certain localities, the specification should be made to read in effect as follows:

> The material used shall be of such quality and shall be used in such proportion as to produce a concrete which shall show a compressing strength of 2,500 lb. per sq.in. (or 2,000 or 1,500, as the writer requires) at the age of 28 days when tested in accordance with the standard methods of testing.

Mr. Chapman shows how his firm has utilized this method of specification and has succeeded in getting a very good aggregate. The suggestion is in effect the same as has been made in a number of cases recently—that concrete materials should be tested on the results in the concrete mixture and not on their composition or behavior as separate parts of the mixture.

Finding Specific Gravity of Aggregates

Prevost Hubbard and F. H. Jackson, Jr., presented a paper entitled "The Specific Gravity of Fine Homogeneous Aggregates," which outlined an investigation to study methods in common use or those which gave promise of being most satisfactory for the determination of apparent and true specific gravity of mineral aggregates such as are used in roadwork, concrete work, etc. Seven different methods were described and descriptions of the tests given in detail. The authors make the following conclusions:

> In the case of rock and slag an appreciable variation may exist between apparent specific gravity and true specific gravity, depending upon the absorption of the material. It is impracticable by any of the methods studied to determine the apparent specific gravity of samples composed of fragments smaller than ½ in. in diameter. Methods employing single test specimens are not safe to use for determining the specific gravity of nonhomogeneous aggregates, even when the average results of three apparently representative samples are taken; fragments not less than ½ in. in diameter for methods employing 1,000-gram samples are satisfactory. With extremely nonhomogeneous aggregates it is recommended that the average of not less than three tests be taken.

Data for Exponential Fatigue Hypothesis

Moore and Seely have compiled a new table of values of constant B for the exponential hypothesis of fatigue, expressed by the formula

$$Stress = \frac{B}{\left(1 - \frac{min.}{max.}\right) N^{\frac{1}{8}}}$$

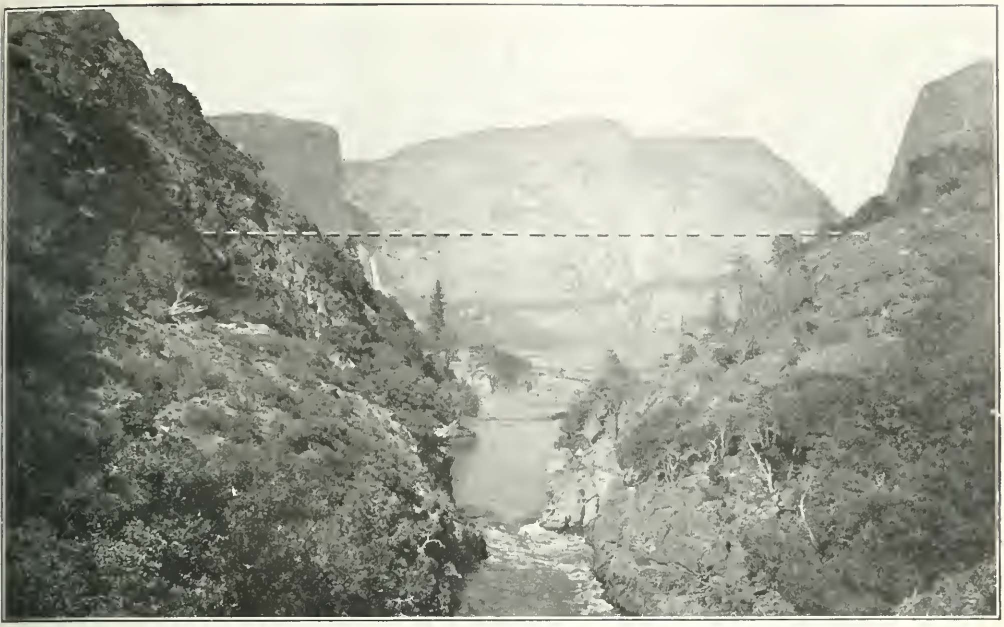
where N is number of repetitions of stress producing failure, and B is a constant. This table is based on test results covering only moderate numbers of repetitions. The whole hypothesis, however, is intended to replace the previously accepted view that there is a lower limit of stress at which infinite repetition will not produce failure. The present table of values, therefore, does not add weight to the hypothesis, but it is reproduced below.

The authors also gave two charts for solving the formula, but the formula is very simple to handle by logarithms. In cases where failure does not mean serious damage, the authors multiply the second term by the factor $(1 + 0.015N^{\frac{1}{8}})$, in which case

$$Log\ S = log\ B - log\left(1 - \frac{min.}{max.}\right) - \tfrac{1}{8}\ log\ N + log\ (1 + 0.015N^{\frac{1}{8}})$$

TENTATIVE TABLE FOR B, BY MOORE AND SEELY

Material	B	Log B
Structural steel and soft machinery steel...	250,000	5.39794
Wrought iron	250,000	5.39794
Steel, 0.45% carbon..................	350,000	5.54407
Cold-rolled steel shafting............	400,000	5.60206
Tempered spring steel................	400,000 to 800,000	5.60206 5.90309
Hard steel wire......................	600,000	5.77815
Gray cast iron.......................	100,000	5.00000
Cast aluminum	80,000	4.90309
Hard-drawn copper	140,000	5.14613



THE SITE OF THE HETCH HETCHY DAM AND RESERVOIR, SAN FRANCISCO WATER-SUPPLY
Line indicates crest of dam

Hetch-Hetchy Dam Site

The accompanying view is one of the best that it has been possible to make of the site of the new Hetch-Hetchy dam on the projected water-supply for the City of San Francisco, Calif. The dam will be about 300 ft. high, the crest coming about where the line is drawn across the gorge in the view. Work is now going on upon the railroad to the site, the diversion tunnel around the dam is about completed and the diversion dam will be finished this year so that construction of the main dam should be started next season.

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New Building Board Goes into Effect in New York

Under a new law a board of review of the building operations in all five boroughs of New York City has just been formed. This board, known as the Board of Standards and Appeals, is headed by Rudolph P. Miller, who has been connected with the building department of the Borough of Manhattan for many years. The other members are noted in the "Personals" column of this issue. Mr. Miller has made the following brief memorandum of the duties of the Board.

The new Board of Standards and Appeals is a sort of clearing house for the orders, decisions and interpretations, sometimes conflicting, of the different city departments that have jurisdiction over building construction and occupancy. The jurisdiction of the board covers the testing of materials; the approval of new materials and methods of construction; the making of rules and regulations, supplementing, where necessary, the existing provisions of law, not only with respect to building construction, but also with respect to fire prevention, means of exit, elevator installation, and plumbing and drainage; the hearing of petitions for variations of the provisions of the labor law, and the hearing of appeals from any order, requirement, decision or determination made by a superintendent of buildings or fire commissioner so far as they relate to the construction, alteration, equipment, occupancy or use of any building. An exception, however, is made in the case of tenement houses; no appeal can be had from any provision of the tenement house law and the tenement house commissioner remains supreme in the matter of interpreting that law. So far as the labor law is concerned the Board's jurisdiction starts at once; in respect to the other matters, it's jurisdiction is not effective until Oct. 1, 1916, when the present Board of Examiners will go out of existence.

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A Projected Railway in Salvador, which will make through rail travel possible from the United States to Granada, Nicaragua, is projected by the International Railways of Central America, of 17 Battery Place, New York City, a corporation affiliated with the United Fruit Co. As described in a paper by F. W. Blackford at the annual meeting of the Montana Society of Engineers, the company owns and operates in Guatemala and Salvador 521 mi. of single-track narrow-gage railways and has projected extensions of 323 mi. Work on these projected lines was partially suspended soon after the beginning of the war on account of the difficulty of financing. Only 84 mi. of the railways now in operation are in Salvador. This country has an area of 7,325 sq.mi., with a population averaging 232 per sq.mi., or as dense as that of the State of Connecticut. The country is extremely rugged and much of it is volcanic, so that the difficulties of railway construction are great. The maximum grade adopted on the surveys of the new lines are 2%, with a compensation of 0.04 per degree of curvature. The maximum curve was 16°. The country is subject to torrential rains. During the locating surveys on Oct. 26, 1913, 12 in. of rain fell between 4 a.m. and 4 p.m. The rain was general over Salvador and in places reached 14 in. in the 12 hr.

News of the Engineering World

Big Storage Reservoirs in North Carolina

Contracts have just been let by the Southern Power Co., of Charlotte, N. C., for three large earth dams near Bridgewater, N. C., the cost aggregating about $2,000,000. The successful bidders were Rinehart and Dennis, of Charlottesville, Va., and the Hardaway Contracting Co., of Columbus, Ga. The contract was awarded jointly.

All three dams will be of earth. The construction plans involve dumping off trestles within the slope lines and washing to the center with high-pressure streams of water. The slopes are to be 2 on 1 and the top widths 60 ft. The largest dam is to be on the Catawba River and is 2,800 ft. long by 135 ft. high. The second one will be on Paddy's Creek and is to be 1,500 ft. long by 155 ft. high. The third is to be on Linville River and 1,100 ft. long by 150 ft. high. There will be concrete spillways and tunnel linings. At Linville two 7,000-kw. generating units will use water released to reservoirs below. The work includes 4,500,000 cu.yd. of main excavation, 50,000 cu.yd. of concrete, 40,000 yd. of tunnel excavation and 100,000 yd. of rip-rap. Ten steam-shovel outfits will be employed and a large concreting plant.

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Two New Railway Chief Engineers

The portraits of the new chief engineers of two Eastern railways are shown herewith. The appointment of R. N. Begien as chief engineer of the Baltimore & Ohio R.R. was noted in *Engineering News*, July 6, p. 42, together with a brief biographical sketch. A. E. Owen's appointment as chief engineer of the Central R.R. of New Jersey was noted in the personal columns of last week.

RALPH NORMAN BEGIEN

Mr. Owen was born in Montclair, N. J., Jan. 19, 1876. He studied engineering at Rutger's College, New Brunswick, N. J., and began his experience in railway work as a draftsman in the office of the tax agent of the Central R.R. of New Jersey at New York City in 1898. The following year he was transferred to the office of the chief engineer. Subsequently he was assistant engineer of the railway at Mauch Chunk, Penn., and at Jersey City, N. J. In 1907 he was promoted to be principal assistant engineer.

ARTHUR E. OWEN

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Minnesota Steel Company's New Plant at Duluth

Ever since the development of the enormous iron-ore deposits lying to the north of Duluth, Minn., projects have been agitated to convert the ore into finished iron and steel at this location, instead of transporting the ore nearly a thousand miles by water and a hundred miles by rail to the furnaces of the Pittsburgh district. At present most of the big ore-carrying vessels have to make their return trips empty. By establishing furnace plants at the head of the Lakes, it would be possible to bring the coal to the ore as well as the ore to the coal, and effect this transportation at comparatively low cost.

The United States Steel Corporation, after the completion of its great plant at Gary, Ind., some years ago, ndertook the development of steel manufacture at uluth. A tract of 1,500 acres was purchased at the ead of Duluth harbor, about nine miles from the center Duluth but within its corporate limits. On this site ere has been completed within the present year a steel-anufacturing plant involving the investment of some 20,000,000. There are two 500-ton blast furnaces and n open-hearth steel furnaces of 75-tons capacity each. he rolling mills in connection with the plant are uipped to turn out steel rails, structural shapes, or erchant bars. The ingots produced are 22x26x77 in., d are handled in a 40-in. reversing blooming mill, e exhaust steam from which is utilized by a low-essure steam-turbine electric-generator unit. The gas om the furnaces is utilized in four twin-tandem gas-gine generator sets of 3,000-kw. capacity and five ngle-tandem gas-blowing engines of 24,000-cu.ft. capac-y each. The coal brought by the Lake steamers is nverted into coke in 90 Koppers byproduct coke ens, so that the plant has the gas from these ovens ailable for use as well as the gas from the blast rnaces. The buildings of the plant are of steel frame nstruction with walls made up of two-piece concrete ocks.

Slag from the blast furnaces is delivered to four slag-anulating pits, and is then utilized for the manufacture portland cement in a 4,000-bbl. cement-making plant vned by the Universal Cement Co. Nearly 2,500 em-oyees will be required for the complete operation of e steel plant and cement plant, and the steel plant can oduce 350,000 tons of steel per annum.

⁂

ngineering Students Number Over Thirty Thousand

The appended tabulated figures on students in the en-neering schools of the United States were presented the recent annual meeting of the Society for the Pro-otion of Engineering Education, through the coöperation the United States Bureau of Education and the ciety's Committee on Statistics. A variety of interest-g comparisons are possible, such as the great increase chemical engineers, the decrease in civil and mining, d the slump and recovery in number of mechanical engi-ers.

STUDENTS IN THE UNITED STATES

Engineering Branch	1906	1911	1915
eneral	2,501	5,591	6,059
nemical	1,234	1,452	2,383
vil	7,962	8,934	7,182
lectrical	5,696	6,128	6,637
echanical	7,426	7,052	7,751
ining	2,826	2,337	1,922
ther	82	....	958
Total	27,727	31,499	32,843

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Straightening Root River for Land Reclamation

A contract for straightening Root River, Houston ounty, Minnesota, so as to substitute 20.7 mi. of river hannel for 31.3 mi. and reclaim 11,765 acres of land bject to overflow three years out of five on the average, as just been awarded on bids received June 3, 1916, to . H. & G. A. McWilliams, of Chicago, at 6.69c. per u.yd. of excavation. The work includes 1,825,151 cu.yd. f excavation, clearing 50 acres of right-of-way, and re-oving and replacing two highway bridges, to be done by Dec. 31, 1918. Contracts for a new railroad bridge and a second highway bridge were not let.

The new channel begins 3 mi. west of Houston and joins the old channel 2 mi. west of the junction of the Root with the Mississippi, about 3 mi. below La Crosse. The bottom of the new channel will be 50 ft. at its upper end, increasing to 72 ft. at a point 3½ mi. above its lower end. The side slopes will be 1 to 1. The fall in its 20.7 mi. of length will be 55 ft. At flood stage the computed velocity is 6 ft. per sec. and the discharge 7,000 sec.-ft. The land reclaimed has an estimated value of $150 an acre. The court has assessed a benefit of $11.50 an acre on the land. The report on the ditch, known as Judicial Ditch No. 1, Houston County, was made by George A. Ralph, Chief Engineer.

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Supervising Architect's Office May Be Superseded

The House of Representatives has just reported the Public Buildings Bill, with a radical provision which changes the present system of conducting federal building work and abolishes, as such, the office of the Supervising Architect. In its stead the bill creates a Bureau of Public Buildings, headed by a Commissioner of Public Buildings to be appointed by the President and to hold office for four years.

The Bureau of Public Buildings will have complete jurisdiction over and control of the selection of sites, drafting of plans and specifications, supervision of construction and care and maintenance of all public buildings. It is provided that as far as possible the officers and employees of the office of the Supervising Architect are to be transferred to the new Bureau. The bill provides for the standardization of buildings in the smaller places and makes such restrictions as to the purchase of sites and construction of buildings as will result in saving of 25 to 50% over previous authorizations.

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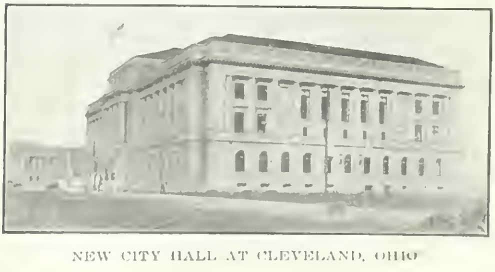
Cleveland's New City Hall and Civic Center

The new City Hall of Cleveland, Ohio, was dedicated with appropriate ceremonies on July 4. The site for the building was selected by a commission in 1898, and this commission worked out at the same time a plan for grouping the principal public buildings of the city. The architect of the City Hall was J. Milton Dyer. The building covers an area 230x380 ft., is five stories high with a basement and sub-basement, and cost about $3,000,000. The structure is of steel framework and reinforced concrete. The exterior walls are of Vermont gray granite,



NEW CITY HALL AT CLEVELAND, OHIO

and Italian marble is profusely used for the interior finish. The architecture of the building was planned to harmonize with the Federal Building, which was the first of the group plan to be erected. The second building of the group completed was the County Court House, which is seen in the background in the accompanying view of the new City Hall. These buildings are located at the top of a bluff overlooking Lake Erie.

The other three buildings which will complete the group plan are a $2,000,000 public library building, which is to be built on a site just across the street from the Federal Building, a Union Station and a Convention Hall. An agreement between the railroad and the city for the new Union Railway Station was ratified by popular vote last November. Work on the construction of the building awaits action by Congress, authorizing the sale of the Marine Hospital grounds, which are part of the site. The bill has passed the Senate and is now before the House. Bonds were voted for the Convention Hall last April. The total cost of these six public buildings will be about $30,000,000.

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Floods Make Havoc in the South

Heavy floods in North and South Carolina, Virginia, Tennessee and West Virginia, on July 15 and 16, caused property damage of some $15,000,000 and the loss of upward of 15 lives. Railroad and telegraph communication has been seriously interrupted and details of engineering work affected are not obtainable.

A small dam and power station of the Dravo Power Co. on the Broad River near Gaffney, S. C., was washed out. An earth fill at the Lookout dam near Statesville, N. C., broke and destroyed an old mill in which cotton was stored. Dams of the Southern Power Co., at Lake Toxaway and Hendersonville were reported out, but this has been denied by the company. The hydro-electric power stations of this company at Lookout Shoals, Catawba, Ninety-Nine Islands, and the steam station at Mt. Holly were partly submerged.

Many railroad and highway bridges were lost, including one under construction by the Southern Ry. over the Catawba River at Belmont, N. C.; there were 14 men at work of whom four were reported rescued. The greatest loss reported in any one place was at Asheville, N. C., where 25 cotton and lumber mills, machine shops, coal yards, etc., and 60 dwellings were washed away. About 1,200 persons were thrown out of work and 400 made homeless.

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Don Juan Whittemore

Don Juan Whittemore, oldest past-president of the American Society of Civil Engineers and an honorary member of the Society since 1911, died July 16, at his home in Milwaukee, Wis. He was 86 years old, but he had retired from active work, as chief engineer of the Chicago, Milwaukee & St. Paul Ry., only six years ago.

In years of service in railway engineering he had had perhaps no equal. He was born at Milton, Vt., in 1830, and entered the engineer corps of the Vermont & Canada R.R. when but 17 years of age. Within two years he was assistant to the chief engineer of the road and in charge of a construction division.

DON JUAN WHITTEMORE

On the completion of the Vermont & Canada R.R. young Mr. Whittemore was appointed Assistant Engineer in charge of a division of the Great Western Ry. of Canada, where he remained until 1852. He then served as engineer for the contractor in the building of the Central Ohio R.R. from Zanesville to Wheeling, W. Va. For the four years following 1853 he was assistant to the chief engineer of the La Crosse & Milwaukee R.R.; then chief engineer of the Southern Minnesota R.R.

During the winter of 1860-61 he was in Cuba as chief assistant engineer of the Ferrocarril Del Oeste. In the spring of 1861 he returned to Wisconsin to become chief assistant engineer of the La Crosse & Milwaukee R.R., the nucleus of the Chicago, Milwaukee & St. Paul Ry., of which Mr. Whittemore was made the first chief engineer in 1863, and of which he remained chief engineer for 47 years. Upon his retirement as chief engineer in December, 1910, the honorary position of consulting engineer of the railway was created for him.

During his long career as a railway chief engineer Mr. Whittemore received many honors. He was elected president of the American Society of Civil Engineers in 1884. The following year he was made a member of the Institution of Civil Engineers of Great Britain. He received the honorary degrees of Doctor of Laws and Doctor of Philosophy from the University of Wisconsin and the degree of Civil Engineer from the University of Vermont. He was also an honorary member of the Western Society of Engineers.

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Plans for an Activated-Sludge plant to treat the sewage of Matawan, N. J., drawn by Geo. A. Johnson, Consulting Engineer, New York City, has been approved by the State Department of Health.

A Collapse of Subway Timbering occurred on Nostrand Ave., Brooklyn, on July 13. Following a heavy rain, a large sewer broke, the water washing out sufficient supports to cause the collapse of 200 ft. of roadway, including the surface tracks of the Brooklyn Rapid Transit Co. An approaching trolley car disregarded a warning and fell into the hole, six persons being injured.

Notable Philippine Railway Completed—The railway from anila to Hondagua, across the Island of Luzon from west to ast has been completed and thrown open to traffic. This provides rail connection between Manila, which is on the west oast, on the China Sea, with the Pacific coast ports on Lopez ay, where direct service may be established with American orts, shortening the route to Manila by several days. The ailway is through primeval tropical forests and has been ur years building.

A Large Amount of Paving in Cleveland, Ohio, is pro-cted but must await popular authorization at an election alled for Aug. 8. The general scheme adopted by the City ouncil calls for a bond issue of $3,500,000 for the extension f 107 streets. Other paving propositions in hand would ring the total bond issue up to $6,500,000. Since for every ollar provided by the city nearly as much is forthcoming om property owners, about $11,500,000 will be expended in treet extensions and repaving in Cleveland, if the two hemes go through.

A Public Buildings Commission to investigate as to what ublic buildings are needed in the District of Columbia to rovide accommodations for all the Federal offices there, with e proper location of such buildings, and their probable cost, provided for in the Sundry Civil Appropriation Bill approved uly 1. The Commission is to be composed of members elected from the committees on Appropriations and on Public uildings of the House and the Senate, together with the uperintendent of the Capitol Building, the officer in charge of ublic buildings and grounds and the Supervising Architect. he report of the Commission is to be made not later than an. 1, 1918.

Openings for Highway Engineers are made by the passage f the Federal Aid Road Act, noted in last week's issue. The ffice of Public Roads and Rural Engineering under Logan aller Page is already seeking experienced highway engineers. An examination is announced, Aug. 8, for Senior High-ay Engineers, at salaries from $2,200 to $4,000 per annum. he competitors will not be assembled for a written exam-ation but will be rated on training and experience. Appli-nts must be at least 30 years old and have had eight years esponsible engineering experience" not less than five of hich must have been in "responsible highway engineering." pplications should be addressed to the Civil Service Commis-on at Washington.

St. Louis Garbage Collectors' Strike Ended—There were no arbage collections in the city of St. Louis from June 30 to uly 6. The white teamsters employed by the street-cleaning nd some other city departments struck for an increase in ay of from $50 to $65 per month. The negro teamsters, who ere practically all on garbage collection, did not strike, but ey were intimidated and refused to take out the teams. The rike was finally settled by an agreement of the Board of stimate (which is composed of the Mayor, President of the oard of Aldermen and the Comptroller) to increase the salaries as demanded. The Comptroller voted against the in-rease on the ground that it is the entering wedge for a id by union laborers on the city treasury.

Bayonne, N. J., Five Days Without Water-Supply—Owing a break in the water-supply main near where it passed nder the tracks of the Delaware, Lackawanna & Western .R. in the Hackensack meadows, the City of Bayonne, hav-g a population of about 68,000, was practically without ater for five days. The water-supply of the city is fur-shed by the New York & New Jersey Water Co., which in rn purchases the water from the Passaic Water Co. The reak is said to have been caused by the vibration of passing ains, and owing to the swamp land through which the pipe laid, there was much delay in getting at the break. Several umps of large capacity were required to unwater the hole. A artial supply of water was obtained by a connection with rsey City mains.

A Section of the Groined Arch concrete roof of the clear-ater basin of the new West Side water filters at Cleveland, hio, collapsed on the night of July 9. No one was hurt. The oof was carried on 20-in. square columns spaced on 15 ft. in squares and reinforced with four ¾-in. vertical round ods, bound with ¼-in. wire every 24 in. The groined arches ere 6 in. thick at crown, about 12 in. thick at spring and einforced with ¼-in. square rods. The columns averaged [illegible] in height. At the time of the collapse none of the ravel or earth fill had been placed on the roof. The failure complete over an area about 30 ft. square and involves four olumns. An official investigation is now under way.

The National Septic Process Protective League, an organization of municipalities and others to coöperate in defending suits for infringements of the Cameron septic tank patents, announces in a circular dated July 6 that over seventy municipalities have already joined the League. H. M. Bracken, of the Minnesota State Board of Health, is President; A. Elliott Kimberly, Consulting Engineer of Columbus, Ohio, is Vice-President, and Frank G. Pierce, Secretary of the League of Iowa Municipalities, Marshalltown, Iowa, is Secretary-Treasurer. The organization of the League was noted in "Engineering News" of Mar. 23, 1916, p. 578. The circular states that "if the present claims of the Cameron Septic Tank Co. are established in court, every sewage-disposal plant in the country that has not settled with this company will be liable for a royalty. On the contrary, if the court of last resort once holds against the company, every municipality is thereby freed from payment of royalty." The League invites the coöperation of other engineers and municipalities not already members.

The Moffatt Tunnel, projected through the transcontinental divide, on the line of the Denver & Salt Lake City R.R., may be financed by a combination of Eastern and Denver capital. Denver newspapers state that a syndicate of Boston and New York banking houses has agreed to subscribe $3,000,000 provided an additional $3,000,000 is raised in Denver. Of the latter amount, $1,000,000 has been subscribed by a syndicate of Denver capitalists and an association of Denver banks and trust companies has agreed to take a second million, leaving one million to be subscribed by small investors. The Denver & Salt Lake Ry., originally the Denver, Northwestern & Pacific Ry., was projected and built by the late D. H. Moffatt, and is planned eventually to reach Salt Lake City. As originally built, the railway crosses the divide at an elevation of about 11,700 ft., and the steep grades and curvature on the summit division of the road add greatly to its operating expenses, while the winter operating conditions are very severe. By driving a tunnel about 3½ mi. long through the ridge the summit elevation would be lowered about 1,700 ft. Numerous attempts have been made in the past ten years to finance the tunnel project through the aid of the State of Colorado or the City of Denver, but they have all been defeated.

The Water-Works of Chattanooga, Tenn., owned by the City Water Co., have been valued by a board of three appraisers appointed under an agreement between the company and the city. The board consisted of J. N. Hazlehurst, of Atlanta, William Wheeler, of Boston, and John W. Alvord, of Chicago. The members of the board disagreed as to the method of computing depreciation on the plant. After agreeing substantially on the cost of reproduction, Messrs. Wheeler and Alvord, adopting the sinking-fund method of estimating depreciation, arrived at a total of $398,675 as the amount to be deducted. Mr. Hazlehurst, in a minority report, used the straight-line method of depreciation, and obtained a figure of $743,159. The final estimate of Mr. Hazlehurst for the total value of the property is $2,000,000. In justification of the fairness of this estimate, Mr. Hazlehurst shows that the city, in case it decided not to purchase the company's plant, could build an entirely new plant by the investment of $2,000,000, which could be operated at an estimated cost of $77 per 1,000,000 gal. furnished, which compares with $104 operating cost by the present plant. Mr. Hazlehurst further shows that the actual money invested by the company in the plant after deducting its profits through the sale of lands is $1,544,000. The water rates it has collected have paid its operating charges, taxes and interest on the investment, so that if the city paid the company $2,000,000 it would be allowing a profit of $456,000 on the company's investment over and above what it has received in interest.

A Bridge Across San Francisco Bay between Oakland and San Francisco is projected by the "Associated Bridge Engineers," made up of Wilbur J. Watson & Co., of Cleveland; William Russell Davis, of Albany, N. Y., and Harlan D. Miller, of Albany, N. Y., and Oakland, Calif. The bridge would cross the bay at its narrowest part and its terminal in San Francisco would be south of nearly all of the main docks for seagoing steamers, so that ocean traffic would not be much interfered with. The bridge as designed would carry four railway tracks, two for through railway trains and two for interurban trains, and three roadways, one for automobile traffic and two on brackets outside the trusses for slow-moving traffic. The total width of the bay at the crossing is about three miles, and with its approaches the bridge would be about five miles in length. The designs are based upon a structure made up chiefly of 250-ft. steel truss spans supported on concrete cylinder piers with pile foundations. Over the deep-water channel in the bay there would be a 600-ft. span 100 ft. above the water and in addition a lift span which could be raised to give 210 ft. vertical clearance to high-masted vessels. Similar spans would be located where the bridge crosses the Oakland estuary, the channel by which vessels reach the piers at Oakland. A public hearing on the plans for the bridge is to be held in San Francisco Aug. 15 and at Oakland on Aug. 7, before a Board of United States Army Engineers, consisting of Col. Thomas H. Rees, Col. Charles L. Potter and Maj. George B. Pillsbury.

The Sundry Civil Appropriation Bill which became law on July 1 provides $7,267,000 for the continuation of work on public buildings previously authorized. The only large items in this are for the Post Office and Court House at Portland, Ore., $425,000, and for the new Interior Department Building in Washington, $756,000. The Public Health Service receives $2,058,000, and in addition special appropriations of $400,000 for the prevention of epidemics, $250,000 "for field investigations of the diseases of man and conditions influencing the spread thereof, including the sanitation and sewage and pollution of navigable streams and lakes of the United States"; and $25,000 for special studies of rural sanitation. The Interstate Commerce Commission, in addition to its regular appropropriation, receives $225,000 to enable it to keep informed regarding safety conditions on railways and to investigate and test block signals, train control and other safety appliances. To carry on the work of railway valuation, $3,500,000 was appropriated. The War Department receives $4,683,000 for improvements and other work at arsenals and munition factories. In this is included $500,000 for a new Government powder plant, $500,000 for increasing the capacity of the Rock Island arsenal, and $800,000 for the Watervliet arsenal. The Engineer Department receives $700,000 for continuing the work on the Lincoln Memorial and the rebuilding of the Aqueduct Bridge across the Potomac River in Washington is authorized, the contract price not to exceed $900,000. For the Interior Department, $700,000 is appropriated for public land surveys, with the compensation of surveyors limited to $200 per month, except in Alaska, where the limit is $10 per day and not to exceed $3 per day for subsistence. The U. S. Geological Survey receives $1,255,000, the Bureau of Mines $955,000, and the Reclamation Service $8,884,000. The Alaska Engineering Commission, for its work in building the Government railway in Alaska, receives $6,250,000. The Coast and Geodetic Survey receives $425,000 for field expenses, $330,000 for its marine equipment, $275,000 for office expenses. For the operation and maintenance of the Panama Canal, $15,800,000 is appropriated; and in addition, $4,535,000 for fortifications, barracks, etc.

PERSONALS

F. H. Chamberlain has resigned as General Manager of the Alabama Power Co., Birmingham, Ala.

S. A. Arnold and **B. A. Tripp** have opened offices in Cleveland, Ohio, under the firm name of Arnold & Tripp, for the practice of landscape architecture.

Henry L. Bowlby, former State Highway Engineer of Oregon, is now Executive Officer of the Pacific Highway Association with headquarters at Portland, Ore.

F. A. Burr has resigned as General Sales Manager of the Tennessee Coal, Iron and Railroad Co. to accept a similar position with the Etna Explosives Co., New York City.

Allen Loomis, of the engineering staff of the Packard Motor Car Co., Detroit, Mich., has resigned to engage in private practice as a consulting engineer, with offices in Cleveland, Ohio.

H. B. McMaster, General Manager of Branches of the Berger Manufacturing Co., Canton, Ohio, has resigned to become Vice-President and General Manager of the Gordon Tire and Rubber Co., Canton.

E. J. Burdick has been appointed Assistant General Manager of the Detroit United Ry. He has been with the Detroit street railway since 1895, and is a past-president of the Detroit Engineering Society.

A. N. Talbot, M. Am. Soc. C. E., Professor of Municipal and Sanitary Engineering at the University of Illinois, has been awarded an honorary degree of Doctor of Engineering by the University of Michigan.

Edward I. Clawiter, Assoc. M. Am. Soc. C. E., has resigned as Engineer in charge of the southern division of Miller & Lux, Inc., to become Engineer of the San Francisco Bridge Co., San Francisco, Calif.

Willis Whited, M. Am. Soc. C. E., Bridge Engineer of the Pennsylvania State Highway Department, received the honorary degree of Doctor of Engineering at Iowa State College at the recent commencement.

Rodman Wiley, Assoc. M. Am. Soc. C. E., Bridge Engineer of the Kentucky State Highway Department, has been appointed Road Commissioner to succeed Robert C. Terrell. The salary of the office is $3,000 per annum.

R. L. Heeren, formerly a civil engineer, Bridge and Construction Department of the Pennsylvania Steel Co., Steelton, Penn., has joined the engineering and sales department of the Bethlehem Steel Co., South Bethlehem, Penn.

J. F. Putnam, Assoc. Am. Inst. E. E., has been appointed Assistant Professor of Electrical Engineering at Sibley College, Cornell University. He was formerly Professor of Physics at St. Johns College, Shanghai, China.

Richard M. Kreutz, formerly a civil engineer, Bridge and Construction Department of the Pennsylvania Steel Co., Steelton, Penn., is now with the sales and engineering department, Bethlehem Steel Co., South Bethlehem, Penn.

Robert Farnham, M. Am. Soc. C. E., recently Assistant to the Engineer of Bridges and Buildings of the Pennsylvania R.R., has been appointed Assistant Engineer of Bridges and Buildings, and his former position has been abolished.

W. J. Collier, of Harrisburg, Penn., has been appointed Plant Engineer of the Steelton plant of the Bethlehem Steel Co., formerly the Pennsylvania Steel Co. He is a graduate in civil engineering of Lehigh University, class of 1895.

William G. Arn, Assoc. M. Am. Soc. C. E., recently Roadmaster of the Illinois Central R.R. at Mattoon, Ill., has been promoted to be Assistant Engineer of Maintenance-of-Way, with office at Chicago, Ill., succeeding Milton B. Morgan, transferred.

A. W. Thompson, M. Am. Soc. C. E., has been appointed Vice-President in charge of traffic and commercial development of the Baltimore & Ohio R.R. system. He is a former Chief Engineer of the railway, and since 1912 has been Vice-President in charge of operation.

C. F. Hinchman, Assistant Engineer of Maintenance-of-Way of the Cleveland, Cincinnati, Chicago & St. Louis R.R. at Mount Carmel, Ill., has been promoted to be Engineer of Maintenance-of-Way, Indianapolis terminal division, Indianapolis, Ind.

J. G. Bloom, M. Am. Soc. C. E., recently Division Engineer of the Chicago, Rock Island & Pacific Ry. at Little Rock, Ark., formerly with the valuation department of the railway at Chicago, has been promoted to be Division Superintendent of the Amarillo division, with headquarters at Amarillo, Tex.

W. Kemp Walker, Assoc. M. Am. Soc. C. E., has resigned his position of Assistant Field Engineer, Roadway Department, Division of Valuation, Interstate Commerce Commission, with headquarters at Kansas City, Mo., to become Engineer in charge of special track work of the Wabash R.R., with offices at Peru, Ind.

J. H. Myers, Assoc. M. Am. Soc. C. E., recently with the Bridge and Construction Department of the Pennsylvania Steel Co., Steelton, Penn., has been promoted to be Assistant Superintendent of the plant, which is now a part of the Bethlehem Steel Co. Mr. Myers is a graduate of Lehigh University in civil engineering, class of 1896.

Henry G. Stott, M. Am. Soc. M. E., Superintendent of Motiv Power of the Interborough Rapid Transit Co., of New York City, was obliged to undergo a very serious operation on Friday, July 7, in connection with a trouble of long standing Mr. Stott has improved since the operation, and his present condition promises a speedy recovery.

A. D. Ludlow, a sewer contractor of Kansas City, Mo., has been appointed Engineer of Sewers, Department of Engineering of Kansas City. He is a former Assistant Engineer of the city engineering department and was Assistant Engineer of the Kansas City Terminal Ry. during the construction of the Kansas City Union Station.

John J. Bernet, Vice-President of the New York Central Lines, Chicago, Ill., has been elected President of the reorganized New York, Chicago & St. Louis R.R. (Nickel Plate), which was recently sold by the New York Central Lines to Cleveland, Ohio, capitalists. Mr. Bernet is 48 years old; he entered the railway service in 1889 as a telegraph operator on the Lake Shore & Michigan Southern Ry.

R. L. Daugherty, for the past six years Assistant Professor of Hydraulics at Sibley College, Cornell University, has been appointed Professor of Hydraulic Engineering at Rensselaer Polytechnic Institute, Troy, N. Y. He succeeds Prof. Lewis F. Moody, who has resigned to engage in private practic Professor Daugherty graduated from Leland Stanford University in 1909. He is the author of three textbooks, "Hydraulic Turbines," "Centrifugal Pumps" and "Hydraulics."

Frank G. White, Assoc. M. Am. Soc. C. E., Chief Assistant Engineer of the California State Board of Harbor Commissioners, has been appointed Chief Engineer of the Board to succeed Jerome Newman, M. Am. Soc. C. E., resigned, as noted in these columns July 6. Mr. White is a graduate of te University of Iowa, and for the past six years has been ief Assistant Engineer of the Harbor Commission. Before tat he was with the City Engineer's department of San lancisco, being employed on the design of several of the ge sewers.

H. H. Rousseau, Assoc. M. Am. Soc. C. E., Civil Engineer S. N., who has been a member of the Isthmian Canal Comssion since 1907, has been ordered home and placed on waiti orders. Mr. Rousseau was made Chief of the Bureau of rds and Docks in January, 1907, and three months later rened to accept the Panama appointment. Since that time he s been resident on the Isthmus and for the most part in irge of building and terminal construction. Under an Act Congress, Mar. 4, 1915, he was advanced to the grade of il Engineer in the Navy, with the rank of Rear-Admiral the lower nine.

Robert C. Terrell has been removed as State Road Commisner of Kentucky. The following extract from an editorial the Paducah "Evening Sun" of June 30 is of interest as a al view of the situation:

> In view of the fact that Terrell has always rendered satistion it will doubtless strike the people of the state as uliar that he was not retained in his position. The only sible anwer is that the governor does not see in Terrell combination of a good servant and an able politician. The road commissioner has never been much of a factor in itics. He has committed the unpardonable sin of attending the business of his department, and unwisely refrained from ting out and participating in the election of state officials, ich is almost as bad in Frankfort's official eye as working the other side.

Radolph P. Miller, M. Am. Soc. C. E., former Superintendof the Bureau of Buildings, Borough of Manhattan, New k City, has been appointed Chairman of the newly created rd of Standards and Appeals, which will have jurisdiction r all building operations in all the five boroughs of the , instead of the control being separate for each borough. new Board has but two salaried members, the Chairman Daniel Sullivan, Secretary. Mr. Miller's salary is $7,500 annum and the Secretary's $3,600. Other members of the rd are L. C. Holden, Architect; William Crawford, Build-Contractor; Howard C. Baird, M. Am. Soc. C. E., of the firm Boller, Hodge & Baird, Consulting Engineers; A. R. Kirkus, eal estate expert, and A. J. Boulton, a Brooklyn labor repentative, who receive $10 a day whenever the Board cones.

William Wallace Ewing, M. Am. Soc. C. E., has been apnted Special Agent of the Bureau of Foreign and Domestic nmerce of the United States Department of Commerce. His rk will be to investigate construction materials and manery in South America. Civil-service examinations for the ition were held in 25 cities and 19 men took the examina-. About two-thirds of these passed the examination and turn were requested to present themselves in Washington an oral examination before the appointment committee. Ewing was successful in both examinations and will rtly commence his duties at the Bureau in Washington. er an extended trip in the United States in conference with exporters, receiving their specifications and other infortion for presentation in the foreign field, a tour of South erica will be made visiting all of the principal centers, ere engineering and construction materials and equipment used. Progress reports will be made during this period. return to the United States it is planned to revisit the orters, advising and conferring with them regarding the t methods to be used in developing the sale of their eral manufactures.

OBITUARY

Richard H. McCary, President of the R. H. McCary Co., genl contractors, Los Angeles, Calif., died June 26.

James L. Brass, Assistant General Manager of the Union fic R.R. system died June 30, at Seattle, Wash. His ly experience was with the auditing department of the intenance-of-way division of the Oregon-Washington Raild and Navigation Co.

Daniel Edmund Garrison, a retired steel manufacturer of Louis, Mo., died July 4. As President and General Manr of the Vulcan Steel Co., he is said to have rolled the t steel rails in the country west of the Mississippi River was 77 years old and retired from active business in 1890.

James Frank Morrison, a pioneer electrical engineer, first esident of the National Electric Light Association, died July at his home in Baltimore, Md. He was born at St. John, B., in 1841. He was a telegraph operator with the Baltimore & Ohio R.R. during the Civil War period. Subsequently he was with the Western Union Telegraph Co. at Baltimore. In 1870 he was made Superintendent of the fire-alarm and police telegraph systems of Baltimore, completely reorganizing them. In 1878 he constructed for the Chesapeake & Ohio Canal Co., what is claimed to be the first long-distance telephone line—210 mi. from Georgetown, V. C., to Cumberland, Md. He was also a pioneer in the electric-lighting industry.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

THE ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The American Association of Engineers has sent out the first annual report of the national treasurer. The total enrollment is 791. The receipts to May 1 were $4,522.34, the disbursements being $4,044.16. The office of the secretary is at 29 So. La Salle St., Chicago. A branch of the association has been formed in Peoria, Ill.

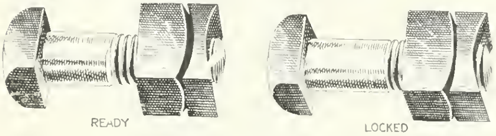
The Association of Railway Telegraph Superintendents has elected the following officers for 1916-1917: President, M. H. Clapp, St. Paul, Minn.; vice-presidents, J. F. Caskey and F. T Wilbur; secretary and treasurer, W. L. Connelly, Gibson, Ind.

The State Association of Planning Commissions of Pennsylvania, a permanent organization of Pennsylvania city-planning commissioners, was formed at a meeting at the Capitol, Harrisburg, on July 11. The following officers were elected: President, A. B. Farquhar, York; vice-president, E. S. Herman, Harrisburg; secretary, J. Herman Knisely, chief of the division of Municipal Statistics, Department of Labor and Industry, the Capitol, Harrisburg, and treasurer, John K Stauffer, Reading. An executive committee, consisting of one member from the planning commission of each of the third-class cities will be appointed by the planning commissions of the various cities. Plans for beautifying cities and problems confronting planning commissions were discussed at the meeting and will be further taken up by the new organization

Appliances and Materials

New Locknut for Bolts

A new locknut has been devised by the Boss Nut Co., of Chicago. The device is shown in the accompanying sketches. The faces of the nut are concave. In applying, the locknut is run up to the holding nut with the fingers; then a wrench is used until the curved surface next to the holding nut is drawn downward and flattened out. Usually a half-turn is sufficient for this. In this position the threads of a locknut are caused to register deeply and firmly into the valley of the bolt thread, and the impinging edges seize the primary nut so tightly as to prevent all three members from rotating in relation to each other. The locknut can be removed only with a wrench.



"BOSS" LOCK NUT

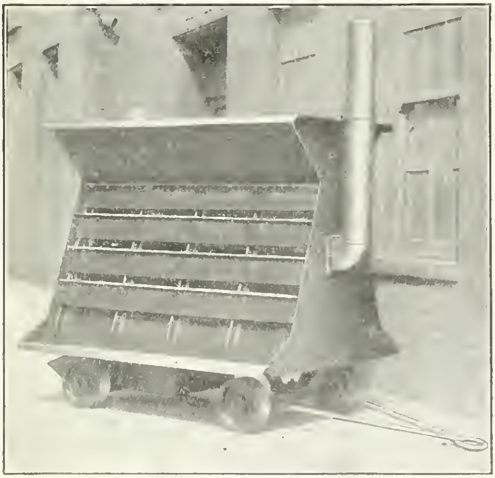
* * *

Gravel Heater and Dryer

A portable device for heating and drying gravel, or grits, particularly for bituminous fillers in block paving work, has been put on the market by Littleford Bros., 453 East Pearl St., Cincinnati, Ohio. The device is the invention of a New York City paving contractor named Mullen, and is known as the Mullen gravel dryer.

The furnace is made of an A-shaped sheet of perforated steel with plain sheet-steel ends, one of which is provided with a fire-door and the other with a smokestack. Outside of the perforated furnace plates are similarly perforated plates or flights, as shown in the accompanying view. These are 3 in. distant from the furnace plates at the bottom and 5 in. at the top.

On top of the A-shaped furnace is a V-shaped hopper with openings into the spaces between the furnace plate and the outside flights, so that the gravel flows down over the furnace plates in a steady stream, so long as the hopper is kept filled.


MULLEN GRAVEL HEATER AND DRYER

One man operates the machine, which it is claimed has a capacity of 4 tons of gravel per hour or 40 tons per 8-hour day. The temperature of the heating can be regulated by the time the gravel is permitted to remain against the furnace plates. The gravel is removed from the bottom of the machine by shoveling.

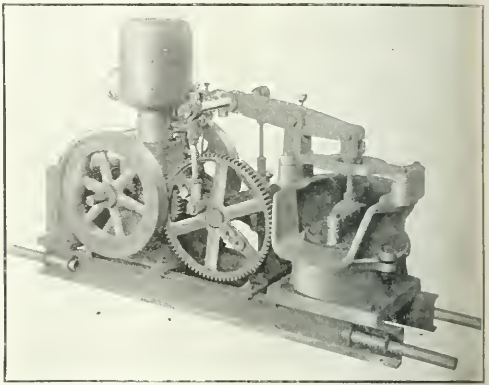
Sewage Filter of Vitrified Pipe

A filter for use with the septic tanks of vitrified pipe described in "Engineering News" March 2 and April 27, consists of a 24x30-in. pipe set vertically and fitted with top and bottom. This is partly filled with sand and gravel (or charcoal). The effluent pipe from the septic tank is turned down and buried in this, so that the liquid rises through the filtering medium to reach the outlet on the opposite side of the filter. The filter is not applied when the tank effluent is discharged into sub-irrigation or drainage tile systems. Both the tank and the filter are made by the W. S. Dickey Clay Mfg. Co., of Kansas City, Mo.

* * *

Power-Driven Diaphragm Pump

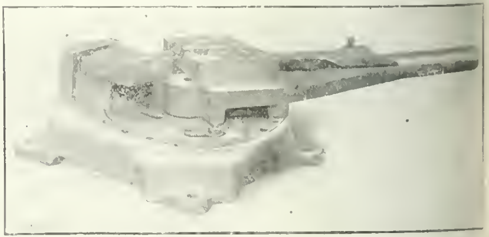
A recent design of portable power-operated diaphragm pump, built by the Barnes Manufacturing Co., of Mansfield, Ohio, is shown herewith. The pump, gears and gasoline engine are mounted on a steel frame, and U-bolts on the sills provide for pipe handles by which the outfit can be moved The engine shaft is connected through gears to a spur wheel carrying a vertical rod attached to a crossbar on the pump beam. A similar rod at the other end of this bar is connected to a crank arm on the spur-wheel shaft. The pump has a 3-in. suction hose and can handle sand, gravel and mud. It makes 65 strokes per minute and has a capacity of 4,000 ga per hr. The engine is of 1½ hp. The complete outfit weighs 500 lb.


DIAPHRAGM PUMP WITH GASOLINE ENGINE

* * *

Bar-Bending Machine

The machine shown herewith is for bending the steel rods and bars used as concrete reinforcement. It is used also f flat bars, etc., and in shop work where it is not desirable to use a press or bulldozer. Besides making ordinary bends it is fitted with special dies for angle, loop, hook and U-bends, and for edgewise bending of flat bars over 2 in. wide. The smallest size, handling cold bars not larger than ½ in., has round, deep base that can be set in a socket in top of a post In the larger sizes a broad, flat base with anchor bolts is used as shown. The largest size will bend hot and cold flats 1x5 in and ½x4 in.; and hot and cold bars 2 in. and 1¼ in. respectively. These machines are built by D. A. Hinman & Co., of Sandwich, Ill.


HINMAN BAR-BENDING MACHINE

Engineering News

OLUME 76 JULY 27, 1916 NUMBER 4

Power Plants and Factories Moved at Seneca Falls

A complete rearrangement of the hydraulic power lants and various manufacturing establishments in eneca Falls, N. Y., has been completed. This has occaioned what is probably the most complete revision of ydraulic and industrial conditions seen in any town in he eastern part of the United States, and it brought with a variety of engineering and legal problems.

In the construction of the New York State Barge Canal rough the manufacturing village of Seneca Falls, placing the old Cayuga and Seneca Canal, the state gineers decided that the best canal arrangement would ult from the construction of a single dam and a flight two locks at the eastern limits of the village, although is would flood all the water powers and destroy water hts at the three dams upstream through the town and cessitate moving a large number of factories and dwell- houses out of the valley.

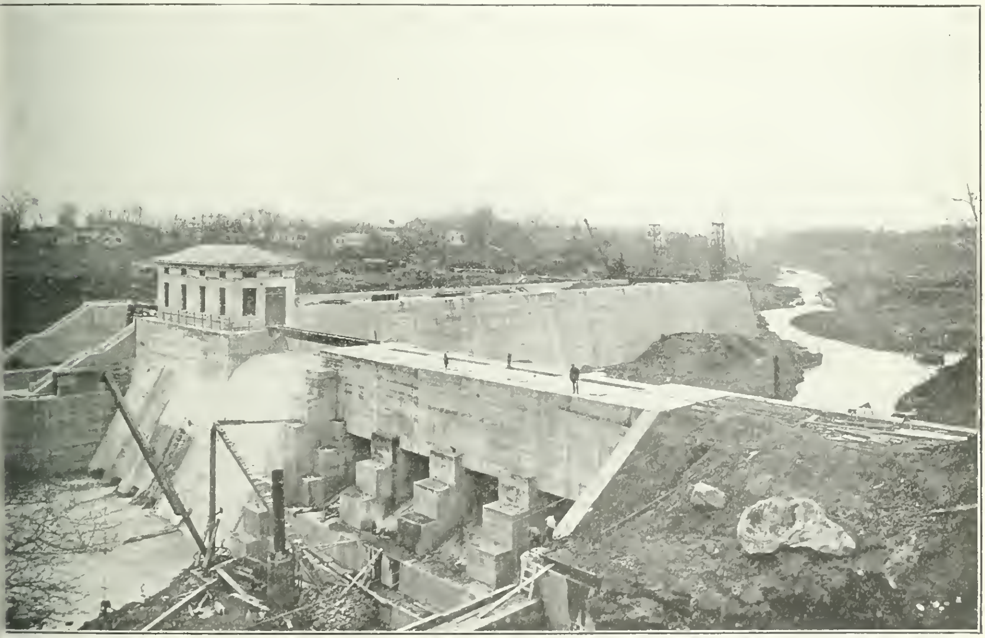


FIG. 1. DAM 2, CAYUGA AND SENECA BRANCH OF NEW YORK BARGE CANAL

Concrete steps in the foreground show the site of the station of the Seneca Power Corporation

The condition of the valley of the Seneca River through village before the Barge Canal construction was started is shown by the accompanying perspective sketch (Fig. 2). All the buildings along the course of the stream have been removed, with the exception of the business blocks along Fall St., from the bend west, on the north bank of the river. The buildings in the vicinity of the Lehigh Valley station remain, but it has been necessary to raise the level of the railroad yards about 4 ft. The basements of buildings along the south side of Fall St., on the north bank of the river, have been flooded out, so that it has been necessary to fill them up. Many brick buildings have had to be rebuilt with reinforced concrete from foundations to above water level.

In the case of the Episcopal church the damages secured made it possible to build a parish house taking the place of the basement facilities formerly used.

The village trunk sewer (a 24-in. vitrified pipe) lay in the valley to be submerged, and it was changed to a 20-in. cast-iron pipe with lead-calked joints, from the downstream side of the dam up for about $^3/_4$ mi. A 20-in.

cast-iron pipe also was laid on a timber crib to carry the sewage from the north side of the river.

Figs. 3, 4 and 5 show close views of the valley at the site of the Cast Thread Fitting and Finishing Co. below the Clary dam, looking east. A good idea is given of the changed conditions throughout the whole stretch of redeveloped territory.

The dam shown in Fig. 1 has eliminated five locks in the district shown by Fig. 2 and backed the water up in a single level stretching upstream about 2 mi. to the village of Waterloo, where a single lock replacing two low-level locks permits the passage of boats from the canal to Seneca Lake. By lowering the pool level below the dam a sixth lock, 5 mi. east, was eliminated.

Consolidation of Water Rights

At the various works scattered up the river through the village there were altogether something over 25 points of diversion for water from the river or supply races.

To carry out plans in building the Barge Canal here, the state was faced with damage claims for water rights alone of upward of $2,000,000. It was seen that if the state acquired these rights it would have no use for the power created at the new dam except for a comparatively small amount needed for the operation of the locks. It was also known that the state could not lease or sell this power at a figure to pay the interest on the cost of the rights. The state, therefore, entered into negotiations with the owners of the water rights for the appropriation of their physical property only, leaving the owners in possession of their several water rights, which it was proposed to transfer to the site of the new dam. To accomplish this change, it was necessary for the owners of power rights to pool their issues and organize into a single corporation for the development of power at the new dam. The one great obstacle standing in the way of the organization of such a company at the outset was the determination of the proper proportion of the stock in the new corporation which each power owner should have.

The canal construction destroyed 15 owners' power rights appurtenant to three dams. As is usual in such cases, the owners along the different races could not agree as to the division of the water nor to the heads at the various dams. To make matters more complicated, it was known that many of their rights were conveyed in old and obsolete terms and, in fact, some in such terms as seemed impossible of interpretation in anything like an exact manner. The owners could not settle these matters among themselves, and they realized that to go into the courts would entail untold expense, ruin many of the owners, and some of them would not live long enough to see the end. They therefore submitted the whole question of their water rights to arbitration and appointed Mortimer G. Barnes, a consulting engineer of Albany, N. Y., as arbitrator working under the code to determine their rights and apportion the stock in the new company among them, his findings to be final and binding on all parties. Ernest G. Gould, of Seneca Falls, was appointed general counsel to the arbitrator. Hearings were held at which sworn testimony was taken to give further light on the transfers, maps and other legal documents offered in evidence. Aside from this the arbitrator made surveys and investigations of races, turbine capacities, etc.

The powers in the village of Seneca Falls were located along five levels which the arbitrator designated as upper, middle and lower levels. In order to determine the proportionate amount of power each owner should have of the whole, it was of first importance to determine the head under which the different powers acted or were entitled to. This problem was complicated in the extreme. Supreme Court decisions fixed the elevation of the dams in some instances, and partition suits fixed the elevation of the same dams at different heights. The actual elevation was still different from either. An engineering interpretation of former conditions and deeds called for still a fourth height. The belief and desires of some of the owners were for yet another height. Probably no one of the different theories was right; surely the powers were not developed under any fixed and definite plan. To make the matter still more complicated the state had constructed a canal in the midst of it all and upset many of the calculations. Out of all this jumble of conditions, elevations were established that satisfied all owners, as follows:

Powers on	Ft. Head
Upper dam	12.72
Middle dam, south side	13.80
Middle dam, north side	15.00
Lower dam, north side	10.80
Lower dam, south side	15.50

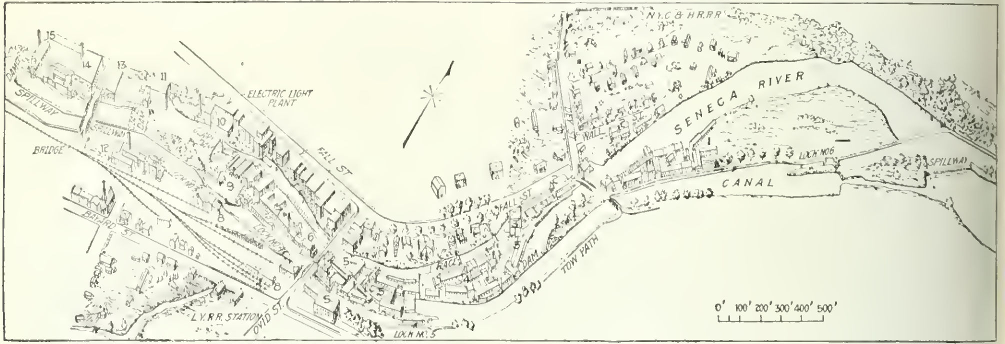
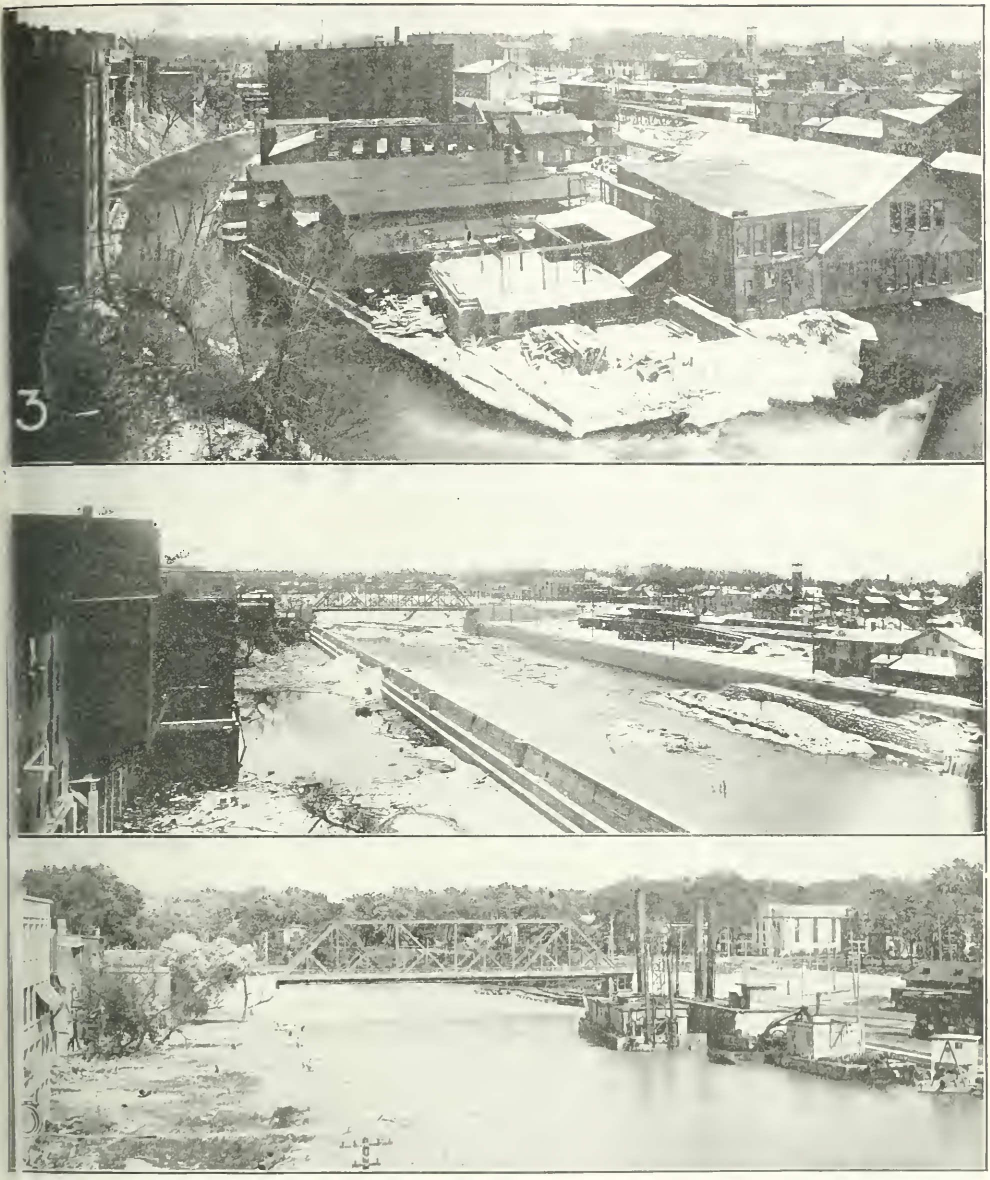


FIG. 2. VALLEY OF SENECA RIVER IN SENECA FALLS BEFORE CANAL RECONSTRUCTION

From a drawing made by H. W. Benedict under the direction of R. E. Phillips, Supervising Engineer

Figures indicate the following works affected: 1—Rumsey & Co.; 2—M. Fritz and H. W. Douglas; 3—C. A. Braman; 4—American-La France Co.; 5—Goulds Manufacturing Co.; 6—Roberts Milling Co.; 7—Ivory Button Manufacturing Co.; 8—Lehigh Valley R.R.; 9—Cast Thread Fitting and Finishing Co.; 10—Clary Electric Light Plant; 11—National Advertising Co.; 12—Seneca Falls Woolen Mills; 13—F. Maier & Sons; 14—Seneca Falls Manufacturing Co.; 15—Seneca Falls Paper Co.



FIGS. 3 TO 5. TYPICAL CLOSE VIEW OF CHANGED CONDITIONS IN SENECA FALLS
ews taken from about same location at different times. Fig. 3—Feb. 18, 1913, original condition. Fig. 4—Oct. 23, 1915, before backfill. Fig. 5—July, 1916, work complete

n the matter of title the problem was still more comated than as to head. The powers on the upper level we originally owned on both sides of the river. The th-side rights were sold and apportioned to abutting ers in proportion to their waterfront. This was later plicated by subdividing and reselling the water rights. I some cases the land was sold and the water rights rtined. In other cases the water was sold and the land retained; and in selling the measurements did not agree with the total, so that controversies thereby arose.

Portions of the power rights on the south-side upper level were sold to different parties on the north side, they in turn selling in part to other parties. The south-side rights originally covered half of the flow. The owner sold ten run of stone, thinking he had sold half. He retained seven first rights and sold to the north side, as a second preference, the next four rights; then he sold three run attached to the south side. The total flood rights went to the north-side owners, and the question arose as to how great they were. This brought in the question of heads—particularly as at the time the south-side owners bought their rights.

There was not much controversy as to the rights on the middle level, north side; at least it was not brought out in the hearings. The greatest complications of all were found on the south-side middle level. The conveyances were in terms of run of stone, inches of water, water to run a 10-ft. wheel, billies, water to run a cotton mill or a sawmill, etc. These rights were complicated by subdivisions, preferences, obsolete terms, lack of knowledge of head at time of conveyance, no knowledge of size of cotton mill or billies, reconveyances and combination of preferences and litigation and controversies as to head.

At the lower level, north side, there was no controversy as to rights. The water was divided into twentieths and so sold. The only trouble was that more than 20 twentieths were sold. The south-side lower level was all owned by one party and no question raised as to title.

In view of this indefiniteness other methods of solving the problem were sought. An examination of the records on another dam on the same stream where the conveyances were all in one term established what the people at that date believed the capacity of the stream to be in the units used. This information was used to check the number of units and assumed values at the dams in question. Next, the capacities of the openings to the wheels were computed and the powers tabulated. The next step was to measure and compute the capacity of the wheels installed. Happily it was found that all these methods checked within reasonable limits.

The important rights on the river, reading downstream, are as follows:

	Power of Wheels, Hp.
Upper Level, North Side	
1. Seneca Falls Paper Co.	200
2. Sarah F. Allen	Not developed
3. Seneca Falls Manufacturing Co.	285
4. Fred Maier & Sons	142
5. National Advertising Co.	218
Upper Level, South Side	
6. Seneca Woolen Co.	300
Middle Level, North Side	
7. Clary Bros.	224
Middle Level, South Side	
8. Cast Thread Fitting and Finishing Co.	240
9. Ivory Button Manufacturing Co.	160
10. Roberts Milling Co.	85
11. Goulds Manufacturing Co.	80
Lower Level, North Side	
12. American LaFrance Fire Engine Co.	Abandoned
13. Chester A. Braman	Abandone
14. Climax Specialty Co.	Abandone
Lower Level, South Side	
15. Rumsey & Co., Ltd.	110

All this information, when carefully studied, gave a process of eliminating most of the unknown terms. After weighting the preferences, a division of the power was arrived at that satisfied all parties. Another hearing was then held at which all stipulated that the findings of the arbitrator were satisfactory and final. Thus closed what might have been a long and rich harvest for lawyers and expert witnesses. A settlement with the state was consummated, and the consolidated power rights are now being developed.

Seneca Power Corporation Plant

Before this settlement was made, however, the state had completed the locks and dam, but had left openings in the dam for the penstocks. As the dam was completed, the design of the power house brought some novel engineering features and problems not ordinarily found.

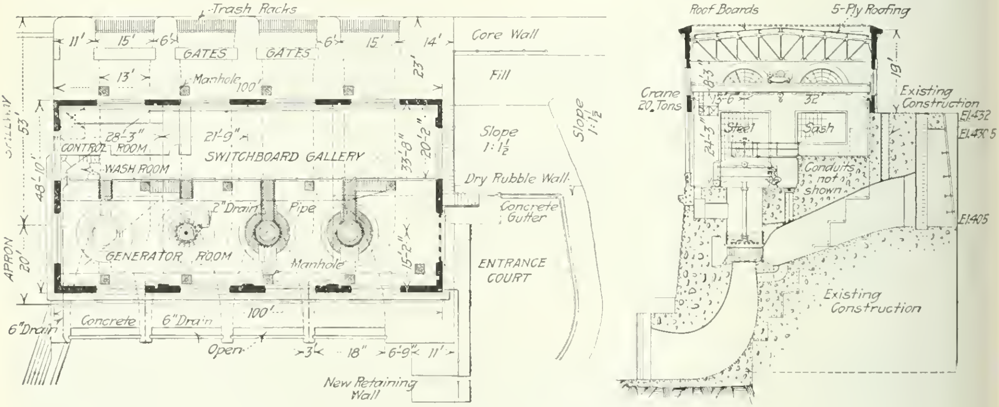


FIG. 6. HYDRO-ELECTRIC STATION OF SENECA POWER CORPORATION AT DAM 2, SENECA FALLS

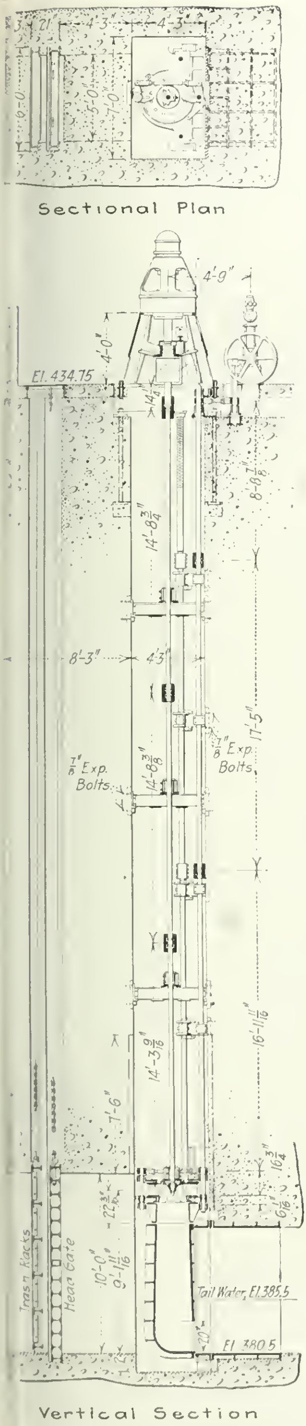
The construction of the dam prior to the construction of the power house required that the power house must be designed as a dam and stable against pressure in the penstock in all directions; this had to be overcome within the power house itself. As a consequence excess weight had to be provided in the building, and all had to be thoroughly tied together by steel. There was no opportunity to tie this back into the dam. To overcome any hydrostatic pressure that might be found in the joint between the dam and the power house, a complete system of drains was provided; and the specifications require that all old concrete must be thoroughly washed with acid before depositing new concrete, in order to secure so far as possible a partial bond.

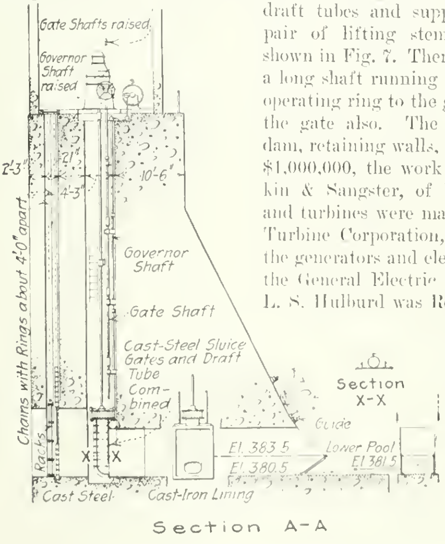
The lower guide wall to the north end of the dam extends 50 ft. downstream from the face of the dam. It is founded on a yielding foundation 16 ft. above the necessary excavation for the power house. The wall is 34 ft. high, of gravity section, and sustains an almost liquid mass of earth. It is necessary to underpin this wall and build a new wall from its base to the bottom of the excavation for the power house. This work is under way. The south side of the power house is the north side of the spillway section of the dam. Water flows over the dam 4 ft. deep and is 16 ft. deep on the apron, along which a guide wall must be built extending under a portion of the apron. No choice could be exercised in the design of the headworks, such as gates, trash racks, stop logs, etc.; openings were left for these purposes.

The general design of the Seneca Corporation's station is shown in Fig. 6. The development calls for four units of 2,500 b.hp. each at 18-ft. head. The power is to be used electrically and is leased to the Central New York Gas and Electric Co. Day & Zimmerman are contractors for the power-house construction. S. Morgan Smith Co. is contractor for turbines and governors, and the Westinghouse Electric and Manufacturing Co. for the electric equipment. Mortimer G. Barnes, of Albany, is engineer for the power corporation.

BARGE CANAL POWER PLANT

In designing the dam and locks of the Barge Canal at the eastern limits of the town it was not proposed at first to generate power for the service, and provision was made for only four sluice gates. Later on, the plans were changed to provide for two 50-hp., 700-r.p.m. hydraulic turbines working under 44-ft. head. As no turbine pits had been provided, it was necessary to mount the turbine casing on top of the sluice gates, combining the sluice gate and draft tube, as shown in Fig. 7. This does not give ideal hydraulic conditions, but the arrangement has worked quite satisfactorily nevertheless. The turbine casing rises with the gate, the runner meantime being fixed and hanging in the draft tube. The vertical shafts are very long, hanging down from the generator about 43 ft. 8 in. in three sections, with three intermediate guide bearings. Where the sluice gates are combined with the draft tubes and support the turbines, a pair of lifting stems are provided, as shown in Fig. 7. There is also necessitated a long shaft running from the wicket-gate operating ring to the governor, rising with the gate also. The cost of state locks, dam, retaining walls, etc., was a little over $1,000,000, the work being done by Larkin & Sangster, of Buffalo. The gates and turbines were made by the Hydraulic Turbine Corporation, of Camden, N. Y., the generators and electrical equipment by the General Electric Co., of Schenectady. L. S. Hulburd was Resident Engineer for the State up to 1916; since then H. C. Smith has acted in that capacity.





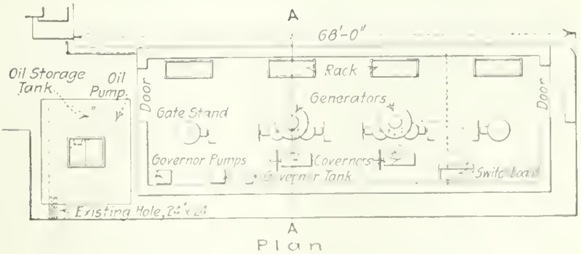
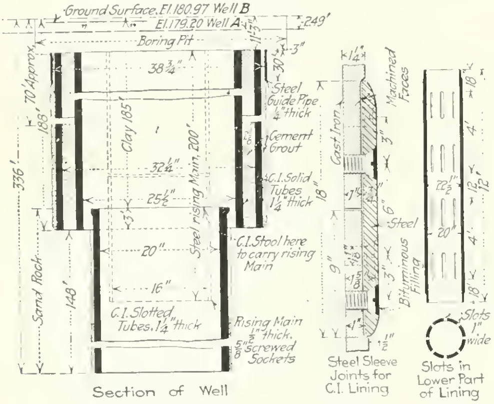


FIG. 7. BARGE CANAL POWER PLANT AT SENECA FALLS, WITH TURBINES ON SLUICE GATES

Lining Wells with Cast Iron and Cement Grout

On account of the corrosive nature of the water two large and rather deep bored wells for the water-supply of Tunbridge Wells, England, were lined with cast iron instead of steel pipe. For a considerable portion of the depth the lining was double, filled between with cement grout, and with grouting also between the outer tube and the bore hole. There was a steel guide tube for the first 30 ft. of the bore, and inside the lining there is a steel rising and suction pipe, thus making four concentric tubes and two rings of grout for a part of the depth of the wells. The object of the grout between the double cast-iron tubes was to protect the outer tube in case the inner one was eaten away by the water. The work was described in detail by W. H. Maxwell, Borough and Water Engineer, Tunbridge Wells, England, in *The Engineer* for May 5, 1916.

Two wells of the same diameter and of approximately the same depth were sunk, each from a boring pit about 12 ft. deep, from the bottom of which a steel guide tube slightly larger than the outer diameter of the outer cast-iron tube was sunk to a depth of 30 ft.


Ground Surface, El. 180.97 Well B
El. 179.20 Well A
2.49'
Boring Pit
3"
70' Approx.
38¾"
30'
Steel Guide Pipe ¼" thick
188'
Clay 185'
Steel rising Main, 200'
Cement Grout
336'
32¼"
C.I. Solid Tubes 1¼" thick
25½"
3'
20"
C.I. Stool here to carry rising Main
Sand Rock
148'
16"
C.I. Slotted Tubes, 1¼" thick
Rising Main ½" thick, ⅝" screwed Sockets
Section of Well
1¼"
Machined Faces
Cast Iron
18"
3"
6"
Steel
9"
Bituminous Filling
1½"
Steel Sleeve Joints for C.I. Lining
18"
4'
22½"
12'
20"
Slots 1" wide
Slots in Lower Part of Lining

DETAILS OF CAST-IRON WELL LINING WITH STEEL-SLEEVE JOINTS

The total depth of each well is about 335 ft. from the original ground surface. The first 188 ft. of this depth is through clay and the remaining depth through water-bearing sandstone, the latter being separated by strata of pale, yellow clay. The water derived from the sandstone contains "salts which, although themselves neutral, may act as electrolytes, causing galvanic activity between dissimilar metals or between dissimilar parts of the same metal." Experience with other well linings in this locality and also laboratory experiments showed that steel lining would be unsafe but cast-iron lining safe. The dimensions of the various linings and other details are shown by the accompanying drawings.

The pipe used for the lining was cast in accordance with carefully drawn specifications as to both material and methods, and every length of it was subjected to test, both as to quality of metal and by a hydraulic pressure of 200 lb. per sq.in. Deflection tests of strips cut from the tubes were also made. Each length of pipe was cleaned directly after casting, immersed in boiling water for further cleaning, and to raise the temperature of the metal, and then dipped twice in Angus Smith coatin maintained at a temperature of 300 to 350° F. Befor shipment, each length of pipe was "packed with sof material to avoid damage to the coating in transit."

The tubes were cast vertically in 12-ft. lengths. Eac of the larger or 32¼-in. tubes weighed about 2¼ lon tons.

The clay through which the wells passed was hard an impervious at first, but after being wet it softened to " soapy consistency of very treacherous character." Settlements and side slips in the clay "were considerable, an at times caused some anxiety, especially in view of th close proximity of heavy engine foundations and thre large pumping mains, carrying about 200 lb. pressure pe sq.in., which had to be maintained in perfect order."

Slips also occurred in the sides of the boring pits. T avoid trouble of various sorts, interlocking steel pilin was driven around the boring pits, but sufficiently fa away from them to give room for sinking 12x12-in. pitch pine piles. Girders were placed upon these piles t distribute the weight of the boring machinery. On th completion of the work, both the steel and wood pilin were left in place, the tops of the steel piling being cu off to proper levels by means of the oxy-hydrogen flam

A few weeks after the wells were sunk and lined, was found that the 20-in. tubes in the sandstone wer sinking, so that there was danger of losing the lap betwee these and the upper double tubes. Cement grout wa therefore placed in the bottom of the space between th 20-in. tubes and the bore hole in the sandstone, to depth of 7 ft. This stopped the settlement.

The method of placing the grouting between the tw upper concentric tubes that formed the lining of th portion of the wells through the clay is thus describe by Mr. Maxwell in his article:

> The portland-cement grout used in the annular space between the inner and outer linings and at the back of th outer lining was mixed to a thick creamy consistency, an all passed through a fine wire netting sieve of about ⅛-in mesh in order to remove all lumpy or unmixed particles. I one boring the grout was simply poured into the tops of th annular spaces to be filled, thereby forcing out the water The grouting thus continued until all spaces were full and th thick grout appeared at the tops of the tubes.
>
> In the second boring, which was of exactly the sam size, the grout was inserted by a different method in order t check the quantity of cement used and to confirm the assumption that the spaces had been solidly filled. In this case a 1-in. diameter pipe was passed down the annular spac for the purpose of conveying the grout down to the bottom o the cavity to be filled. The 1-in. pipe was fed with grout from a Greathead grouting cylinder and forced forward by compressed air. After discharging the contents of the grouting cylinder the 1-in. pipe was raised in the annular space by a previously calculated amount, so as just to reach the surface of the last deposit of grout. This process was continued until the space was quite full. On comparing the weight of cement used in this case with that used in the boring first grouted up it was found to be identical within a very trifling amount. All grouting operations once started were continued day and night, if necessary, without intermission.

The contractor for sinking and lining the wells was Isler & Co., Southwark, England. The cost of the two wells complete was "just under £6,000," or in round numbers, $25,000. This price did not include the 20-in. rising and suction mains inserted in the wells. Mr. Maxwell states that a week's test of the yield of the wells by means of compressed air showed a discharge at the rate of 30,000 Imp. gal. per hr., or about 1,700,000 U. S. gal. per 24 hr. Mr. Maxwell adds that had he had the necessary plant a larger yield could have been secured.

New Railway Bridge Over Ohio at Metropolis, Ill.

SYNOPSIS—The longest simple truss span ever built and the extensive use of silicon steel in the trusses are striking features of this bridge.

Work on the great railway bridge over the Ohio River Metropolis, Ill., was resumed early in the spring and being prosecuted actively. The bridge is specially table for having a double-track channel span 720 ft. g between end pins (the largest simple truss span ever lt), for the extensive use of silicon steel in the main mbers of the trusses and for the exceptionally high e-load assumed in the design. A description of the dge was given in *Engineering News,* July 29, 1915, l tests of the steel were given June 8, 1916.

The first truss at the north end is 300 ft. long c. to c. end pins and is followed by four spans of 552 ft., then 720-ft. channel span and a 246-ft. deck truss span. ere are steel viaduct approaches at each end, and these ry a concrete slab deck for ballasted tracks. The dge will contain nearly 17,000 tons of metal, the estited weights being as follows: 3,896 tons of structural el and 144 tons of castings for the 720-ft. span; 8,603 s of steel for four 552-ft. spans: 846 tons for 300-ft. n; 560 tons for 246-ft. span; 520 tons of casting for truss spans; 1,539 tons of steel and 73 tons of casting the north (Illinois) approach; 673 tons of steel and tons of castings for the south (Kentucky) approach; al, 16,886 tons.

The substructure consists of eight main piers, built of crete. Seven of these will have deep foundations, k by the pneumatic process in the sand and gravel of river bed.

Progress of Construction

Work on the foundations was commenced in June, 15, having been delayed for a time on account of conions incident to the war in Europe. It has been inrupted to some extent by high water in the river. e status of this part of the work may be summarized follows: Of the eight piers for the seven truss spans, s. 1, 6 and 7 (counting from the north end) have n landed at the final depth, and Nos. 2, 3 and 8 are ler construction, with Nos. 4 and 5 not yet begun. s. 6 and 7 are those for the channel span. The lowter elevation is 281.2 ft. above sea level, and the caiss for the present six piers have reached the following oths:

	Depth Below Low Water, Ft.
1 Landed, pier completed	49.05
Not landed	18.91
Not landed	48.90
6 Landed, pier nearly completed	74 76
Landed, pier nearly completed	63.93
8 Not landed, no pneumatic caisson	4.70

For the truss span, material is being delivered, but no sework for the erection has yet been placed. The 90-ft. viaduct approach at the north end has been comted, except for the two 90-ft. girder spans adjacent to river spans. The steelwork is erected and the conte deck slabs are placed, ready for ballast and track. The north approach fill, 6,000 ft. long, is well advanced, 69,000 cu.yd. having been placed out of an estimated total of 134,000 cu.yd. In the 570-ft. viaduct approach at the south end the concrete pedestals are completed and the castings placed ready for the column of the towers.

Design of Trusses

The assumed live-load provides for engines of the 2:8:0 class, of Cooper's E-90 loading, and a train load of 7,500 lb. per ft. of track. The structural design of the trusses is very heavy, as will be seen by the accompanying drawings of the 720-ft. span. The top chord, end posts and main verticals are of H-section, with channel-shaped built-up webs and a continuous transverse horizontal diaphragm.

Some of the connection plates are 1¾ in. thick and are of enormous size, and the main chord angles are 8x8 in., with metal 1⅛ in. thick. This chord and the main posts and diagonals are all riveted up, except that eye-bar diagonals are used in two panels at each end. The end pins for the shoes are 15 in. in diameter. The end panels of the bottom chord have four built-up channel-shaped webs 39¼ in. deep, connected by diaphragms. The bottom chord is of eye-bars, except in the end panels, as noted. The largest eye-bars are 16x$1\frac{5}{16}$ in., with 14-in. pins.

The floor-beams are 76¼-in. plate girders framed between the posts, with bottom corners cut away to clear the chord pins and the ends reinforced by diagonal channels, as shown. Between these are four lines of 62⅝-in. plate-girder stringers.

The trusses are spaced 37 ft. c. to c., as shown in the cross-section. It will be observed that this drawing shows only a single track, with ties carried by the two inside stringers. This arrangement is to be used until the traffic requires a double track, when the ties will be laid upon the two sets of stringers. The ties are 12 in. c. to c. and have steel tie-plates for the 90-lb. track rails. There will be outside guard timbers 18 in. from the gage side of the rail head. The inside guard rails are heavy angles, laid with the flange inward (to form a path for derailed wheels) and backed by a timber laid flat upon the ties. A temporary plank walk with hand-rail will be laid along the west side of the single track.

A special feature of the bridge, as previously mentioned, is the extensive use of silicon steel. Records of chemical and physical tests of the material were given in *Engineering News,* June 8, 1916. With steel of 0.30 to 0.35% carbon, the silicon averages 0.30 to 0.40%. This metal is used for the top chords, main posts, main diagonals and the end panels of the bottom chords. All other rolled structural material is of medium steel. The eye-bars and pins are of nickel steel.

Engineers and Contractors

This great bridge is for the joint use of the Chicago, Burlington & Quincy R.R. and the Nashville, Chattanooga & St. Louis R.R., forming the main part of a link to complete a new route from the Northern States to the

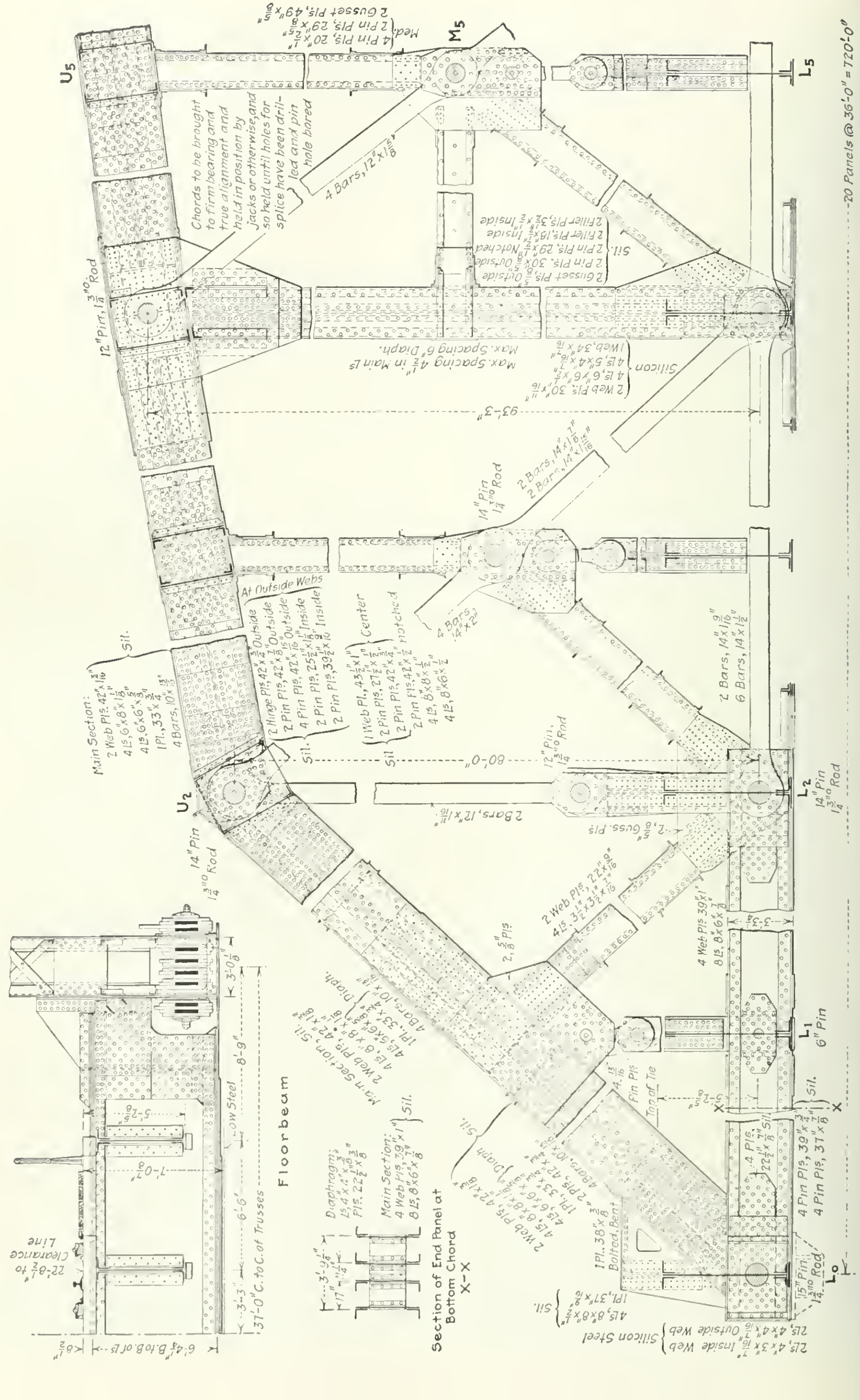


FIG. 1. ELEVATION OF END PANELS AND DETAILS OF FLOOR-BEAM OF OHIO RIVER BRIDGE AT METROPOLIS, ILL., THE LONGEST SIMPLE TRUSS EVER BUILT

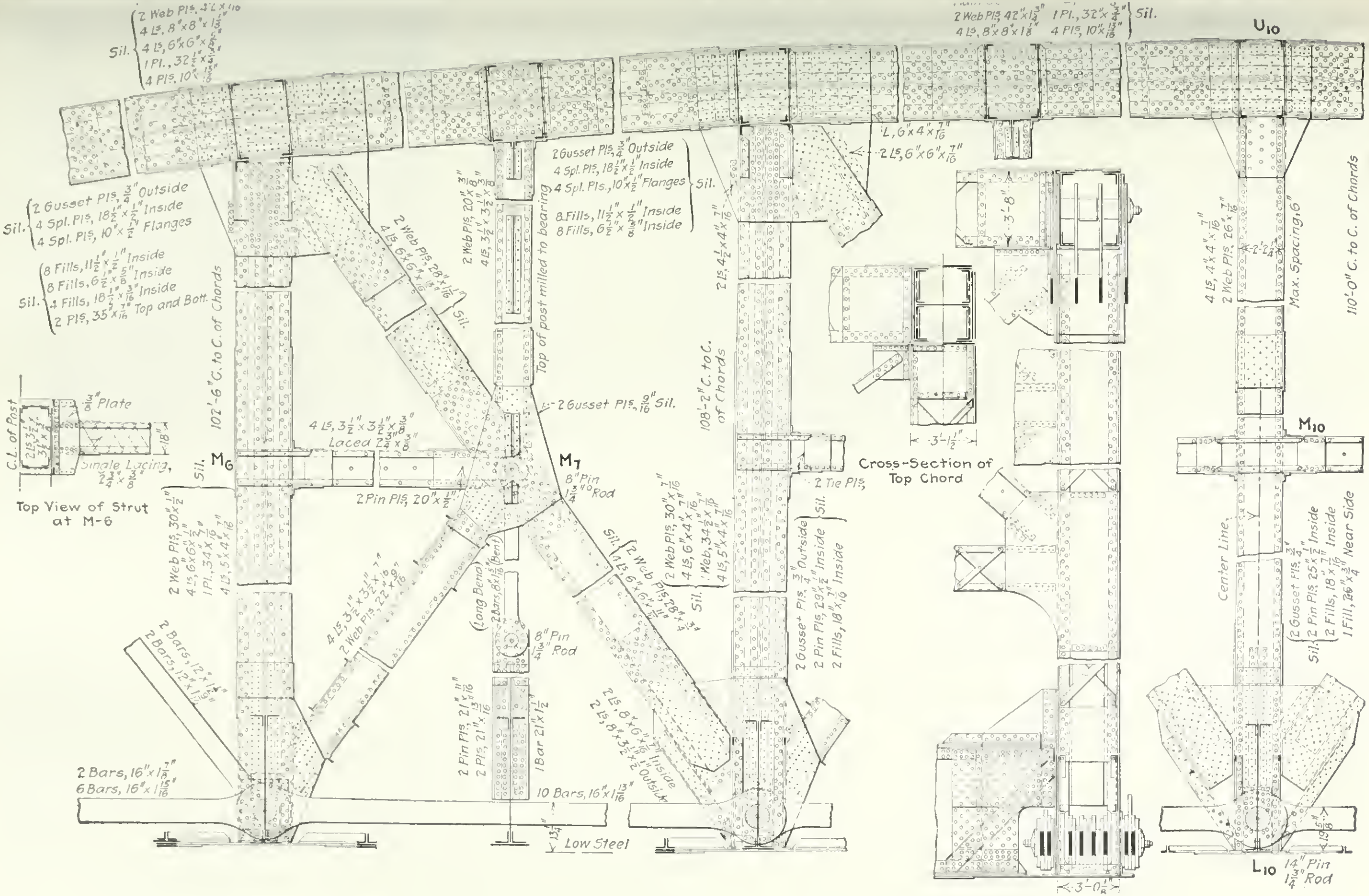

Sil. 2 Web Pls., 32" x 11/16; 4 Ls, 8" x 8" x 1 1/8"; 4 Ls, 6" x 6" x 5/8"; 1 Pl., 32 1/2" x 3/4"; 4 Pls. 10" x 13/16"
2 Web Pls., 42" x 1 1/4"; 4 Ls, 8" x 8" x 1 1/8"; 1 Pl., 32" x 3/4"; 4 Pls., 10" x 13/16" Sil.
U10
Sil. 2 Gusset Pls., 3/4" Outside; 4 Spl. Pls., 18 1/2" x 1/2" Inside; 4 Spl. Pls., 10" x 1/2" Flanges
Sil. 8 Fills, 11 1/2" x 1/2" Inside; 8 Fills, 6 1/2" x 5/8" Inside; 4 Fills, 18 1/2" x 3/16" Inside; 2 Pls., 35" x 7/16" Top and Bott.
102'-6" C. to C. of Chords
2 Web Pls., 28" x 11/16"; 4 Ls, 6" x 6" x 11/16" Sil.
2 Web Pls., 20" x 3/8"; 4 Ls, 3 1/2" x 3 1/2" x 3/8"
Top of post milled to bearing
2 Gusset Pls., 3/4" Outside; 4 Spl. Pls., 18 1/2" x 1/2" Inside; 4 Spl. Pls., 10" x 1/2" Flanges Sil.
8 Fills, 11 1/2" x 1/2" Inside; 8 Fills, 6 1/2" x 5/8" Inside
2 Gusset Pls., 9/16" Sil.
L, 6" x 4" x 7/16"
2 Ls, 6" x 6" x 7/16"
2 Ls, 4 1/2" x 4" x 7/16"
108'-2" C. to C. of Chords
3'-8"
3'-1 1/2"
Cross-Section of Top Chord
4 Ls, 4" x 4" x 7/16"; 2 Web Pls., 26" x 7/16"
2'-2 1/4"
Max. Spacing, 6"
110'-0" C. to C. of Chords
M10
Center Line
Sil. 2 Gusset Pls., 3/4"; 2 Pin Pls., 25" x 1/2" Inside; 2 Fills, 18" x 7/16" Inside; 1 Fill, 26" x 3/4" Near Side
3/8" Plate
C.L. of Post
2 Ls 3 1/2" x 3 1/2"
18"
Single Lacing, 2 3/4" x 3/8"
Top View of Strut at M-6
M6
Sil.
4 Ls, 3 1/2" x 3 1/2" x 3/8"; Laced 2 3/4" x 3/8"
2 Pin Pls., 20" x 1/2"
M7
8" Pin; 1 3/4" ⌀ Rod
2 Web Pls., 30" x 1/2"; 4 Ls, 6" x 6" x 1/2"; 1 Pl., 34" x 7/16"; 4 Ls, 5" x 4" x 7/16"
4 Ls, 3 1/2" x 3 1/2" x 7/16"; 2 Web Pls., 22" x 9/16"
(Long Bend) 2 Bars, 8" x 1 5/16" (Bent)
8" Pin; 1 3/4" Rod
Sil. 2 Web Pls., 28" x 3/4"; 4 Ls, 6" x 6" x 11/16"
2 Web Pls., 30" x 7/16"; 4 Ls, 6" x 4" x 7/16"; Web, 34 1/2" x 7/16"; 4 Ls, 5" x 4" x 7/16" Sil.
2 Tie Pls.
2 Gusset Pls., 3/4" Outside; 2 Pin Pls., 29" x 1/2" Inside; 2 Fills, 18" x 7/16" Inside Sil.
2 Bars, 12" x 1 1/4"; 2 Bars, 12" x 1 5/16"
2 Bars, 16" x 1 7/8"; 6 Bars, 16" x 1 15/16"
2 Pin Pls., 21" x 11/16"; 2 Pls., 21" x 13/16"
1 Bar 21" x 1 1/2"
10 Bars, 16" x 1 13/16"
2 Ls, 8" x 6" x 7/16" Inside; 2 Ls, 8" x 3 1/2" x 1/2" Outside
1 3/4"
Low Steel
3'-0 1/8"
1 9/16"
L10
14" Pin; 1 3/4" Rod

FIG. 2. MIDDLE PANELS OF METROPOLIS BRIDGE AND CROSS-SECTION OF CENTER POST

Gulf and Southeastern States. Its construction is entirely in the hands of the former road, and for convenience of organization a separate company was formed to construct the connecting link between Metropolis, Ill., and Paducah, Ky., a distance of 15 mi.

This line is known as the Paducah & Illinois R.R., the Chief Engineer of which was the late C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy R.R. The land portion of this line is now completed, communication across the river being maintained by a car ferry, with landing cradles, as described in *Engineering News*, Sept. 23, 1915.

The bridge was designed by Mr. Cartlidge, and all detail drawings were made under his direction in the railway company's office. All plans were submitted for approval to Ralph Modjeski, Consulting Engineer for the bridge. The Union Bridge and Construction Co., of Kansas City, Mo., has the contract for the substructure, and the American Bridge Co. has the contract for the fabrication and erection of the steel superstructure. The steelwork is being made at the latter company's shops at Gary, Ind. The inspection is in charge of Modjeski & Angier, of Chicago.

* * *

Million Square Feet of Cement Tile Used for Roofing

A recent example of the extensive use of reinforced-concrete tile for roofing is the new Chicago plant of the Crane Co. The buildings are of steel-frame construction, with reinforced-concrete floors and curtain walls. The architects were Graham & Burnham. The contractors were Lanquist & Illsley, and the Blome-Sinek Co. The roofing tiles were furnished by the Federal Cement Tile Co., of Chicago.

The roofs aggregate about 1,000,000 sq.ft., and different kinds of tile are used to meet varying requirements of the different buildings. These are shown in Fig. 1. The machine shop, generator room of power house, and buildings in which the finer class of work is done, have flat roofs of hollow tile in slabs 2x5 ft. These are 3 in. thick, with a 1-in. air space between the inner and outer 1-in. surfaces. The garage has a flat roof of single-thickness tiles 2x5 ft.; these are $1\frac{5}{8}$ in. thick, reduced to $1\frac{1}{4}$ in. at the ends where they rest on the purlins.

The flat tile roofs are covered with composition roofing. They weigh (for the tile alone) about 18 lb. and 25 lb. per sq.ft. for the single-thickness and hollow tile respectively. With I-beam purlins, these tiles rest directly on the steel, but with channel purlins channel-shaped shoe tiles are placed on the top flange to give the necessary width of bearing.

The foundry, storehouse, boiler house, etc., have single-thickness pitched tiles. These tiles are 4x2 ft., 1 in. thick, with a lug at the upper end to hook over the purlins. The outer surface has a rib on each side, and when the tiles are butted together an inverted trough-shaped, or roll, tile is placed over the joint, as shown. This is sealed with elastic cement, making the joint air-tight. A rib or roll in the middle of the outer surface gives additional stiffness. These tiles weigh about 16 lb. per sq.ft. For the power house, hollow pitched tiles are used, of the same size but similar to the hollow flat tiles. These weigh 25 lb. per sq.ft.

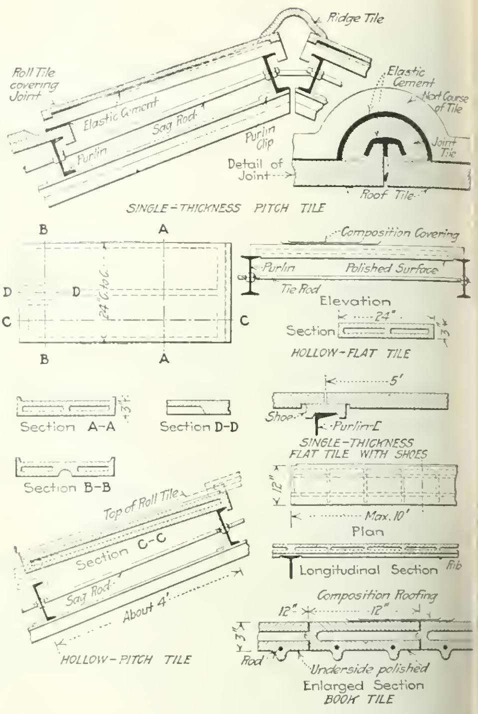


FIG. 1. TYPES OF CEMENT TILE FOR ROOFING

Where roof lighting is required, as in the storerooms etc., glass-insert tiles are used. These are 2x4 ft., 1 in thick, with a large pane of $\frac{1}{4}$-in. wire glass. The glass i set in the concrete during the process of manufacture with a cushion strip around it to provide for expansi and contraction. These tiles weigh about 16 lb. per sq.f Fig. 2 shows a roof of this glass-insert tile constructio at the plant of the Packard Motor Truck Co., and give an idea of the amount of light thus supplied. Anothe

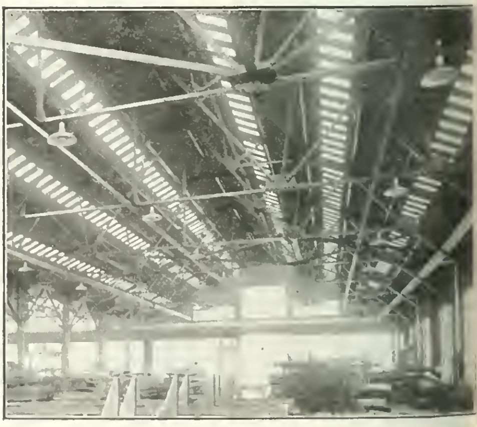


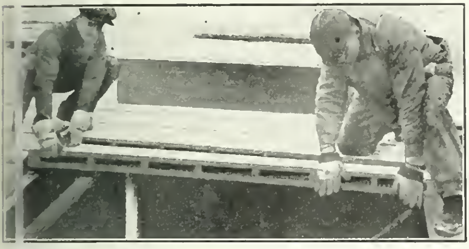
FIG. 2. SHOP ROOF OF CEMENT TILE WITH GLASS INSERTS (USED IN PLACE OF SKYLIGHTS)

ial form of flat roof is made with book tile, in hollow s 1x10 ft., having tongue-and-groove joints and a 1-in. ai space between the two surfaces. Fig. 3 shows the a ng of a book-tile roof, to be covered later with com- tion.

he tiles are made of sharp torpedo sand and portland ent proportioned 2¾ : 1, and colored red. The mixture ade moderately wet, and is tamped by hand in metal ds. A special finish is given to the inner side of the tiles to produce a dense and polished surface. The forcement consists of a sheet of galvanized wire net- , except that light rods are used in the book tiles. T tiles are seasoned under cover for about four weeks.

he tiles for the Crane Co. plant were made at the ufacturer's factory at Hammond, Ind., and stored e until the steel roof framing was ready. By this ngement they were taken directly from the cars to the , thus avoiding storage and rehandling at the site and ring prompt delivery. From 50 to 100 squares (of sq.ft.) were laid daily.

hese tiles form a permanent roof, with little or no cost maintenance and repair. Their use eliminates the ssity for interior wood sheathing, painting or plaster- and exterior covering is required only on flat roofs. tiles interlock and are self-fastening, and adjust selves to slight variations in the steel framing. They ot affected by gases or acid fumes. The glass-insert provide for ample roof light without the use of ary skylights and metal framing. The tiles have used extensively on factory and mill buildings, car s, warehouses and other structures.



3. LAYING ROOF OF CEMENT-TILE HOLLOW SLABS

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he Government Nitrate Plant

ngress has authorized the President to proceed with construction of a Government nitrate plant and opriated $20,000,000 for the work. The act of orization gives the President a free hand in arrang- or the design and construction, except that the plant be built and operated solely by the Government and in conjunction with any other industry or enterprise ed on by private capital.

cent events are likely to cause work upon this enter- to be undertaken with all possible speed. The two gs to be done first will be the selection of a suitable r power at which to erect a plant and of the process e used in nitrate manufacture. It is likely that a on some river in the South will be chosen.

ith reference to the various processes for the fixation trogen, while a great deal has been published recently erning the commercial development of nitrate pro- ion in Norway and in Germany, American engineers should remember that the first commercial production of nitrate from atmospheric air by electric current was made at Niagara Falls in 1901 by the process invented by Charles H. Bradley.

It had been known from the very early days of chemistry that under the intense heat of an electric arc it was possible to cause a combination of the nitrogen and oxygen in the air. Bradley was the first, however, to work out a commercial process of accomplishing this in such a manner that the product could be utilized.

The work at Niagara Falls carried on by Bradley and Lovejoy, while a success technically, was a failure financially. Under ordinary conditions, nitrate products made by the electrical process must compete in the market with those made from the imported Chilean nitrate. Numerous syndicates which have carefully investigated nitrate production in this country during the past decade have been unable to figure out a sufficient profit in the artificial nitrate industry to make the establishment of a plant a particularly attractive financial proposition. In Europe, on the other hand, with cheaper labor, cheap power at the great waterfalls in Norway, and an enormous market for nitrate both for use in fertilizers and for the manufacture of chemicals and explosives, the nitrate industry has had a rapid development.

According to a review of the various nitrate processes now in use, published in the *Engineering and Mining Journal* of June 17, the Pauling process, which operates on a somewhat similar principle to the Bradley and Lovejoy process, is utilizing more than 200,000 electrical horsepower in Norway at the present time, while further additions in hand and contemplated will bring the total power consumption to about 500,000 hp. Another process, of which more has been heard in this country, is the treatment of calcium carbide with atmospheric nitrogen when calcium cyanamid is produced. This product may be used directly as a fertilizer or as a basic material for the manufacture of ammonia or cyanide. It has been authentically reported that there are 16 cyanamid plants in operation in the world, of which four are in Germany, three in Italy, two in Switzerland, one each in Norway, Sweden, France, Japan and other countries. One of these is a plant in Canada—that of the American Cyanamid Co., described in *Engineering News*, Jan. 7, 1915.

Another process, the Serpek, works through the combination of certain metals and metalloids with nitrogen. It is claimed that a German inventor has succeeded in making aluminum nitride with an amount of electric energy only one-eighth of that required for the electric-arc process and one-half that for the cyanamid process. The process may also be used to produce pure alumina for the manufacture of aluminum. Another German process is the Haber process, in which ammonia is produced by the union of hydrogen and nitrogen direct. This is said to be such a commercial success that German capital has been withdrawn from the Norwegian plants for investment in the Haber process, which does not require cheap power. The *Engineering and Mining Journal* states that the Southern Aluminium Co., which is building a very large water-power plant at Whitney, N. C., for the manufacture of aluminum, plans to start the manufacture of alumina by a thoroughly commercial process and then to change over unit by unit to the Serpek process, in which aluminum nitride is formed from bauxite and decomposed to form ammonia and alumina.

Military Ponton Bridges Used in the United States Army

By Percy E. Barbour*

SYNOPSIS—Outline of the standard equipment prescribed by United States Army regulations and now carried by the regular army and by the militia units.

When a river is more than 4 ft. deep or when its bottom is of mud or quicksand, it is considered unfordable and recourse must be had to ferrying or to military bridges; a ponton[1] bridge may be placed when a stream is more than 2 ft. deep.

The standard bridge equipage used by the United States Army is of two types, heavy and light. The heavy type, carried on wagons known as the reserve train, enables bridges to be built sufficient for all requirements of an army on the march. The reserve train is mobile enough to move at the ordinary rate of marching and accompanies the main body of troops. In the light equipage, capacity is sacrificed somewhat for the sake of further mobility to enable a bridge to be carried with a rapidly moving column of light troops, such as advance guards, cavalry expeditions, etc.

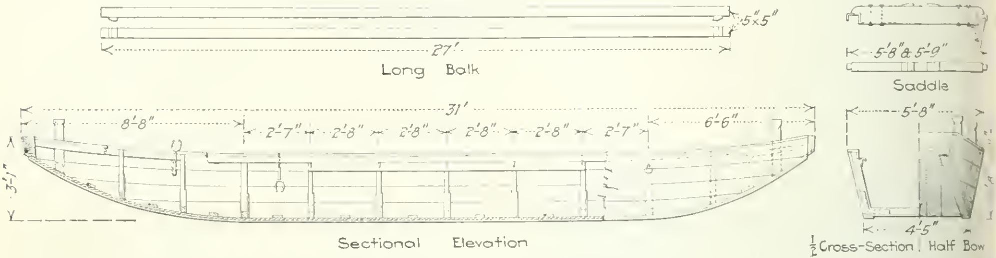

FIG. 1. STANDARD WOODEN PONTON, UNITED STATES ARMY

The principal parts of a military bridge are the pontons, or boats; the longitudinal bars, or stringers, joining them, called balks; the crossplanks, called chess; and the beams that hold the chess in position, called side rails.

The pontons carried by the reserve train are complete wooden boats, Fig. 1, and are transported on wagons. Each boat weighs 1,600 lb., has a displacement of 9½ tons and will carry 10 men armed and fully equipped—a total weight of about 9,300 lb. When assembled as part of a bridge, the supporting power is rated considerably lower; and with a factor of safety of 4 and a distance between supports of 14 ft. 1 in., the uniform safe load is 9,500 lb., or 660 lb. per lin.ft. The corresponding concentrated load in the center is 1,750 lb., which is about the weight from one axle of a 5-ton wagon and load.

The pontons for the light equipment carried by the advance-guard train are canvas boats and are constructed at the point where needed, the material being carried by the train. The canvas ponton weighs 510 lb., has 6 tons' displacement and will carry 20 men fully equipped and its crew. The floor system used with this light ponton has nine-sixteenths the strength of the heavy floor for concentrated loads, but an equal capacity for uniform loads because the span between the pontons is shorter.

The canvas for the ponton is carried in a wooden box and is shown laid out flat on the ground in Fig. 2. It is made of 0000 cotton duck, double

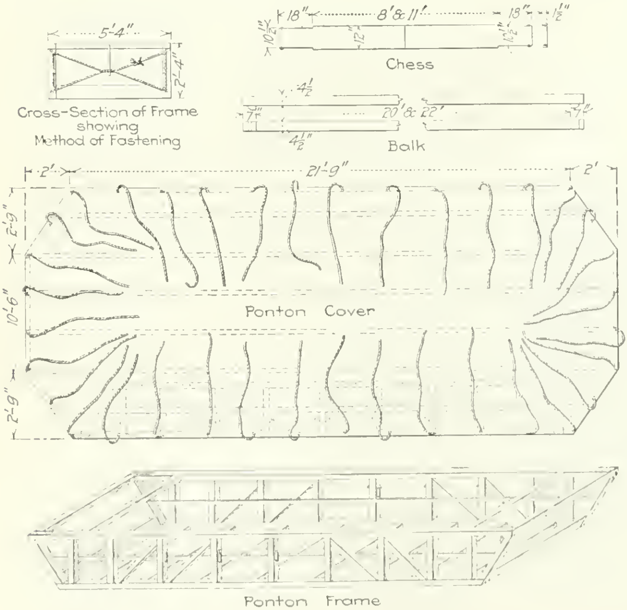

FIG. 2. STANDARD CANVAS PONTON, UNITED STATES ARMY

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*First Lieutenant, 22nd New York Engineers on United States field service, on duty at McAllen, Tex.

[1] Although pontoon is a common spelling of this word, the French spelling, ponton, is used in all United States Army publications and most scientific works.

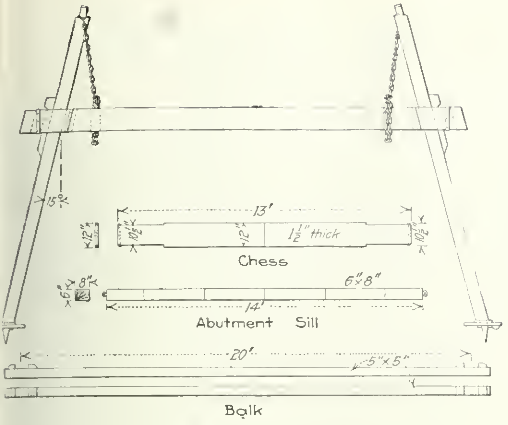


FIG. 3. STANDARD APPROACH TRESTLE

umed, with the border doubled for 1½ in. in width. e clew-line eyelets are of metal. The clew-lines are -in. diameter manila rope 5 ft. long.

In assembling the canvas ponton the canvas cover is d on the ground, and one of the side frames is laid it. In this side frame are mortises, into which are erted the tenons on the transoms, or crosspieces, of ich there are 14. The second side frame is next ced, a rope is passed through the rings of the side mes, made fast and twisted with a rack stick to hold ponton frames together. The frame is turned over the canvas, and the cover is lashed first on both sides l then on both ends. The ponton is now ready to launched. As it is very light, it need not be built at water's edge, but can be easily carried a considerable tance by six or eight men. The ponton is provided h a 75-lb. kedge anchor, 30 fathoms of 1-in. manila e, boat hooks, paddles, etc.

Trestle Approaches to Ponton Bridges

s the canvas ponton, after having been launched, ould never be allowed to touch the bottom, it will be essary to use a trestle approach at the ends if the ter near the bank is shoal. The structure used is at is known as the Birago trestle, shown in Fig. 3. is trestle consists of two legs, a trestle cap, two pieces ⅝-in. chain, shoes, pins and sundries. The trestle assembled on the ground after the determination of proper depth of water to enable the placing of the stle cap at the proper height, where it is held by the ins and the small false legs used as keys. The trestle set up in a vertical position and held by guys. An utment sill is embedded in the ground at the approach to the bridge, at right angles to its axis, and is secured by four pickets or stakes.

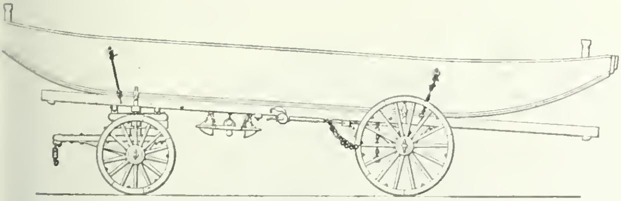


FIG. 4. STANDARD WAGON FOR RESERVE TRAIN

Balks are laid from this abutment sill to the trestle cap, the first ponton is brought into position beyond the trestle, and balks are laid from the trestle to the ponton. Successive pontons are brought up and balks are laid between them, the chess, or crossplanks, are placed, and the side rails are laid on them.

Fig. 4 shows the wagon and method of transporting the wooden and canvas pontons. The load of the ponton wagon for the heavy train is 2,900 lb. and the weight of the wagon 2,200 lb., making the total load 5,100 lb. A team of six to eight animals is used. The load of the canvas-ponton wagon is 1,985 lb.; the wagon weighs 1,750 lb., making a total load of 3,735 lb. Four to six animals are used. The other wagons in the train have lighter loads respectively, except the trestle wagon of the light train, which has a total weight of 3,810 lb.

Both the heavy and the light trains are composed of four divisions each. In the heavy train each division carries material sufficient to construct a bridge 225 ft. long, having 11 bays. The complete equipage of this train weighs, wagons included, 315 lb. per ft. of bridge; not including wagons, 169 lb. per ft. A division of light equipage will construct 186 ft. of bridge. The entire equipage, including wagons, weighs 275 lb. per ft. of bridge; without wagons, 128 lb. per ft.

Ponton bridges have been successfully constructed across streams 2,000 ft. wide and so deep and rapid that the pontons could not be held by their own anchors, so that it was found necessary to attach cables to schooners anchored above and below the bridge to hold the pontons in position.

When such a bridge has to be constructed over a navigation channel, it is comparatively easy to construct a drawspan that can be opened and closed by slacking off the upstream cable and allowing the drawspan to drift down with the current and be swung around out of the channel. Where wide draws are required, the drawspan may be in two parts, one swinging on each end of the bridge. Military trestle bridges are applicable only to shallow rivers with firm bottom and no likelihood of sudden change in water level. On a rocky bottom they are difficult to construct, on a soft bottom they sink, and on a sandy bottom they undermine, so that for a quickly built structure for the use of troops ponton bridges are far preferable.

The American ponton-bridge equipage was designed, in practically its present shape, by a board of engineers sitting just before the Civil War. They incorporated various features of military-bridges found abroad and adapted the pontons to mule-wagon transportation. Their great success was immediately demonstrated in 1861-65. The mules themselves are an important factor in ponton-bridge work and have to be trained for the service. The quartermaster's department is not relied on for transportation. Motor trucks may be utilized at times but they usually cannot approach the banks of the stream to be crossed so that the mules are generally required.

Hydraulic-Fill and Wheeled-Scrapers for Levees

SYNOPSIS—Details of special construction on a modern, large size drainage project.

The reclamation of the low-lying and wet lands within the St. John Levee and Drainage District, in the southeast section of Missouri, will be effected by means of levees to exclude flood water and ditches to carry off the surface water. This project, which must provide for an area of about 425,000 acres, was reviewed in *Engineering News,* Sept. 17, 1914. Work is now in active progress.

A levee along the entire river front of the district, from above Bird's Point to the City of New Madrid, Mo. (about 90 mi.), is being built by the United States Government. Very large drag-scraper excavators are being used for this work, as described in *Engineering News,* May 25, 1916. It will be some years before this is completed, however, and in order to secure early protection for New Madrid and the comparatively high ground to the north of the city, the District is now building a levee extending along the river front of the city for about a mile, and then north about 10 mi. to Farrenburg. It is building also a ditch extending east and west to connect the Black, James and St. John bayous, and so carry off flood waters. There will be also an extensive series of drainage ditches throughout the district, aggregating 200 mi.

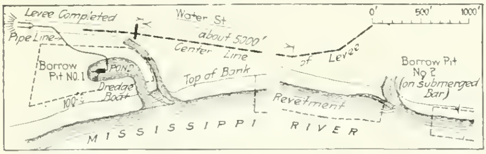


FIG. 1. PLAN OF THE HYDRAULIC-FILL LEVEE AND CONSTRUCTION PLANT AT NEW MADRID, MO.

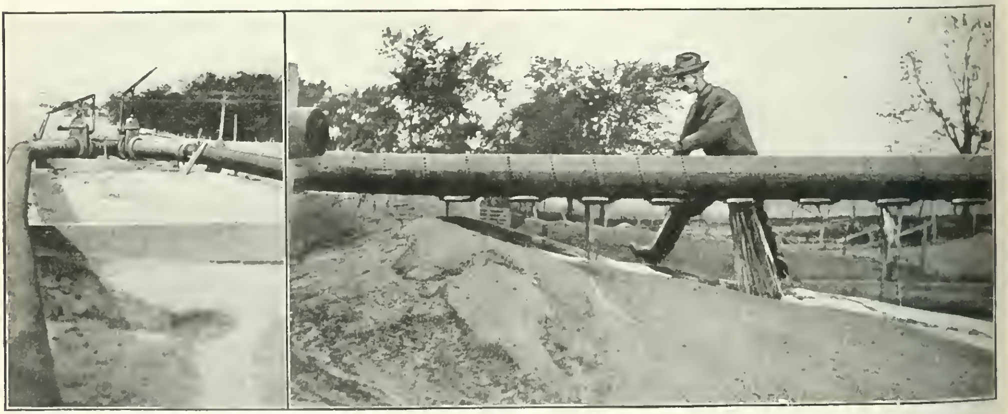
The completion of the Government levee along the river front (a few years hence) will close the St. John's outlet south into the Mississippi, just east of New Madrid. Plans to provide for this have been considered. Flood gates may be placed to pass the drainage water or a pumping station may be built, but the latter would be expensive in construction and maintenance. Another plan, is to close the river outlet altogether and to extend the main ditch westward behind the city and through the slight rise known as the Sikeston ridge to connect with the ditch system of the adjacent Little River drainage district.

The chief engineer for the district is Charles H. Miller, of Little Rock, Ark.; C. V. Hansen, of New Madrid, Mo., is Assistant Engineer in direct charge of all the work. The work now under construction includes the following: Hydraulic-fill levee, 1 mi. long, 250,000 cu.yd. at 20c. per yd.; the Hillsboro Dredging Co., Tampa, Fla. Earth levee (teams and scraper), 10 mi. long, 500,000 cu.yd., at 13½c.; A. B. Hunter, New Madrid, Mo. Main ditch, 23 mi. long, floating dipper dredge work, 1,800,000 cu.yd. at 5.38c.; A. V. Wills & Sons, St. Louis, Mo. Most of this work is to be completed during 1916. Major Markham, U. S. Corps of Engineers, at Memphis, Tenn., is in charge of the river-front levee for the district.

HYDRAULIC-FILL LEVEE

The levee which extends along the river front for about a mile at New Madrid, Mo., is being built of sand pumped into place. This levee will be on top of the present river bank, the site being cleared, all stumps blown out with dynamite, and some buildings razed.

The present bank has a stone revetment, placed by the U. S. Government. The United States Engineers in charge of this district would not permit sand to be pumped from the river below the downstream end of the revetment, and required the borrow pit to be at least 100 ft. from the river. At the upstream end, however, the dredge boat will be in the river, and will take sand from a partly submerged bar, with a discharged line on pontoons to the shore delivery pipe. (For locations see Fig. 1.)



FIGS 2 AND 3. PIPE LINE ON HYDRAULIC-FILL LEVEE AT NEW MADRID

Fig. 2—Double discharge pipes on end of delivery pipe, showing regulating valve on each pipe. Fig. 3—Discharge pipe with bottom openings fitted with slides

For the present work at the borrow pit (south of the c) the dredge boat cut its own channel from the river t the site of the pit, and is now working in a pit which ny be excavated to a depth of 30 to 40 ft. It is enl ged simply by undermining the sides with the sand s tion pipe and allowing the material to cave in. This pit w l remain permanently, to serve as a storage pond for l s for a sawmill company. On this condition the comp y donated the right-of-way for this part of the levee. A the levee will occupy the present location of a public r d, a new road has been built along the land side.

he dredge boat is a timber barge, about 80x26 ft., 5 ft. d p, equipped with a Fairbanks gasoline engine of 80 h and a 10-in. centrifugal pump. The hinged sand s tion pipe is of Z-shape and is raised out of the water w n the pump is required to deliver clear water as for c ning out the pipe. The discharge pipe is carried by p toons in the borrow pit and connects to the shore discl rge pipe. It was considered that this pump should be a to deposit 1,000 cu.yd. of sand in 12 hr., and this rd has been reached. The material is mainly river s l, with some pebbles, and occasionally some mud or e h. The discharge contains about 10% solid matter. W k is carried on continuously day and night, except on S days.

he shore discharge pipe is 10-in. spiral riveted pipe i engths of about 18 ft. with telescoped joints. Its

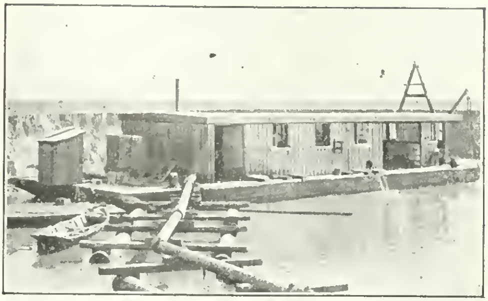


FIG. 4. DELIVERY END OF DREDGE WITH PIPE ON PONTOONS

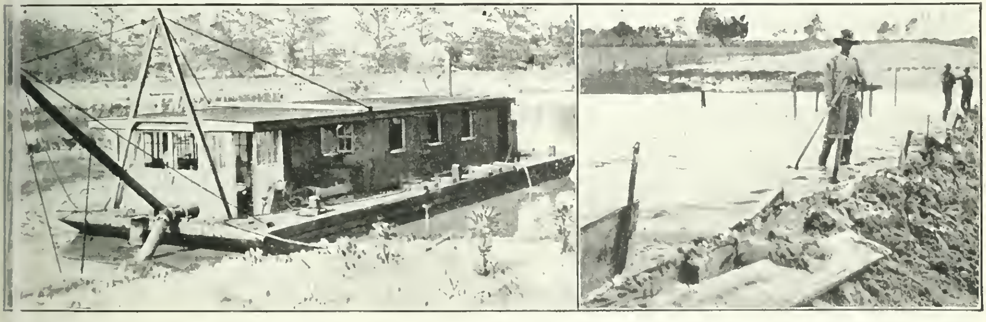


FIG. 5. SUCTION END OF GASOLINE-HYDRAULIC DREDGE, AND BAFFLE BOARDS ALONG SIDES OF FILL

m imum length for direct discharge from the pump is l it 1,500 ft. For the greater distance required when ping from the sand bar, a booster pump will be placed it ,500 ft. and then the material can be delivered 3,000 t arther, or 4,500 ft. from the dredge boat. The pump a keep the 10-in. pipe full.

his shore pipe sometimes gets choked with sand, and then to be cleaned out by pumping clear water through t. This necessitates signaling between the point of disl ge and the dredge boat. The sand suction pipe is conr ed by a man in a cabin on the boat, and at a point the discharge on the fill is erected a signal within his . This is a post with a long arm pivoted near the top o wing in a vertical plane; one end carrying a red flag lamp, the other a white.

he discharge pipe ends in a Y-branch with two parallel i s each fitted with a gate valve. One pipe is in service e the other is closed for shifting and extending. The a section on each branch is a pipe with numerous om openings fitted with slides. The end of the pipe is pported on a crosspiece nailed to two stakes embedded in the fill, and the discharge flows through a steep trough or chute to the surface of the fill. On either side is a line of boards (about 12 ft. apart) to limit the flow to the central part of the fill, and along these are wings or baffle boards, which are shifted inward as the fill rises. Views of the work are shown in Figs. 2 to 5.

The wet sand packs so solid that no allowance is made for shrinkage. The best results are obtained by building up the central part of the fill to grade, and then letting it spread on either side. If it is attempted to fill to the entire bottom width first, a large amount of material is wasted, as the flow is not so easily controlled. The water escaping from the fill is led to a ditch on the land side of the levee, and flows to one of the drain culverts, beyond which it finds its way back to the borrow pit. This ditch becomes lined with the finer material and will be cleaned out before being covered by the fill. The completed fill will be sown with bermuda grass.

At the lower end of the levee five residence buildings have to be raised about 10 ft. to the new elevation, and will be placed on concrete foundations. The 10-ft. crown of the levee will be on the river side of the buildings, forming a public path.

At intervals there are reinforced-concrete culverts to carry off drainage water from the land side of the levee. These are rectangular box culverts 3x3 ft. with flap valves to close against flood water. The valves are operated by chains in square concrete manholes which extend to the top of the levee. There will be also four sewer outlets, of 4- to 10-in. pipe. Each of these will be embedded in concrete, forming a rectangular box 6 in. thick. Vertical slide gates will close these against flood water, the gates being operated through manholes

The levee now being built north of the city will be about 10 mi. long, extending from the river to Farrenburg. It is being built by wheeled scrapers, the material being mainly a heavy red earth, containing very little sand. This is taken from borrow pits on the outer or water side. These are kept not less than 30 ft. from the toe of the slope, and rarely exceed 3 ft. in depth.

The levee has a crown width of 8 ft. with 1 on 3 slopes. An allowance of 15% is made for shrinkage, the top being filled 15% higher than grade line. The maximum height is about 18 ft. Where the levee makes a right-angle turn in leaving the river to run north, a spur is run out from the corner, to prevent water from running against it and causing erosion. The site of the base of the levee is cleared and plowed, to insure a bond, and all stumps are blown out with dynamite. No muck ditch under the levee is considered necessary, though this was proposed originally. On the land side is a berm of 20 ft., except that where a road is built along the levee berm this width is made 35 ft.

Along the edge of this inside berm is a ditch to intercept drainage water. At intervals of about a mile are reinforced-concrete box culverts to carry this water through the levee. The culverts are from 18x18 in. to 36x36 in., with an apron and wing walls at each end, and a cutoff wall or collar near the middle to prevent water from working through the fill along the concrete face.

In each culvert is a Coffin flood gate of the hinged flap-valve type, closing automatically against flood water but normally held open by a chain passing up a manhole. For culverts 18x18 in. the manholes are of 12-in. sewer pipe; those on larger culvert are of brick. The flood gates are circular, as no square gates were in stock, and would have been expensive if made specially. The concrete at the gate chamber is rounded to fit the circular opening of the gate. The culverts have a grade of 3%, so that the rush of water will make them practically self-cleaning. At the inlet end is a simple grating.

The contractors for this levee are working from 19 to 28 wheeled-scrapers of ½-yd. capacity, with two-mule teams. For each three scrapers there is a three-mule snap-team to help the scraper teams while loading. Two plows with two-mule teams break up the ground to make the loading easier.

Besides the team drivers there are a straw boss and dump man at the dump, a loader for each three scrapers at the borrow pit, and a man to handle each plow. This crew works about 12 hr. per day. With this outfit there is placed 30,000 to 40,000 cu.yd. per month.

Main Drainage Ditch

The main ditch, which will carry off flood waters, will be about 25 mi. long, from Black and James bayous to St. John Bayou, entering the Mississippi just east of New Madrid. This ditch and all the drainage ditches will be excavated by floating dipper dredges having 2½- to 5-yd. dippers. The excavation will be mainly in heavy black gumbo or buckshot, which is expected to stand well in the slopes. The main ditch will have a bottom width of 30 to 70 ft., a water depth of 8 ft., and side slopes of 1 : 1, with a 15-ft. berm and a spoil bank on each side. For this ditch a right-of-way 250 to 350 ft. wide is cleared. The trees are cut at a height of about 3 ft., except that on the berm they are cut at about 18 in.

Grade-Crossing Elimination at Memphis Bridge Terminals

By J. H. Weatherford*

The year 1916 will see the completion of the new $5,000,000 railroad and free highway bridge now being built over the Mississippi River at Memphis, Tenn., by the Arkansas & Memphis Railway Bridge and Terminal Co. This bridge in addition to carrying a double-track railway between the trusses, has a double roadway for vehicles carried on cantilever brackets outside the trusses on each side. The bridge parallels the present single-track bridge of the St. Louis & San Francisco Railroad Co. and is only 200 ft. upstream therefrom. This bridge will not only provide more adequate railroad facilities, but it will be the only highway bridge across the Mississippi River south of St. Louis.

Extensive railroad yards and track approaches on the eastern side of the river made necessary a number of grade separations of both the old and the new bridge tracks from the city streets. As originally planned, these grade separations would have required extensive lowering of streets to permit the separation of the grade of Pennsylvania St. from the St. Louis & San Francisco R.R. In an endeavor to avoid the expense and damage resulting, the track-diversion plan shown in Fig. 3 was suggested by the writer and worked out by the engineers of the St. Louis & San Francisco R.R.

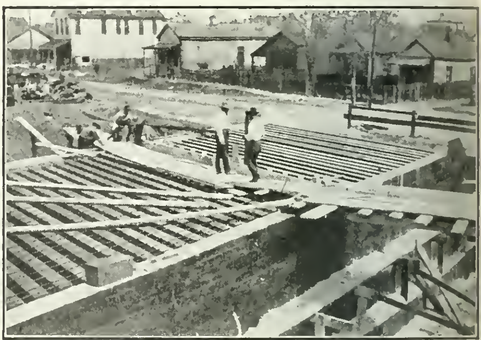


FIG. 1. INDIANA ST. SUBWAY, SHOWING CONSTRUCTION OF I-BEAM FLOOR

This new plan involves the abandoning of approximately 3 mi. of track and the substitution therefor of about 2 mi. on a new location, with the net elimination not only of a mile of track but also of nearly fifty crossings. In carrying out the work the tracks are to be raised a maximum of about 10 ft., and this work is now well under way.

Fig. 3 also shows joint subways being built by the bridge company and the Rock Island Railroad Co. at Indiana St. and at Pennsylvania St. and a separate subway being built by the Frisco R.R. at Pennsylvania St.

Three other subways under contract between the railroads and the city, one at Florida St. and Railroad Ave. and a double subway where Carolina Ave. crosses the Frisco and Iron Mountain tracks are also affected by the changes in alignment and grade. The double subway at Carolina Ave. is shortened to about half its original length and the street depression is greatly reduced.

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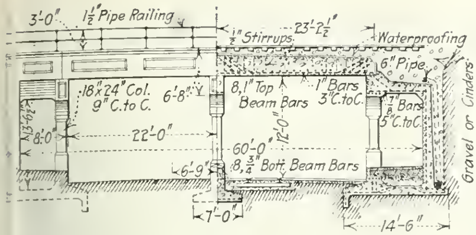
*City Engineer, Memphis, Tenn.



F. 2. TYPICAL END ELEVATION AND CROSS-SECTION OF CAROLINA AVE. AND FLORIDA ST. SUBWAYS

Tracks spaced 12½ ft. c. to c. Four floor slabs per track, e h 6 ft. 2½ in. by 23 ft. 2½ in. Designed for Cooper's E55 l ding. Impact. 50% of live-load.

Quantities per lin.ft. of subway:

S floor system	4.74 cu.yd.
A itments	4.87 cu.yd.
C ter supports	0.98 cu.yd.
Total	10.59 cu.yd.

Wing walls (right angle 20 ft. long), each 26.81 cu.yd.

R nforcement of slabs	173 lb. per yd.
R nforcement of substructure	140 lb. per yd.

All concrete 1 : 2 : 4.

ig. 2 shows a typical end elevation and section of the s ways at Florida St. and at Carolina Ave. except that total width between abutments on Carolina Ave. will b 5 ft. The design is especially noteworthy on account o he extensive use of reinforced concrete and of the box t e of abutments, a feature designed by W. F. Schultz, C ef Engineer on these subways. Street grades on the s way approaches will be approximately 4% and the p ing will be of vitrified brick on a concrete foundation. hese two subways, exclusive of paving, but including p perty damages will cost approximately $175,000 of w ch the city's expense will be approximately $25,000 p the cost of paving.

he Pennsylvania St. subway will be 80 ft. wide be- t en abutments, with 50-ft. wide roadway. The col- u ns are located on the curb line and in the center of the st et and the subway will be 356 ft. long from portal to p al. The abutments are of gravity type with rein- f ed sidewalk slabs and I-beams encased in con- c e for the roadway slabs, following the usual design.

The Frisco subway crosses Virginia Ave. and Pennsylvania St. intersection and will be a double-track through girder structure with columns on the curb line and short sidewalk spans. The main span will be 79 ft. 6 in. with two end spans of 21 ft. each and gravity-type abutments. The girders are to be encased in concrete and the floor will be a concrete slab.

The Indiana St. subway will have gravity type abutments and a single 24-ft. span of I-beam construction encased in concrete. Fig. 1 shows the I-beam floor of this subway being placed and Fig. 4 shows a longitudinal section and elevation. The north 24 ft. of Virginia Ave. will be depressed as shown in Fig. 4, the remainder of the street being separated from the depressed portion by a gravity-type retaining wall. The subway is designed to carry one-way traffic only and will be exclusively used for west-bound traffic over the Arkansas and Memphis bridge.

One of the features in connection with the work will be the moving of a two-story and basement brick building, one of the city public schools, about 200 ft. away to a new location.

The expense of the subways and bridge approaches, now being constructed, will be approximately $700,000 including property damages and paving, all of which, except a minor portion of the paving will be borne by the railroad companies. In addition approximately $550,000 will be expended by the Rock Island Railroad Co. in building new yards.

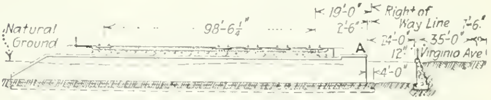


FIG. 4. LONGITUDINAL SECTION OF INDIANA ST. SUBWAY

The work is in charge locally of K. G. Williams, Resident Engineer representing F. G. Jonah, Chief Engineer, St. Louis & San Francisco (Frisco) R.R., C. A. Morse, Chief Engineer, Chicago & Rock Island R.R. and C. D. Purdon, Chief Engineer, Cotton Belt R.R. The interests of the City of Memphis are in the hands of the writer.

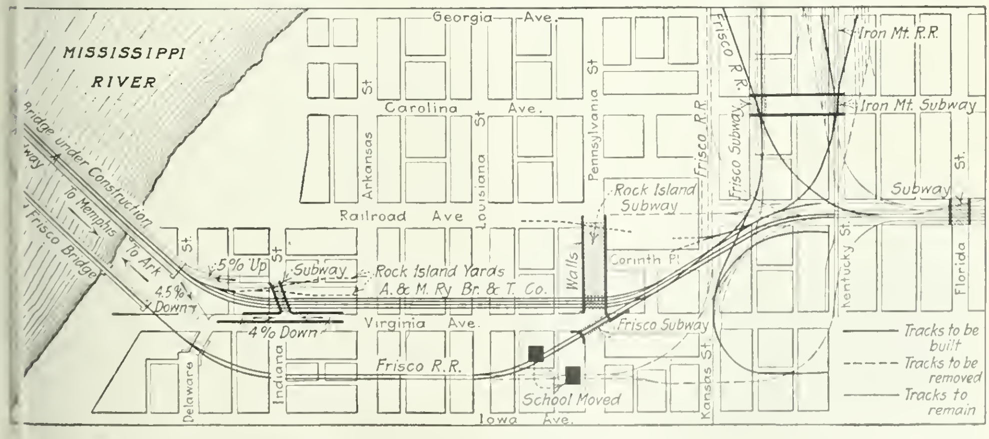


FIG. 3 MAP OF STREETS AND RAILWAY TRACKS AT EASTERN TERMINAL OF RAILWAY BRIDGES ACROSS THE MISSISSIPPI RIVER, MEMPHIS, TENN.

Showing track and street changes for grade-crossing elimination

Lagscrewed Joints in Timber

By H. D. Dewell*

SYNOPSIS—Results of tests made in connection with the Panama-Pacific exposition wooden frame buildings.

Among the new tests of timber joints made by the writer on the Panama-Pacific exposition last year were 14 joints fastened by lagscrews. The tests on bolted joints and the conclusions as to safe practice in design were reported in *Engineering News* of July 20, 1916. The present article covers the lagscrew tests.

Of the 14 tests, 4 were on joints in which a ½-in. steel plate was fastened to a timber block, and 10 were on joints in which wooden plates, 1¼ in. to 2 in. in thickness, were lagged to an 8x8-in. block. The detail makeup of these joints is shown in Fig. 1. Some of the stress-deformation curves secured in the tests are shown in Fig. 4.

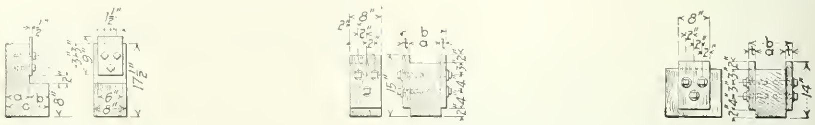


TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE S-T

Joint Number	Size of Lagscrew	a	b	c
7	¾x4½ in.	6 in.	4 in.	10 in.
8	¾x4½ in.	6 in.	4 in.	10 in.
9	⅞x5 in.	7 in.	5 in.	12 in.
17	⅞x5 in.	7 in.	5 in.	12 in.

TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE A-T-E-B

Joint Number	Size of Lagscrew	t	a	b
A	⅞x5½ in.	2 in.	8 in.	12 in.
C	¾x4½ in.	1¼ in.	8 in.	10½ in.
D	⅞x5½ in.	2 in.	8 in.	12 in.
F	¾x4½ in.	1½ in.	8 in.	11 in.
G	⅞x5½ in.	2 in.	8 in.	12 in.
H	¾x4½ in.	1⅜ in.	8 in.	10¾ in.

TABLE OF DIMENSIONS, LAGSCREW JOINTS, TYPE A-T-C-B

Joint Number	Size of Lagscrew	t	a	b
B	⅞x5½ in.	2 in.	8 in.	12 in.
E	⅞x5½ in.	2 in.	8 in.	12 in.
I	¾x4½ in.	1⅜ in.	8 in.	10¾ in.
J	¾x4½ in.	1⅜ in.	8 in.	10¾ in.

FIG. 1. DETAILS OF TEST JOINTS MADE UP WITH LAGSCREWS

An autographic testing-machine record was taken in all the tests in addition to the direct readings of slip; with joint 7 the autographic record only was made. In joint 9 the load was removed at 6,000 lb., when a slip of 0.05 in. had taken place. Here, as in the case of the bolted joints, there was some permanent set, although on again applying 6,000 lb. the deflection registered the same as before, or 0.05 in.

In testing the all-timber lagged joints the thread-and-card method was used throughout, so that the direct-reading curves represent the true slip of the joints. It will be noticed that the two curves—the direct reading and the autographic—follow closely together, but that the autographic curves always indicate a greater slip than the direct readings; this difference is undoubtedly due to end crushing.

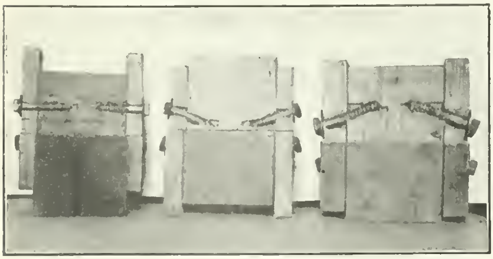


FIG. 2. THREE OF THE LAG-SCREWED JOINTS AFTER TEST, CUT APART

In Kidder's "Architects and Builders Pocket-Book" there is published a table giving the resistance of lagscrews when used to fasten a metal plate to timber, the accompanying illustration showing the lags bearing against the ends of the timber fibers and subjected to shear. The method of arriving at the values given is not explained. A ¾x4½-in. lagscrew with a plate of $\frac{5}{16}$-in. minimum thickness is stated to be worth 2,100 lb. when employed with Oregon pine (Douglas fir); similarly the working resistance of a ⅞x5-in. lagscrew is given as 2,800 lb. Prof. H. R. Thayer states that lagscrews may be treated as bolts and their resistances for equal diameters assumed the same.

In the "Proceedings" of the American Railway and Maintenance-of-Way Association, Vol. 10, Part II, there is published a method for determining the safe resistance of a track spike to lateral displacement. This method is also given in Jacoby's "Structural Details." Referring to Fig. 3, the load P in terms of the maximum bearing stress s is

$$P = sdl^2/(4l + 6e)$$

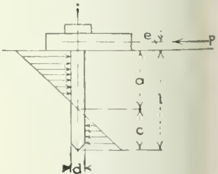


FIG. ESS DIAGRAM FOR LAGSCREW

Applying this formula to joints 7, 8, 9 and 17, assuming the diameter of the lagscrew to be constant and equal to the nominal diameter of the lag and using the limiting bearing stress of 1,300 lb. per sq.in., there is found for the case of the ¾x4½-in. lagscrew and ½-in. plate a safe resistance to lateral displacement of 770 lb. Similarly for a ⅞x5-in. lagscrew the safe resistance is 1,040 lb. The maximum flexural stress in the lagscrews is 10,700 lb. per sq.in. for the ¾-in. lag and 13,400 lb. per sq.in. for the ⅞-in. lagscrew.

For recommendations of Kidder and Thayer and values as derived from the foregoing formula see Table 1.

The author's previous tests on lagscrewed all-timber joints, in which ¾x4½-in. lags were used in fastening 2-in. planking to 12-in. blocks, with the screws bearing

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*Civil Engineer, 58 Sutter St., San Francisco, Calif.

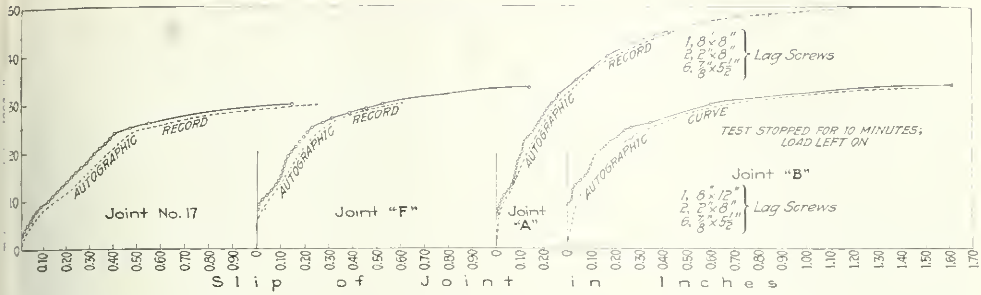

FIG. 4. TYPICAL LOAD-SLIP CURVES FOR LAGSCREWED JOINTS

against the fibers of the planking and across the fibers of the block, showed the average ultimate strength of a lagscrew in this joint to be 4,187 lb. No detail measurement of slip was made, but it was noticed that the first movement appreciable to the eye occurred at an average load of 2,423 lb. and was approximately $\frac{1}{16}$ in. to ⅛ in. in amount.

TABLE 1. STRENGTH, IN POUNDS, OF LAGSCREWS FASTENING STEEL PLATES TO TIMBER

	¾x4½-In. Lag	⅞x5½-In. Lag
Kidder	2,100	2,800
Thayer	1,125	1,575
Theoretical	770	1,040
Tests*	770	900
Tests†	975	1,300

*One-half the values for limiting deflection of $\frac{1}{16}$ in. †Values for deflection of $\frac{1}{32}$ in.

Discussion of Tests

The test results show that: (1) For loads up to 2,000 lb. per screw the strength of a ⅞-in. lag is not appreciably larger than that of a ¾-in. lag; and (2) the working values as given by Kidder correspond to a slip of 0.08 in. for the ¾-in. screw and 0.12 in. for the ⅞-in. lagscrew.

Possibly the strength of the lagscrews as shown by the four tests is low, since there was some bending of the plates and a consequent tension in the upper screws. However, this condition could not have existed in the earlier stages of the tests.

Using the limiting deflection of $\frac{1}{16}$ in. as in the case of the bolted joint, with a factor of two for working loads, it is seen that the safe working resistance of a ⅞-in. lagscrew in such a joint (a thin steel plate lagged to timber) is one-half of 1,800 lb., or 900 lb. For consistency the corresponding resistance of a ¾-in. lagscrew may be taken at 770 lb. (proportional to the respective diameters, since bearing and not bending determines the working resistance). Similarly for a limiting working load of $\frac{1}{32}$ in. the capacity of a ⅞-in. lagscrew is 1,300 lb. and a ¾-in. lag 975 lb. These values are in accordance with those found previously by the theoretical method.

On comparing the curves of the lagscrewed all-timber joints with those of the bolted joints it is evident that, while the ultimate strength of the former is far below that of the latter for the same diameter of lag or bolt, the lagscrewed joints are stiffer for the same load, up to the break in the curve.

An examination of the joints cut open shows some interesting points. The lagscrews have evidently been subjected to much less bending than the bolts; indeed, in some cases no bending is apparent. They have, however, resisted tension, which the wood was unable to withstand, as is evidenced by the partial withdrawal of the lag. The reflex bending noticed in the bolts is almost entirely lacking, and the distribution of pressure exhibited by the crushing of the timber fibers is different from that of the bolts.

In addition to the moments produced by the pressures here shown there exists a couple, formed by the pressure of one side of the washer against the timber and a corresponding pull of the threads of the screw on the main block. Whether this condition exists in the early stages of the test, it is not possible to state. A theoretical consideration of the problem was considered, but was abandoned on account of impracticability.

The superior stiffness of these joints over the bolted joints, for loads up to 3,000 lb., may be accounted for in part by the tight fit of the lagscrews in the timber and by the binding action of the tightly drawn washers, producing both friction between the timbers and restraint in the bending of the lags, although it is believed that the friction of the joint is a negligible quantity.

As in the case of the bolted joints, there seems to be practically no reduction in stiffness for the ⅞-in. joints, in which the lagscrews bore across the fibers of the timber in the main block. This statement holds true only for loads of approximately 2,000 lb. per lagscrew. In ultimate strength such joints are far below those having all end bearing; the failure is sudden and due to splitting of the main timbers.

Fig. 5 gives curves showing the average strength of the joints with each size of lagscrew and also the average strength of the individual lagscrews, with the corresponding deflections. With the criterion of a working strength of one-half the load corresponding to a slip of $\frac{1}{16}$ in., the safe resistance of a ¾x4½-in. lagscrew may be taken

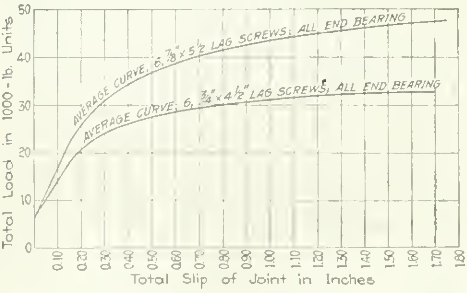

FIG. 5. AVERAGE LOAD-SLIP CURVES FOR LAGSCREWS

as 900 lb., while that of a 7/8x5-in. lagscrew may be taken at 1,050 lb. Similarly for a working slip of 1/32 in. the respective resistances are 1,375 lb. and 1,500 lb.

For joints in which a metal plate is fastened to timbers by means of lagscrews it is believed that the values of 900 lb. for a 7/8x5-in. lagscrew and 770 lb. for a 3/4x 4½-in. lagscrew are reasonable working values and that 1,300 lb. and 975 lb. respectively should be the maximum allowable capacities used.

For all-timber lagscrewed joints similar to those tested the values of 1,050 lb. for a 7/8-in. lag and 900 lb. for a 3/4-in. lag are recommended for design, with a maximum of 1,500 lb. and 1,375 lb. respectively.

All working values advocated are for timber in a dry condition and for use in interior building construction.

The author wishes to express his appreciation of the kindness of Mr. Olsen, of the Tinius Olsen Co., for the use of his testing machine, and of E. L. Peck for operating the machine. Thanks are due C. E. Blee for assistance in making the tests and to L. F. Fulcher, under whose supervision the joints were framed. Especial acknowledgment is due A. W. Earl for many valuable suggestions in interpreting the results of the tests.

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Siphon-Operated Hydraulic Ram of Long Standing

By H. S. Palmer*

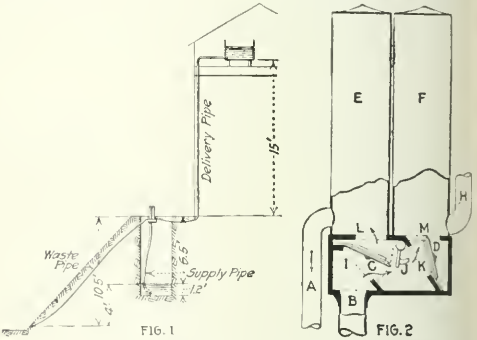
While investigating the ground waters of certain parts of Connecticut in 1915, the writer's attention was called to a unique hydraulic ram owned by H. S. Parmelee, of Granby. The ram was patented Dec. 9, 1856, by Erastus W. Ellsworth, of East Windsor Hill, Conn. (letters patent, No. 16,176). The ram is so designed that it may be put at the crest of a siphon. The energy necessary to raise the water above the crest is the kinetic energy of the moving column of water in the siphon tubes. Mr. Parmelee's ram (see Fig. 1) is at the mouth of a dug well 7.7 ft. deep, containing 1.2 ft. of water (Oct. 25, 1915). The waste pipe discharges at a point 10.5 ft. below the mouth of the well, so that there is an effective head of 4 ft. The reservoir is on the second floor of the house, 15 ft. above the mouth of the well.

The ram (see Fig. 2) consists essentially of a rectangular chest with two inclined partitions, in which are openings, *I* and *K*, with flap valves, *C* and *D*. In the bottom there is a connection to the supply pipe *B*, and in the top two openings, *L* and *M*, leading to the waste pipe *A*, and the delivery pipe *H*, respectively. Between *L* and *A* and between *M* and *H* are two tubular air chambers. The key-shaped lever *J*, controls the rapidity of beat and also starts and stops the action; it is turned by a hand shaft passing through a stuffing-box in the back of the chest.

The action of the ram is as follows: A column of water flowing up the supply pipe *B* and down the waste pipe *A* acquires sufficient velocity to throw the valve *C*, which is double-acting, up against the opening *L*, thus stopping the flow to the waste pipe. The kinetic energy of the water column in the supply pipe then drives a little water past the valve *D* and up the delivery pipe *H*. When the motion is arrested and a reverse surge set up in the chest, the valve *C* falls from its upper seat and a new cycle is initiated by a flow of water through the siphon. Enough air is brought in through the supply pipe to keep the air chambers full.

When the siphon is empty it can be started, provided there is some water in the reservoir, by turning the key-shaped lever *J*, counterclockwise so that the peg raises the valve *D*. Water then flows from the delivery pipe, through the chest, and down into the waste pipe. When the waste pipe is full of water the valve *D* is allowed to drop. The water in the waste pipe produces a partial vacuum in the chest that raises valve *C* from its lower seat and draws water up the supply pipe. This action fills the waste pipe with air which is expelled by again opening the valve *D* with the key *J*, and allowing water to run down from the reservoir. Then with both legs of the siphon full of water the cycle of operations will commence automatically.

The front of the chest is a glass plate so that the operation of the parts may be observed. The rapidity of the beat may be regulated to some extent by means of the key *J*. When the key is turned close to the valve *C* the current of water trying to go down the wastepipe is concentrated and enabled to throw the valve against its upper seat more promptly, thus shortening the beat. This regulation is accomplished without actual contact between valve and key. The ram may be stopped by turning the key at the proper moment to hold the valve *C* against its upper seat until the surge in the chest has died out. With the legs of the siphon full of water all that is needed to put the ram in operation is to raise the delivery-pipe valve *D* a little by means of the key.



FIGS. 1 AND 2. ELLSWORTH SIPHON RAM

The siphon ram is essentially like the common ram except that the waste valve is inclosed in such a way as to prevent the loss of the partial vacuum at the crest of a siphon. This ram could also be operated as an ordinary ram at the foot of an inclined supply pipe. The second air chamber *E* is needed to smooth off the flow.

At a distance of 25 ft. it is almost inaudible. That it is inexpensive to run is shown by Mr. Parmelee's statement that "25c. a year would cover the time and labor in cutting new washers for the valves"—the only repair he has had to make. It is remarkable that this machine is not on the market. It is eminently suited to raising small quantities of water from a shallow well where it is difficult or impossible to dig a trench for a pipe sloping to an ordinary hydraulic ram.

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*Geologic Aid, United States Geological Survey, Washington, D. C.

Sioux City Concrete Pavements

SYNOPSIS—Sioux City, Iowa, has some 40 mi. of concrete paved streets and roads that have shown remarkable results in freedom from cracking and resistance to wear. These concrete pavements are laid in a different manner from that followed elsewhere. A member of the editorial staff of "Engineering News" visited Sioux City recently to examine these pavements, and the following article summarizes his observations.

Concrete pavements which have been in use five years l which show block after block without a single crack; icrete pavements which have been under traffic two or ee years and on which the marks left in the original nting are still to be seen; concrete pavements which costing practically nothing for maintenance; con- te pavements laid on grades of 12% to 16% which e satisfaction to teamsters; concrete pavements which e been a complete success from the beginning and preferred by property owners to any other type— se are some of the things which are hardly believable an engineer unless he actually visits Sioux City, Iowa, l sees them with his own eyes.

In addition, it may be remarked that some of the er concrete pavements in Sioux City are only 5 in. ck, and all are laid on crowned subgrades. Some ets have crowns as high as 14 in. The pavement laid recent years, however, is 6 in. thick.

Success Not Due to Local Conditions

Engineers whose experience with concrete pavements been less satisfactory are apt to say that the success the Sioux City concrete pavements must be due to uliarly favorable local conditions—subsoil, drainage some more mysterious cause. As a matter of fact, areful examination of all the pavements and of roads l streets where pavements are under construction leads vitably to the conclusion that the conditions of soil, inage, climate, traffic, etc., are quite as trying to con- te pavement as the conditions in any Northern or stern American city of 50,000 population.

The range of temperature in Sioux City is from 115° —35° F. Sudden extreme variations of 50° are unusual. Rainstorms with a precipitation of 1½ in. n hour occur. Many streets are poorly provided with rm sewers. The subsoil in some instances is heavy, ck and sticky. Some of the concrete roads that are v under construction run through lowlands and umps. Therefore local topographic, climatic and soil ditions cannot account for Sioux City's remarkable cess with concrete pavements.

Concrete on All Kinds of Streets

The 40-odd miles of concrete pavement in Sioux City ludes streets of every character—downtown heavy- ffic streets, residence streets and country roads— l these pavements are on grades varying from level to 1%. With years of actual experience under all these ditions, City Engineer T. H. Johnson not unnaturally come to look upon concrete as a universal paving terial and stands ready and willing to pave any kind street with it. Property owners almost unanimously petition for concrete when new paving is proposed. To the 40-odd miles of concrete paving already laid in Sioux City about 20 mi. more is to be added this year. Obviously, these things could not be if extraordinary success had not been attained with the use of concrete as a paving material.

About 15 mi. of the concrete-paved streets has street-car tracks. Concrete paving has proved so satisfactory that it has not only been adopted as standard by the city, but the street-railway company of its own accord has used concrete paving on several miles of repair work on pavements of other types. Figs. 3, 4 and 5 illustrate the details and appearance of some of these street-car track pavements.

Reasons for the Success

The prime factor in the success with concrete pavements at Sioux City is good workmanship. The second and hardly less important is good materials. Specifications help, but of themselves could never bring about either of these factors, for good workmanship and uniformly good materials are the products of eternal vigilance only. The Sioux City pavements are built under the constant personal supervision of a man who is heart and soul absorbed in this work. These are the real local conditions that influence results.

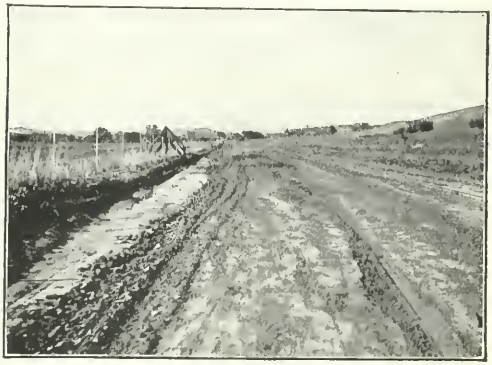

FIG. 1. ROLLED SUBGRADE ON A SIOUX CITY "STREET," SHOWING COUNTRY-ROAD CONDITIONS

Thorough rolling of the subgrade is practiced even on steep grades. Only one instance could be found where the pavement slabs had moved or crept, and this one case was not serious, as only one corner of a slab had been raised. The specifications provide that the subgrade shall be rolled with a roller weighing not less than six tons, and the entire surface shall be passed over at least twice, with the usual provisions for filling holes and depressions and for wetting the subgrade before placing the concrete.

The cement must meet the requirements of the standard specifications of the American Society for Testing Materials. The sand used is an excellent quality of bank sand, testing 100% or better by the Ottawa standard. The coarse aggregate in most cases is Sioux Falls (S. D.) granite—a hard, reddish granite that makes first-class concrete material. Some pavements, however, have been made of concrete in which a washed gravel was used, and these to all present appearances are hardly less satisfactory than the pavements built with granite aggregate. The proportions (used at present) are 1 part cement to 6½ parts of sand and coarse aggregate (leaner mixtures have been used). The usual mix is 1:2½:4, which is considerably leaner than that recommended by the leading authorities on concrete-road construction. The following clauses from the specifications govern the character of the aggregate:

> The fine aggregate shall consist of bank sand or screenings from gravel, graded from fine to coarse, passing when dry a screen having four meshes per linear inch; shall preferably be of siliceous materials, clean, coarse, free from loam, vegetable or other deleterious matter; not more than 25% shall pass a screen having 50 meshes per linear inch, and not more than 3% shall pass a sieve having 100 meshes per lienar inch.
>
> The coarse aggregate shall consist of crushed granite or quartzite, passing a 1½-in. screen and held on a ¼-in. screen, and containing no sandstone or soft, flat or elongated particles, and free from dirt, loam, vegetable and other deleterious matter.

MIXING AND PLACING THE CONCRETE

Great care is given to mixing the concrete. Only a batch mixer of approved type may be used, and it must be equipped with a batch meter or some other automatic device for properly timing the mix. The mixing must continue for a full minute after all the materials are in the drum of the mixer, and the drum must be rotated at a speed of at least 12 r.p.m. The drum must be completely emptied before another batch is introduced. The mix, while not sloppy, is moderately wet.

The time of mixing concrete is an element in which nearly every contractor is tempted to economize. It is therefore necessary to see that a mixer of sufficient capacity is provided and that it is not overloaded. Experience in Sioux City up to the present year has been with one-bag batches; but one contractor is hastening progress by loading a 16-cu.ft. mixer with two-bag batches, which is within the rated capacity of the machine. The actual result, however, is a concrete no better mixed than a one-bag batch rotated ½ min. To prevent these conditions and insure a good mix, the specifications are to be revised to include a limit to the size of the batch to be mixed in machines of certain rated capacities. Thus a 15- or 16-cu.ft. mixer would not be used for greater than one-bag batches nor a 21- or 22-cu.ft. mixer for greater than two-bag batches, an so on.

Precaution is exercised in handling the wet concret from mixer to pavement. Turnover carts for conveyin the concrete are prohibited; bottom-dumping devic must be used. The reason is that if wet concrete conveyed any distance the coarse aggregates settle t the bottom and when the load is dumped they are a on top, which defeats the great object aimed at—th *densest concrete obtainable.*

Rakes and hoes in spreading and leveling are n permitted. The spreading is done with shovels. Tw or more workmen, usually four, stand in and on the concrete, and they are continuously employed in going ove and over the surface with long-handled oak-plank float 14x16 in. by 2 in. thick.

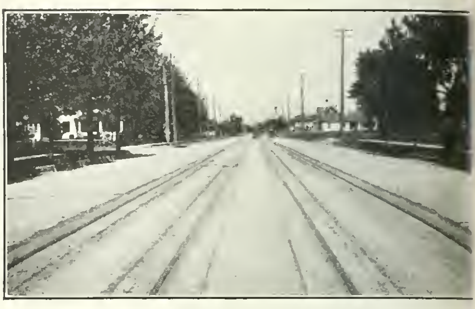
FIG. 4. STREET WITH TWO CAR TRACKS PAVED WITH CONCRETE

ADDING DRY MATERIAL

It is at this point that there is introduced the chie feature in which Sioux City concrete paving practice a developed by Mr. Johnson differs from the practice o substantially all other engineers. As soon as the concret is smoothed off by the floats to approximately the forn of the finished roadway, there is spread over it a dr mixture of equal parts of cement and sand sufficien to absorb all surplus water. Every engineer knows hov promptly concrete will stiffen when such a dry mix i added. The workmen can walk on it immediately, an

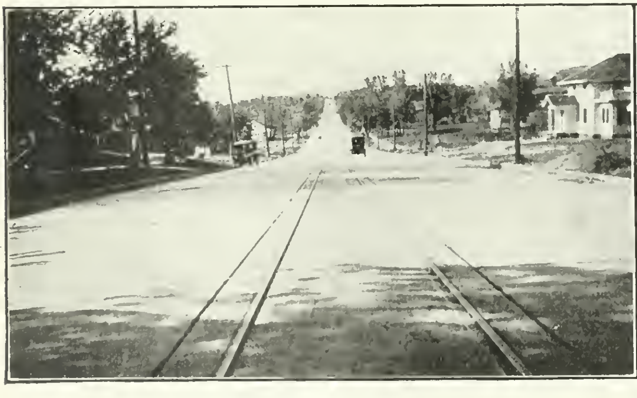
FIG. 2. JACKSON ST., SIOUX CITY, AN EXAMPLE OF GOOD CONCRETE PAVEMENT

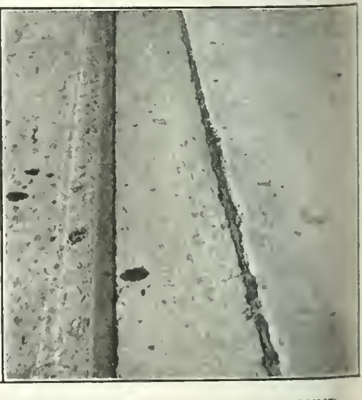
FIG. 3. DETAIL OF PAVING AROUND CAR RAIL

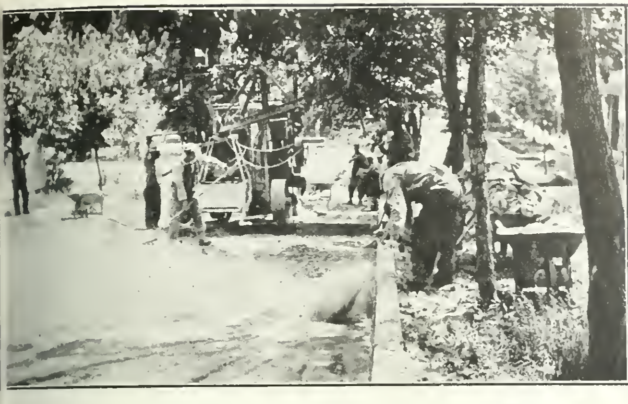

FIG. 6. SPREADING MIXTURE OF DRY SAND AND CEMENT

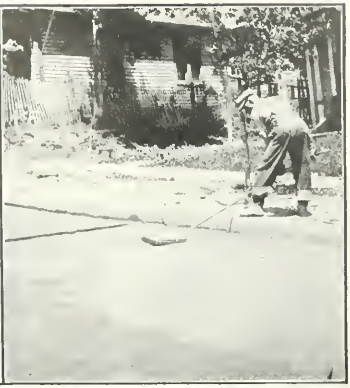

FIG. 7. FINAL FLOATING PROCESS

y continue working it with the heavy plank floats til all the surplus water is brought to the surface and orbed by the dry mix.

This process was fully described by Mr. Johnson in ontribution to *Engineering News* of June 10, 1915, l also at the annual Conference on Concrete Roads, d in Chicago Feb. 15 to 18, 1916. The specification ering this part of the work is as follows:

> After the concrete is deposited and brought to a proper wn, it shall be immediately gone over at least twice with oat about 12x14 in. in size, made of 2-in. oak plank and rying an 8-ft. gas-pipe handle. Immediately following , a dry mixture—one part cement and one part sand—that passed a No. 8 screen shall be evenly applied over the ire surface in sufficient quantity to absorb all water. er this the floating shall continue until the dry mixture is roughly incorporated with the mortar previously flushed he surface. Subsequent floatings shall follow at intervals 5 min. until the entire surface has been floated not less n five times after applying the dry mixture. At the last ting the mortar shall have reached a stage where it is ty and adhesive and is slightly drawn along with the float.

MANNER OF FINISHING IS IMPORTANT

t is chiefly on this feature of finishing that other ineers differ with Mr. Johnson, and to this feature . Johnson attributes a large share in the successful come of the work. Whatever other virtues the float- process and the addition of dry mortar may have, re is no question that they help materially to obtain lense concrete. Much water is squeezed or sucked , which flushes to the top and is absorbed by the dry xture of sand and cement. This water would other- e remain in the green concrete until evaporated or drawn downward into a base not sufficiently wetted. is generally accepted that when water leaves concrete water, it carries along with it some cement. If allowed be absorbed by the base, cement is carried down- d where it is not needed. By forcing the water out ough the surface, the cement is carried toward the of slab where it is needed.

The floating or puddling of the wet concrete un- btedly helps to prevent the formation of interior air bles, which cause a porous concrete, even when ex- mely minute. This floating is kept up until the face begins to stick to the float, or in other words il the initial set has begun. The surface mixture n has almost the consistency of retempered mortar. e last floating leaves a scored, roughened surface, yet with all pores sealed, and the grains of fine aggregate coated with cement, rather than sharp and angular as when roughened with a broom, as is shown in Fig. 9. Chips of concrete broken from old pavements show a remarkably tough, fine-grained, flinty, dense concrete, the plane of cleavage being often smooth and more resembling an igneous than a sedimentary rock.

Noteworthy things in connection with the finishing and floating are these: No strikeboard, templet or other similar device is used to form the surface of the pavement. Once the concrete is properly distributed with shovels, it is not again disturbed. The crowning and all finishing are done by eye with the use of the floats.

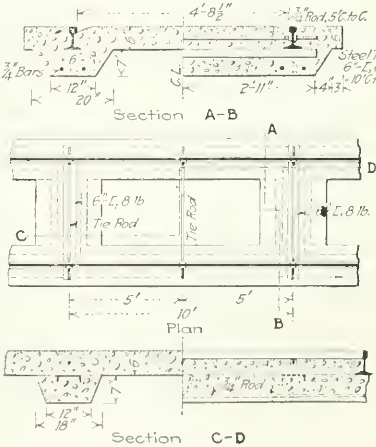

FIG. 5. DETAILS OF STREET-CAR TRACK CONSTRUCTION

It seems remarkable that a smooth, even surface and grade can be so obtained, but with a properly prepared subgrade and skillful workers it not only can be, but is regularly done in Sioux City practice. This simply means that the shovelers must have the necessary intelligence and skill to place the concrete properly at the start. Complicated crowns and valleys for drainage at street intersections are made in the same manner. Mr. Johnson in his discussion at the Second National Concrete Road Conference last February advocated this method of finishing concrete pavement in the following words:

> We are told that it takes about 4 cu.ft. of water to mix an ordinarily wet yard of concrete, only about one-half of which is used in hydrating the cement, the other half remaining in the concrete as free water. In other words, 7½% of the total volume is free water, and if left there to evaporate would result in voids equal to 7½% of the mass.
>
> Our first floatings remove a portion of this free water and so close up the structure of the concrete that subsequent evaporation is materially reduced. The dry mixture completes the removal of this free water, as is shown by the immediate stiffening of the concrete so that the balance of the finishing is done directly from its surface, without disturbing it a particle. This also furnishes enough mortar for properly finishing the surface. Being a rich mixture, it counteracts the effects of dust, dirt and other impurities brought to the surface by the water and effectually seals all the pores in the pavement, preventing evaporation and affording a hard, tough, dense, impervious skin coat for the surface of the pavement. This dry mix being half sand prevents the surface from crazing, as would be the case if neat cement were used.

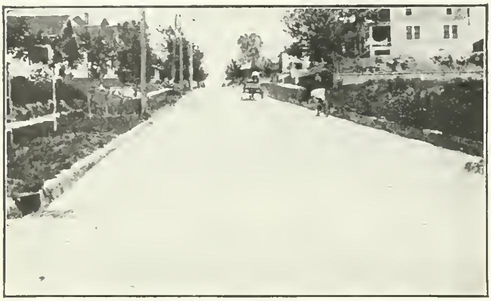

FIG. 8. CONCRETE PAVING ON A 16% GRADE

The proper curing and protection of the pavement are not slighted. It is customary with a new pavement to require one man to be regularly employed throughout the day for a period of at least seven days in sprinkling the surface with a stream of water from near-by hydrants. When the temperature is below 50° F., the sprinkling is sometimes omitted, as of course it is in rainy weather. No traffic is allowed for 14 days.

Joints ½ in. wide are made transversely every 35 ft and longitudinally between the new pavement and the curbs or gutters on each side. They are formed by inserting during construction and leaving in place a joint filler consisting of strips ½ in. thick, which have a width 1 in. greater than the thickness of the pavement. The material composing these strips is ¼ in. of asphalt between two layers of the best grade of wool felt, thoroughly saturated, coated and bonded with a pure asphalt. (The now widely used Carey sandwich joint was originally devised to meet this specification.)

Concrete Paving and Concrete Girder Support for Car Tracks

The longitudinal joint between the paving alongside the street rail laid by the railway company and laid by the city consists of a single thickness of the best grade of saturated wool felt. In making transverse joints the concrete is deposited and tamped or spaded on both sides of the joint, floated with a standard "split" float and the edges of the concrete rounded with an approved "edger." The concrete for paving in the track area is mixed rather wet, 1:2½:4, and it is well puddled under the ties and rails. The form of construction is shown in detail in Fig. 5. The base and pavement proper a laid in one operation.

Longitudinal joints are placed between the paving done by the street-railway company (1 ft. on each side of the rail) and the remainder of the street pavement. No transverse joints are made, and a fine crack opens over each tie. The street cars that use these tracks are 20-ton 8-wheel cars with 21-ft. wheel base.

It will be noticed that here is a case where the concrete-girder construction for street-car tracks, which was extensively used a dozen years ago and generally abandoned, is now giving excellent satisfaction. Further, and still more important, here is a rail embedded directly in concrete, with no provision for elastic support, such as has so often been declared to be necessary, and both the concrete and the rail are standing up. Of course, the street-car traffic and the vehicle traffic of Sioux City are nothing like as heavy as those of Chicago or New York; but there are thousands of miles of street-railway track subjected to no heavier service than that at Sioux City, and what will succeed there should succeed in a hundred other cities.

The street paving and track foundation cost about $2.75 per sq.yd., with rock at $2.25 per cu.yd.; sand, $1 per cu.yd.; cement, $1.40 per bbl.; common labor at $2.50, finishers at $5 and teams at $5 for a 9-hr. day.

Conclusions

Certain mooted points in Mr. Johnson's specifications have been looked on more or less as fads or hobbies. They are not. They are the products of continuous trial and experience. There is no detail in the method of construction outlined that has not sprung from some previously unsatisfactory experience or which has not been proved essential for a desired result.

Again, in attaining the results that make Sioux City pavements truly remarkable no small amount of credit is due to the contractors with whom Mr. Johnson has worked. They have shown a willingness to coöperate and to follow as well as to make suggestions. Having established a reputation for their work, it is natural for them to wish to maintain it.

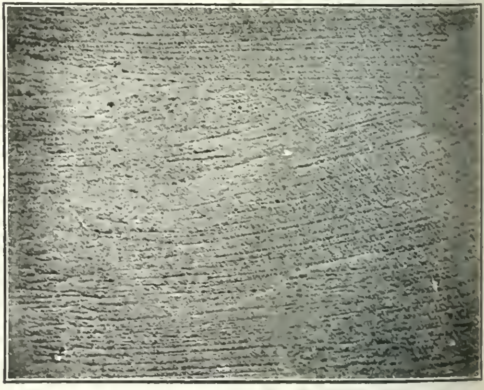

FIG. 9. APPEARANCE OF COMPLETED SURFACE OF A PAVEMENT IN USE FOR SEVERAL DAYS

In conclusion it must not be inferred that the object of this article is to make out that Sioux City pavements e perfect or that they contain no cracks or other im- prfections whatsoever. It was impossible in a two days' vit to obtain by personal inspection an exact knowl- ege as to what percentage of the pavement slabs have c cked. Last fall, however, Mr. Johnson made such an i pection of between five and six miles of pavements i a typical district, pavements two to five years old, a l he found about 1% of the slabs showing cracks, which v uld seem a fair index of the condition of the whole y dage. The widths of the pavements varied from 30 t 40 ft. and the lengths of the slabs from 25 to 35 ft., 2 ft. being the distance between expansion joints in the e lier pavements. It is also true that there are three- a l four-year old pavements one-half and even a mile l g which show absolutely no cracks throughout their e ire lengths.

The only concrete pavement in Sioux City that shows s ns of serious deterioration is one over which materials v e hauled in building a new pavement. Motor trucks c rying 15 to 20 tons were driven over this stretch of p ement at high rates of speed, and the effects of this t tering are plainly evident in the many cracks. The p ement was only 5 in. thick.

There remain unanswered queries that are sure to be r sed. Are concrete pavements satisfactory to traffic on 1 % grades? Apparently Sioux City concrete pavements a . Tests and demonstrations have been made on the s eet shown in Fig. 8, which horses have no difficulty in c nbing with heavily loaded wagons. The pavement is r er really slippery even when wet. The character of t surface when new is shown in Fig. 9. This rough- r s apparently lasts several years, and the concrete itself n f gritty, granite-like texture.

s it possible to make satisfactory repairs in concrete p ements after openings have been made for sewers, w er pipe, etc.? In Sioux City it is done. There is no d ying that these concrete pavements are difficult to b ak into. Openings have to be chipped away with drills a . sledges. Breaking up the slabs with crowbars is not p sible. Repairs over backfills are made in the same n aner as the original pavement, care being taken to e n and wet the edges of the pavement so as to obtain as g d a bond as possible. Some of these repairs are hardly n iceable.

What has been the maintenance cost of Sioux City's c erete pavements? Practically nothing. Except on t street referred to above, where the pavement was r ned by motor trucks, most of the cracks which have s wn up are too minute to require filling with tar. A s ll amount of tar patching has been done, but the cost i nsignificant when distributed over the 1,000,000 sq.yd. o concrete pavement in the city.

Iow much more than ordinary concrete pavements do se Sioux Citly pavements cost? Approximately 10c. p sq.yd., and all this goes into labor or *workmanship.* A already stated, the mix is leaner than current practice, n reinforcement is used, and armored joints have never b n considered essential. In other cities with inexpe- r iced contractors the cost of the better workmanship m ght be more.

t is unfortunate that physical tests have not yet b n made to demonstrate the difference between Sioux C y paving concrete and other concrete. For instance, t s for abrasion, porosity and specific gravity might p ve that just as much difference exists between a block of concrete made by the methods described and a block in ordinary concrete-paving practice as exists between hard-burned No. 1 paving brick and an underburned No. 3 brick. To make such tests would require that the blocks be sawed out of typical paving slabs, with such care as not to destroy any of the original bond between the particles within the test piece. Few city engineering departments are equipped to obtain such test pieces, and Sioux City is not one of them.

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New Methods of Handling Coal and Ore

Recent developments in coal- and ore-handling apparatus were discussed in a brief talk by C. D. Gilpin at a meeting of the Association of Iron and Steel Electrical Engineers, in Pittsburgh. He described a new style of coaling dock recently installed in a Southern port. The purpose of the design is to obtain the flexibility of the bin system without the high initial cost of the latter. Part of Mr. Gilpin's description follows:

> The dock carries a runway next to the water edge and not very much above water level; on this runway travels a loading tower. Behind this is another runway, elevated above the first by means of a trestle and carrying on its rails a turnover car dumper of the movable type. Beyond the car-dumper runway is a return track for empty cars. The loaded cars are pushed onto the dumper by means of a locomotive, and the coal is dumped into a 100-ton hopper on the rear of the loading tower, the dumper having been brought into line with the latter. The tower hopper is provided with a gate, through which the coal is fed into a scraper conveyor. The latter carries the coal up a pivoted inclined boom which extends out over the boat when loading and carries a telescopic chute at its outer end so that the coal may be directed where desired. The conveyor on the boom is the largest ever built of this type, having a capacity of 3,000 tons per hr. when the boom is approximately level.

Another loading tower will be added to this equipment as soon as business warrants it, so that one tower may be kept busy loading into empty hatches while the other takes an occasional carload from the dumper for trimming hatches already partly filled. Such a system as this may be operated by one 300-kw. rotary converter, and the peak loads are not sufficient to cause any noticeable variation at the end of a 6,600-volt line 4 or 5 mi. long.

At the Chuquicamata plant of the Chile Exploration Co. two gantry cranes are used to handle copper ore in and out of six concrete tanks 150x100 ft. by 16 ft. deep. The tanks are filled with ore by means of a gantry crane carrying a 36-in. belt conveyor. After a tank has been filled with ore, sulphuric acid is turned into it and the copper leached out. The residue is then excavated by another gantry, the trolley of which is almost identical with that used on stiff-leg unloaders along the Great Lakes. The operator is located directly over the bucket of the gantry and can therefore work very close to the sides and the bottom of the tank without injuring the sheet-lead lining. A simple mechanical distance limit is used to prevent over-travel when lowering the bucket. The tailings are dumped into a chute that projects over the tank, while the refuse is discharged into cars.

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The Coal Production of the United States in 1915 as announced by the U. S. Geological Survey was 442,600,000 tons of bituminous coal and 89,000,000 tons of Pennsylvania anthracite. The three leading states in soft coal production were Pennsylvania, with 158,000,000 tons, West Virginia with 77,000,000 tons, and Illinois with 59,000,000 tons. The other states in which more than 10,000,000 tons were mined, are in the order of their production: Ohio, Kentucky, Indiana and Alabama.

Field and Office

Seagoing Barge-Emptying Dredge for China

By F. C. Coleman*

The accompanying views show an interesting type of dredge that has recently been developed by A. F. Smulders, of Schiedam, near Rotterdam, for the Hai-Ho Conservancy Board, Tientsin, China. This dredge is of the barge-emptying and suction-loading type, and is capable of discharging the spoil into barges alongside, or through a floating pipe line 1,000 ft. in length, or through a shore delivery pipe line over a distance of 9,800 ft. The length between perpendiculars is 124 ft. 8 in.; the breadth is 32 ft. 10 in., and the depth 10 ft. 8 in.

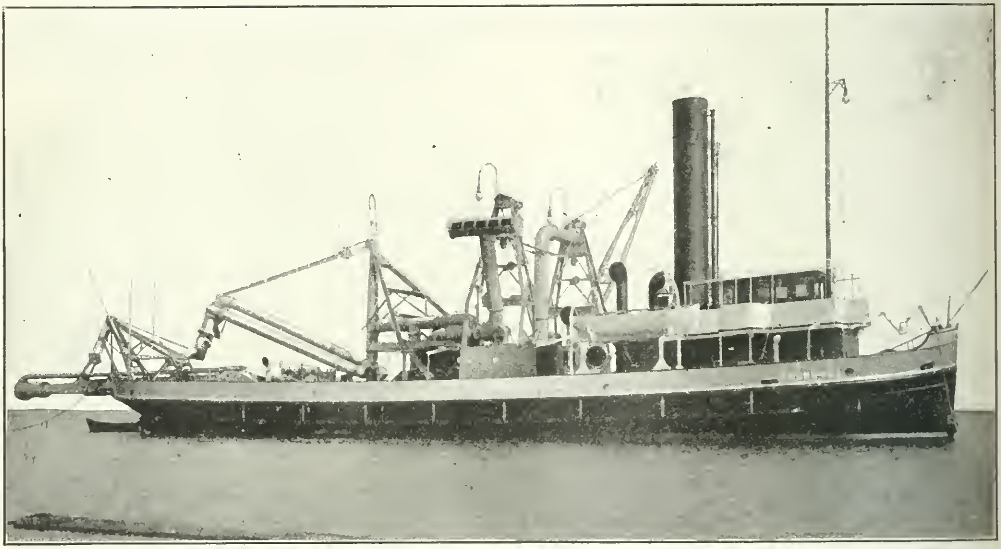

FIG. 1. SEAGOING BARGE-EMPTYING DREDGE "CHUNG-HUA" FOR HAI-HO CONSERVANCY BOARD

The vessel is used as a suction dredge, either working at side anchors or in motion, and as a stationary pumping station for the discharge ashore of spoil out of barges. For pumping while in motion, the dredge is arranged to discharge over either side into barges towed alongside or through an opening in the bow, at which a floating pipe line is connected when dredging at side anchors. For balancing the vessel the shore-delivery pipe line is fitted on the port side, while the barge suction is usually swung over the starboard side. The suction pipe for direct dredging at anchor is provided with a suction mouth, armed with a sleeve, so fitted as to avoid clogging when dredging a furrow 8 ft. deep in easily collapsible earth. When the dredge is in motion, the suction pipe is capable of reaching to a depth of 20 ft. and when dredging at anchor, with a different suction mouth, can reach to a depth of 25 ft. The normal service speed is approximately 8 knots.

The hull is of Siemens-Martin steel and was built in accordance with Bureau Veritas rules and under special survey. The hull is divided into seven water-tight compartments. There are two compound double-crank engines, with surface condensers, for propulsion, each developing 250 hp. at normal speed. One of these is arranged to be uncoupled from the propeller shaft and coupled to a 22-in. pump when the dredger works as a pumping station. One compound double-crank engine, with surface condenser, developing 500 hp. at normal speed, is placed in the middle of the vessel for driving two sand pumps. The exhaust steam of the auxiliary engines is discharged in the condenser of the sand-pump engine. The stern sand pump draws from the 24-in. suction pipe for direct dredging or from the 20-in. suction pipe for barge emptying. A stone-catching box is placed between the sand pump and the suction pipes; the mixture is delivered overboard into barges on either side or through the floating pipe line. An elbow is fitted instead of a pipe if the mixture has to go to the second sand pump as when both are working in compound for shore delivery. One compound double-crank high-speed engine drives directly a three-stage centrifugal pump for delivering water at the suction mouth at a pressure of 100 ft. water column.

The two main boilers are of marine type and have a heating surface of 1,500 sq.ft. each; the working pressure is 120 lb. A donkey boiler also works at a pressure

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*Central Station Hotel, Newcastle-on-Tyne, England.

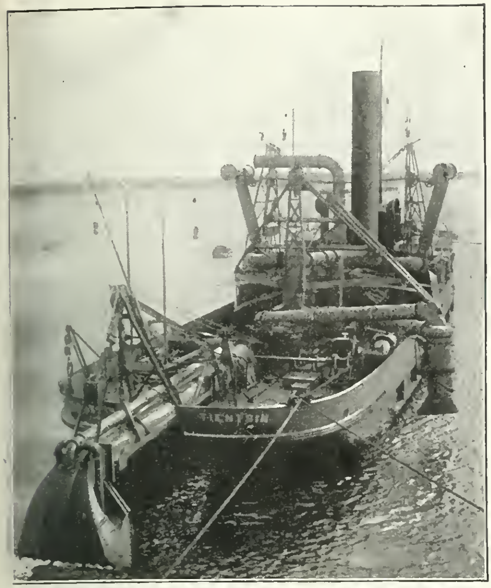


FIG. 2. DREDGE "TIENTSIN" OF TIENTSIN, CHINA

f 129 lb. On deck are the suction-pipe hoisting gear. he maneuvering winches, anchor davits, etc. An engine nd 100-volt generator supplies current for six arc lamps f 3 amp. each, and the necessary 16-c.p. incandescent amps in crew space, cabins, engine and boiler comartments. Search-light apparatus is provided to be ocasionally used instead of some of the arc lamps. On eck. in front of the funnel, there is arranged the wheelouse, which is at the same time the chart room. In t are placed steam and hand steering gear for working he rudders, a compass and a twin- and two single-reply legraphs. The dredge has cabin accommodation for he officers, and crew space. The cabins are steam eated.

When working as a pumping station and discharging poil over a distance of 9,800 ft. through a $24\frac{3}{8}$-in. pipe ine, the dredge delivers by means of the sand pumps 35 u.m. of water per minute; the water-pump output is 6 cu.m. of water per minute. When dredging at anhor and discharging through 1,000 ft. of 20-in. floating ipe, using one sand pump, the duty is 35 cu.m. per ninute; while dredging in motion and delivering into arges alongside the output for the sand pump is 70 u.m. of water per minute.

This dredge is the ninth vessel that the Smulders comany has supplied to the Hai-Ho Conservancy Board. t would appear at first sight that in China manual labor or dredging work would be much cheaper than mechanal power; but, despite the fact that Chinese labor harges are five times lower than in Europe, mechanical ppliances have proved to be much below the cost of manal labor. This difference is brought about not only by eason of the high power developed in a dredging plant, ut also, by reason of the fact that coal is 50% cheaper in hina than in Europe; and the weather does not affect he general expense with dredging machinery so much s with human labor.

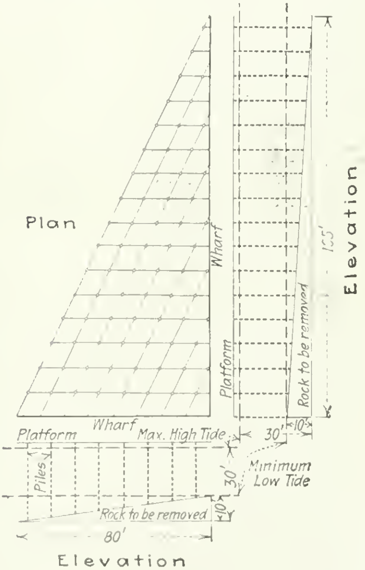
Subaqueous Rock Excavated from Platform

By Charles C. Phelps*

A submerged ledge of rock recently had to be removed at the drydock of the Grand Trunk Ry., Prince Rupert, B. C. Although the water is calm at this place, the rise and fall of the tide averages 20 ft. The shallowness of the water over the rock to be excavated and the large tidal variations rendered impractical the usual methods of subaqueous excavation by means of drill boats or adjustable drilling platforms (as described by the writer in *Engineering News,* Nov. 18 and 25, and Dec. 2, 1915). Instead, a temporary platform was erected over the entire work at the same level as the main dock, as shown in the accompanying sketch. There was sufficient mud overlying the rock to assist in holding the piles in place.

A drill with 9-in. stroke and $6\frac{1}{2}$-in. bore (Ingersoll-Rand, K 64) was used. It was mounted in a heavy cast-iron saddle which was substituted for the usual weight on an ordinary pile-driving outfit. A 20-hp. oil-fired boiler supplied the steam to operate the drill. The ways were greased and the improvised drilling rig was slid around on the platform wherever it was desired to put down a hole.

The rock was a very hard schist weighing 168 lb. per cu.ft. The holes were 3 in. in diameter spaced on 5-ft. centers. Sixty per cent. powder was employed, made up in special sticks 15 in. long and 2 in. in diameter. The ground was broken by this so that it could easily be handled with an orange-peel bucket.



SKETCH OF PLATFORM USED IN ROCK EXCAVATION AT PRINCE RUPERT

The drilling was started on Feb. 7, 1916, and finished on Apr. 13. Drilling was carried on six days per week, 20 hr. per day. In addition, the men worked on one Sunday, but were idle for five days, making a total of

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*Ingersoll-Rand Co., 11 Broadway, New York City.

54 days in operation. The average progress on an average day ranged between 5 and 6 ft. per hr., which covered the effect of delays and dead time. The average speed per hour while actually drilling was about 8 ft. The greatest progress attained in a day of 20 hr. was 120 ft. The poorest footage record was 9 ft. in 20 hr. The total footage drilled during this period was 4,269 ft. with a loss of 299 ft., leaving a net result of 3,970 ft. of holes. A total of 335 holes were shot and 72 holes were abandoned.

This contract was taken by James R. Stirrat; M. J. Hobin, of Prince Rupert, was the superintendent.

Digging End of Power Shovels

The digging equipment, the "business end," of a power shovel comprises the swinging circle, boom, dipper sticks and dipper, the swinging and crowding engines (which are practically always duplicate), the hoisting engine and the rigging. There is a great similarity among the engines used by the several shovel manufacturers. They are practically always of the double-cylinder, horizontal reversing type. In most cases, the boiler is purchased from a boiler manufacturer, and in probably all but one instance is designed for a working pressure of 125 lb.

The design of shovel booms varies in the case of the different manufacturers, but the two general types are the two-piece white-oak boom—armored inside and outside with steel plates, with the clearance space from the center of the boom to the base filled with white oak—and the all-steel boom. Believers in the armored boom claim that it can withstand stresses which would throw an all-steel boom permanently out of true. They claim further that the rivets in an all-steel boom are bound to work loose—an inconvenient condition when in the field. Makers of steel booms, while admitting that there have been cases where rivets have worked loose in the field, retort that the working loose of the bolts which clamp the armor plates around the oak booms is not less annoying. The Marion, Erie, Bucyrus and Osgood shovels can be equipped with either type.

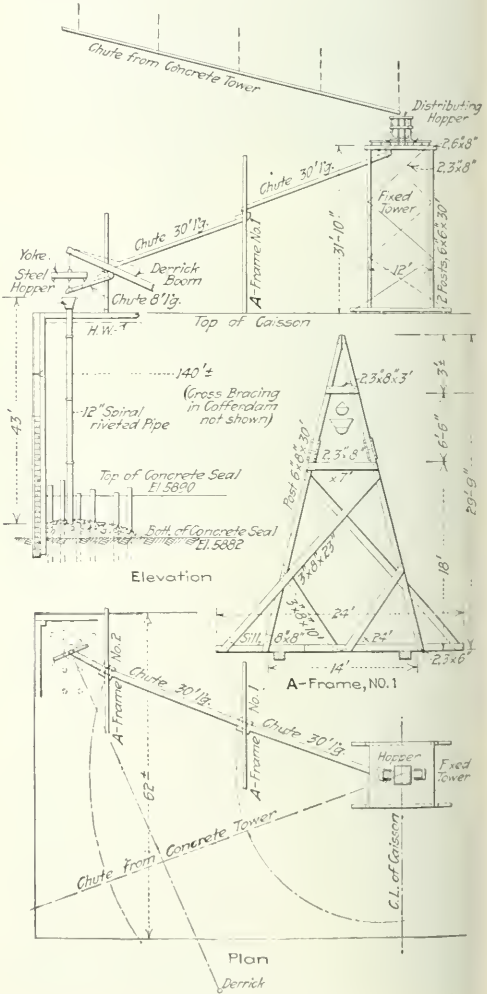
Large steam shovels, i.e., the 6- to 8-yd. machines used for stripping coal usually have all-steel booms well trussed and braced. In one instance the boom is pin connected to step castings resting on the two inner sills of the rotating frame immediately over the roller path, and is stayed by rods running from the truck frame to the middle of the boom.

The boom and dipper handle built by the American Steel Dredge Co. for their single-line shovel is of unusually neat and compact construction. Instead of employing bolts and rivets, the boom is built up of two channels welded together, flange to flange. This makes a smooth-surface box section.

The Thew idea in booms is that an all-steel heavy channel construction is the best. The Thew shovel is distinctive on account of its two independent crowding devices, both operated from the same hoisting engine. When the contractor wants to do road grading, he removes the long dipper stick and uses the short dipper arm. When he wishes to dig a trench he uses the shipper-shaft crowd, and chains the short dipper to the boom structure after removing the dipper. The trussed-boom structure consists of steel shapes and plates placed vertically, horizontally and diagonally, resulting in two booms in one.

Concrete in Dry Open Caisson Deposited by Tremie

The substructure of the Lifton pumping station at the Bear Lake river-storage development, Utah, was built by sinking by inside excavation an open timber caisson, about 62x140 ft. in plan, a depth of 45 ft., driving piles in the bottom and filling the caisson with concrete, first depositing a seal layer 8 ft. deep in the bottom. The seal was placed in the design in the expectation of heavy water pressure, but the excavation proved drier than expected, so that the seal virtually is a pile cap. The concrete above the seal elevation is full of openings for pump inlets, etc., which require a great amount of formwork inside the caisson proper. The caisson furthermore was thoroughly cross-braced, so that altogether there was a great deal of timber work which would interfere with the deposition of the concrete inside the caisson. On this account and further to remove the possibility of poor concrete due to



LAYOUT OF CONCRETE DISTRIBUTOR ON LIFTON STATION FOUNDATION oo long a drop, a tremie system of concrete deposition vas installed. Contrary to usual tremie practice there vas no water through which the concrete had to fall.

The accompanying drawing shows the details of the remie layout. It consisted primarily of a central fixed ower resting on the top cross-bracing of the caisson, with distributing hopper which took the concrete from the hute leading from the main concreting tower and disributed it through secondary chutes to the tremie. The econdary chutes rested on intermediate A-frames which vere moved around the top cross-bracing of the caisson as different parts were concreted. From the A-frame arthest from the center tower a short chute led to the remie, which was hung by means of an I-beam yoke from he boom of a derrick, the mast of which was outside of he caisson area. The smaller A-frame was removed as he concreting approached the center of the caisson area.

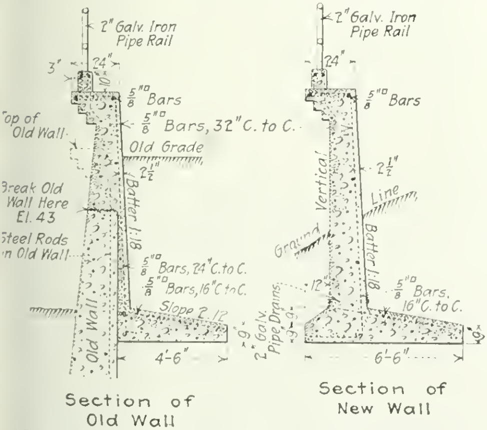
The tremie proper consisted of a 12-in. spiral riveted ipe with a funnel top dependent from the yoke. The peration was conducted in the same manner as the usual remie work in water is carried on; that is, the bottom of he tremie pipe was kept buried in the concrete and raised lowly, so that the concrete ran out only at the rate at vhich it was fed.

This work was carried out by the Jarrett-Chambers 'o., Inc., 30 West 42d St., New York City.

Building New Retaining Wall on Top of Old One

By C. E. Hasse*

In the course of recent improvements on Colorado Ave. n Santa Monica, Calif., the problem of increasing the eight of an old retaining wall was solved in an unusual nanner. The street grade along the south property line as raised an average of 4 ft. The original fill was nade some twelve years before and was well compacted. The old concrete wall was anchored to concrete blocks under the street fill, and the foundation extended a considerable depth below the original ground surface.



ADDITIONS TO RETAINING WALL AT SANTA MONICA, CALIF.

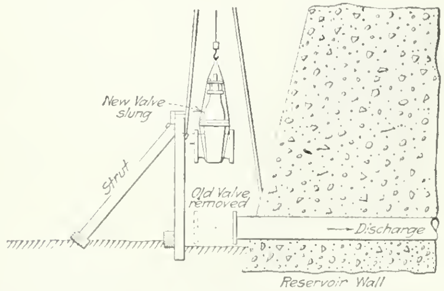
After a careful study of these conditions and the eculiar design of the old wall, it was decided to consider the old wall as a strip of solid rock foundation to carry the toe of a reinforced-concrete wall of cantilever type. Enough of the top of the old wall was broken off to expose about 18 in. of the vertical rods for tying together the old and the new work. The railing and the coping were made to conform in appearance with the old work that did not come within the scope of the reconstruction. The joint of the battered face of the old wall with the vertical face of the new wall was covered by a mask giving the effect of a pilaster.

In the drawing the section at the left shows a typical cross-section of the new wall built upon the old. At the right is a cross-section of the new wall, which extended 80 ft. beyond the old wall. The complete removal of the old wall and the construction of a new one to the full height would have more than doubled the cost of the construction.

The design was worked out and the plans were drawn by the writer under John A. Morton, City Engineer.

Replacing a Reservoir Scour Valve Against Pressure

A scour-valve spindle was found stuck, at the Katoomba storage reservoir in New South Wales. The occasion for attempting to operate it came when it was decided to increase the height of the dam. It was necessary to maintain the water near the old level during this work, since the water could not be wasted nor could it be allowed to rise against the green concrete as the dam was built higher. Another spindle was obtained and inserted through the nut. This time, when the key was applied, the spindle was turned a few threads when the cast-iron lug holding the nut snapped and the whole valve became unworkable. This accident was not due to any unusual stress, but merely to the cementing of the valve faces against the guides owing to long disuse. In the recent report for 1915 of the department of public works, F. C. Kendall of the Water-Supply and Sewerage Branch explains the measures taken to replace the valve.



HOW A NEW SCOUR VALVE WAS PLACED AGAINST PRESSURE AT THE KATOOMBA STORAGE RESERVOIR

A new valve (both old and new were 12-in. stop valves) was at once obtained having a flanged connection bored to suit the flanged end of the scour pipe. Over the site of the valve a shear-leg tackle was erected and the new casting was hung directly over its intended permanent position, as shown in the sketch. Before taking off the old valve, a vertical timber frame was erected at a distance from the scour-pipe flange about 2 in. in excess of the length of the valve casting. The frame consisted of two 6x6-in. uprights bottomed and fixed securely against a sill piece, and tied at the top by the heavy crosspiece and braced by diagonal struts on the downstream side as shown.

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*City Engineer's office, Santa Monica, Calif.

The bolts in the flange of the old valve were unscrewed and drawn back flush with the scour-pipe flange, all ready to insert in the new valve. A gang quickly pulled away the old valve, and the water began rushing out through the pipe under 26-ft. head.

The new valve was lowered through the water by tackle. It was directed against the framework so that in descending it was guided by the uprights. When the flanges of valve and pipe were opposite each other, the pressure was almost entirely relieved and the new valve was bolted to the pipe flange with little difficulty.

Concreting with Dump Car and Inclined Tower

A new idea in the placing of concrete is shown in the accompanying view. This represents the work on the foundation for an office building at the coke works of the Youngstown Sheet and Tube Co., Youngstown, Ohio, which is being built by the Stone & Webster Co.

Instead of a vertical tower with elevator bucket to the head of the distributing spout there is a steel incline on which a car is operated by a cable hoist. The car receives the batch from the mixer and dumps it automatically into the hopper-head spout at the end of the incline. At the right the concrete material is being dumped into the charging hopper of a Jaeger vertical-drum concrete mixer of 10 cu.ft. capacity. At the side of the drum is the gasoline engine which operates the mixer and the hoisting cables for both the charging hopper and the 10-ft. concrete car. One man controls all movements of charging, mixing and dumping.

The incline is 50 ft. long, and is built of 4-in. channels in 10-ft. lengths, supported by adjustable legs or bents of steel angles. The car is of the same capacity as the mixer and is dumped automatically at the head of the incline. The spouts are in 12-ft. lengths, mounted on pivots, so that they can be swung to any desired position and thus cover a considerable area.

This method of handling concrete is considered of special advantage for work which is not large enough to warrant a high elevator tower and long spouting system. It eliminates the labor cost of wheeling, as well as the difficulties of handling carts or wheelbarrows in restricted space. Steady and rapid progress can be made, as one batch is being mixed while the car is making its trip with the previous batch, so that the car is in almost continual operation.

The mixer, engine, hoist, water tank and charging hopper, together with the gallows frame for the hopper cables, are all mounted on a steel-frame truck, making a complete and portable unit. The entire outfit, including incline, can be erected in about 1½ hr. and dismantled in about ¾ hr. This concrete distributing system was devised by the Jaeger Machine Co., of Columbus, Ohio, which builds the outfits complete.

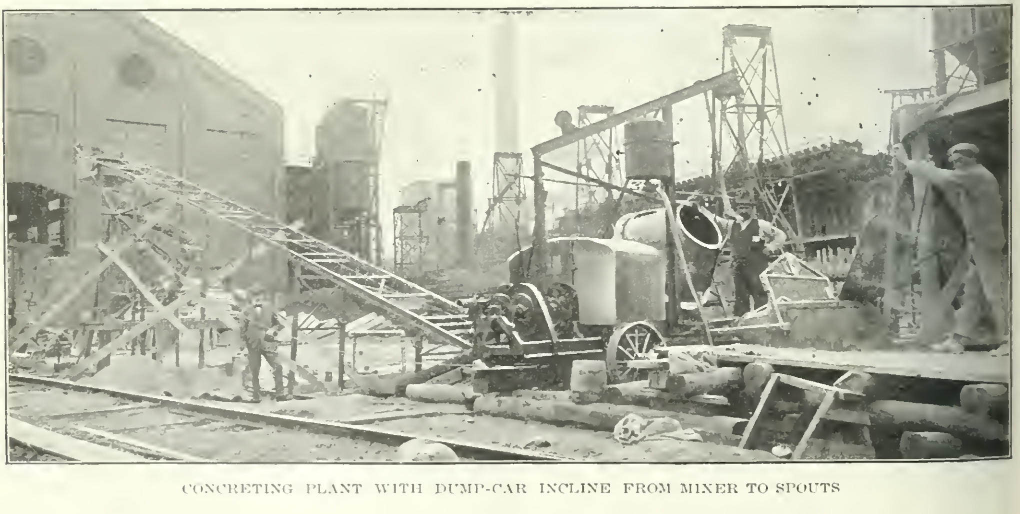
Two Recent Specifications for Hand-Mixed Concrete

Where reinforced-concrete pipe for culverts is made by company forces, the amount made at one time may be too small to warrant the use of a mixer. Two railways which make their own culvert pipe specify quite different methods of mixing the concrete by hand: one mixing the cement, sand and stone before adding water, while the other adds water before the coarse aggregate.

On the Great Northern Ry. the concrete mixture is 1:1½:4, using either gravel which will pass a 1-in. screen, or crushed stone that will pass a 1-in. and be held by a ¼-in. screen. For hand-mixing the specification makes the following requirements:

> The stone (or gravel) and sand shall be spread on a watertight platform to a depth of 6 in.; on this the cement shall be evenly spread and the mass turned till of a uniform color. Water shall then be added sufficient to make a plastic mass, and the whole turned over and over until thoroughly mixed.

On the Michigan Central R.R. the concrete mixture is 1:2:4, using stone or gravel that will pass a 1-in. and



CONCRETING PLANT WITH DUMP-CAR INCLINE FROM MIXER TO SPOUTS be held on a $\frac{1}{4}$-in. screen. For hand-mixing the specification is as follows:

The sand shall be spread on a water-tight platform. The cement shall then be evenly spread over the sand and the mass spaded until thoroughly mixed. The dry mixture shall then be raked to the sides to form a hollow, into which the necessary amount of water shall be poured, and the mass shall then be spaded until the mortar is thoroughly mixed to a uniform consistency and color. The mortar shall then be spread out to a thickness of about 6 in. and the stone be deposited in the same. The whole mass shall then be turned, shoveling it toward the center in a heap and then raked out again. This process shall be repeated not less than six times or until all the stone is fully covered.

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Street Work Done Under Tent

In spite of severe rains, an urgent piece of storm-drain repair under a street in Charlotte, N. C., was recently completed by City Engineer S. H. Lea, after a tent had been pitched over the excavation.

During a record-breaking storm (1.5 in. of rainfall in a half hour) a low-lying section of the city was flooded, and after the water had subsided a sink hole, about 4x6 ft., was found over an old drain. A force was set to work to excavate down to the drain, which was about 14 ft. below ground. Rain continued to fall, and the sides of the pit caved at frequent intervals—although they were well braced.

To protect the concrete work and to allow the men to proceed without interruption, a 10x12-ft. tent was erected over the pit. The drain, a 24-in. terra-cotta sewer pipe, was found to be in bad condition. It was 20 years old and had crumpled in places; at the main break it had collapsed at the bottom from the load of earth above it.

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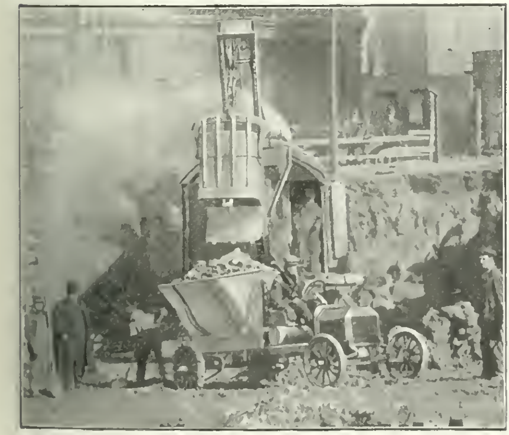
Converted Automobile Used as Motor Dump-Wagon

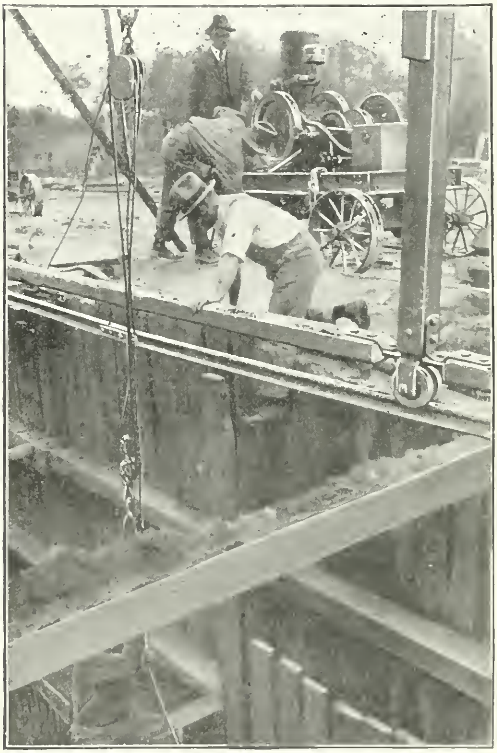
A light motor dump-wagon adapted for use on small jobs is shown in the accompanying view. It was built by the Smith Form-a-Truck Co., of Chicago, for a contractor at Detroit, Mich. The truck is made from a Ford automobile. The rear axle is removed and the Smith extension frame attached in its place, the engine being connected to a countershaft carrying the sprockets for driving chains to the rear wheels. On this frame is mounted a $1\frac{1}{2}$-yd. Lee dumping body. The machine is rated at 1 ton capacity, with allowance for 50% overload. Nearly 90% of the load is carried by the rear axle.



MOTOR TRUCK OF 1-TON CAPACITY, MADE FROM A FORD AUTOMOBILE

NOTES

Backfilling Machine Pulls Sheetpiling—In the construction of the Como-Snelling sewer system, St. Paul, Minn., described in "Engineering News," June 8, 1916, the contractor had occasion to remove a large quantity of wood sheetpiling driven in the lower half of a trench 25 to 30 ft. deep. For doing this he utilized an Oshkosh backfilling machine. The hauling line was passed down to a sheave under the truck of the machine and thence over another through a snatch-block to a three-part tackle hung from a beam on the Carson trenching-machine framework and taking hold of the sheetpile by a jaw. The hoisting tackle could be readily moved the full span of this beam without moving the backfiller. The contractors, the Thornton Brothers Co., St. Paul, stated that the device had saved much time and money.



PULLING SHEETPILING WITH BACKFILLING MACHINE

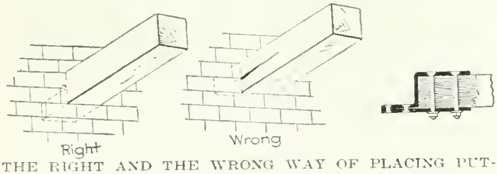
A New Steel Car for the Bureau of Fisheries, especially designed for carrying live fish long distances, has just been put into service. Insulated tanks on each side of the car contain 130 ten-gallon cans in which the fish are carried. The water in the cans is aërated by air pumps driven by steam from a 6-hp. boiler. Tanks for a reserve water supply are located beneath the car. An icebox of one-ton capacity enables the transportation of species which require the water to be kept cool. The car also contains living accommodations for the crew of five men that travel with it. The total weight of the car and equipment is 150,000 lb., and it is designed for a load of 35,000 lb. The car is 60 ft. long and is carried on two six-wheel trucks.

The Cost of Operating a Ford Motor Car for three years, during which time it ran 14,225 mi., is given in the following summary, from the records of the Grand Valley project of the United States Reclamation Service. The car is a 1912 model 20-hp. 4-cylinder 5-passenger Ford. It was the only motor car owned by this project up to the first of this year. The following is an itemized cost record:

Classification	Year 1915		3 Yr. to End of 1915	
	Unit Cost	Amount	Unit Cost	Amount
Gasoline	$0.0105	$60.31	$0.0121	$172.04
Lubricants	0.0035	19.81	0.0025	35.70
Tires (including repairs)	0.0145	82.89	0.0163	231.85
Other repairs	0.0535	306.22	0.0475	676.01
Supplies	0.0010	5.95	0.0007	9.26
	$0.0830	$475.18	$0.0791	$1,124.86
Other incidentals:				
Garage expense	0.0061	35.00	0.0076	107.90
Towing	0.0016	9.00	0.0007	10.00
Chauffeur	.....	.....	0.0009	12.65
Depreciation	0.0408	233.39	0.0310	443.82
Totals	$0.1315	$752.57	$0.1193	$1,699.23

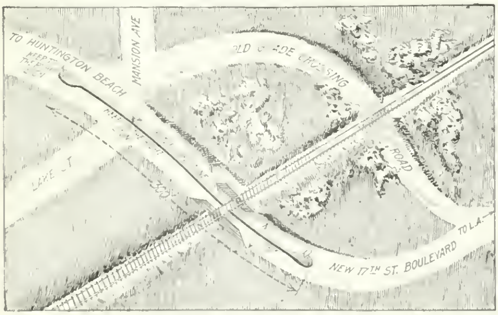
The number of miles run in 1915 was 5,721, and the average number of miles per gallon of gasoline was 17. The total number of miles run per gallon of lubricant was 231.

Putlogs, Putlocks, Puds and Crossbars are synonymous, being the several names given by masons and builders to horizontal sticks that jut out from a wall and afford direct support to the planking of a temporary platform. They are discussed in a new book, "Scaffolds." The best putlog material is chestnut, spruce being a good substitute. Split or hewn material is preferable, but the chief requisite is the soundness of the material. Putlogs should be at least 4x4s when used in the ordinary bricklayers' scaffold, and should project over the ledgers at least 1 ft. They should be placed as shown in the left-hand sketch, and at least three should be provided under every plank of the platform. Brick walls are frequently laid up with wide intervals between the rows of brick, a space of ⅝ in. being more or less common. This has led to the devising of forms of putlogs that enable the builder to erect a scaffold without leaving out bricks here and there for the support of the platform. One of these special designs is shown at the right in the sketch. Instead of being notched at the end the putlog is fitted with a shoe consisting of two pieces of sheet steel each about ¼ in. thick, one piece lying straight along the bottom, the other being bent at right angles twice. Three strips are folded together as shown and their free ends joined by countersunk rivets. The tongue is narrow enough to allow being placed between two successive rows of bricks.



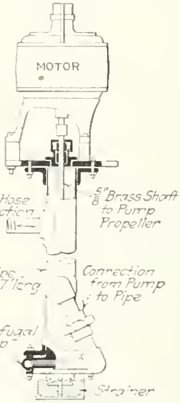
THE RIGHT AND THE WRONG WAY OF PLACING PUTLOGS, AND A PUTLOG FOR WIDE BRICK SPACING

No Grade Crossings need be encountered in entering Huntington Beach, Calif. The sketch shows the worst grade crossing eliminated. Two bad features obtained here formerly: The right-of-way of the Southern Pacific tracks was obscured by trees and a cut, and the highway crossed the track with a reverse curve. The road has been straightened to some extent, as shown. The railway crosses the road on a 50-ft. span. This is unfortunate, as the boulevard is elsewhere 75 ft. wide. A center curb of concrete 6 in. high runs along the road for 150 ft. on each side of the crossing. At the ends of the curb large electric signs warn vehicles to "Keep to the Right."



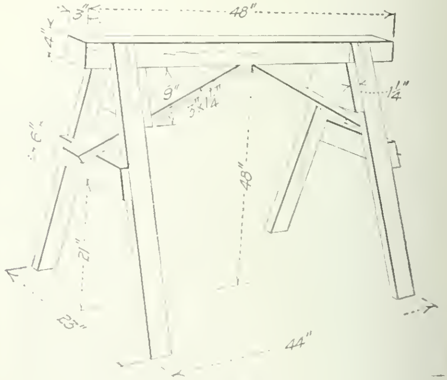
HOW DANGEROUS CROSSING WAS ELIMINATED AND THE SHARP CURVE STRAIGHTENED

A Manhole Pump, home-made and motor driven, as built by the Rochester (N. Y.) Gas and Electric Co., is shown in the accompanying sketch. Construction and use are thus described in the company's employees' magazine: A ¼-hp. 1,400-r.p.m. vertical motor and a small centrifugal pump were connected by a 3-in. spiral-riveted pipe 7 ft. long. The pipe acts as a support for the motor, is long enough so that the pump can be lowered into the water without submerging the motor and at the same time conducts the water from the pump to the street level. The shaft of the motor and the impeller of the pump are connected by a ⅝-in. brass rod running through the 3-in. pipe. The complete apparatus weighs about 170 lb. and is supported by a small crane attached to one of the company's trucks. The crane is a small pipe with a long-radius bend and hook at one end, so that the pump can be swung over the edge of the truck and lowered into the manhole by means of a block and tackle. The pump requires only a small amount of power, and the motor is operated by the battery that operates the truck. In the spring of the year and after heavy rains the manholes that have no drains are flooded with water above the cables. The cable ducts connecting the manholes allow the water to flow from manhole to manhole until a number have become filled, making it necessary to pump the water out before any work can be done on the cables. In the past a hand pump was used. This motor-driven pump will empty a manhole in 15 min., whereas it would take two men almost an hour to do the same work with a hand pump.



ROCHESTER MANHOLE PUMP

A Well-Designed Horse of the mason variety is shown in the sketch. This structure—it is sufficiently important in the building trade to be thus dignified—is often used as a support for planking, thus forming a scaffold. Sometimes this temporary construction reaches six or eight tiers in height. Such scaffolding is unstable at best and not infrequently is a criminal menace reflecting upon the building superintendent or his superiors. There are various arrangements of timbers all answering to the name of horse, but the design presented herewith and recommended by the Travelers Insurance Co., of Hartford, Conn., is about as cheap and as simple as one could ask.



A MASON'S HORSE BUILT BOTH FOR STRENGTH AND CHEAPNESS

Editorials

Prospects for Railway Building in Russia

The recent remarkable military successes of Russia and the placing of a $50,000,000 Russian loan in the United States make opportune the announcement by the American-Russian Chamber of Commerce[1] of New York City that great opportunities for American capital and American engineering talent will be open in Russia after the close of the war. The organization referred to includes a number of the leading bankers and business men of New York, Boston and other cities.

More than any other European country, Russia is rich in undeveloped natural resources. The prompt exploitation of these resources will be essential for Russia in order to meet the enormous war debt that it has incurred. It is noteworthy, however, that this debt has been largely subscribed by its own people, a thing that has only been made possible by the great economic advance that Russia has made since the close of the Russo-Japanese war.

In order to develop its vast natural resources in mineral wealth, agriculture and lumber, a large amount of railway construction is the first essential. During the war, as is well known, Russia is building a large mileage of military railways made necessary by military conditions. This will be followed at the close of the war by commercial railway lines, leading Russian economists estimating that at least 10,000 km. per annum must be built. The United States, notwithstanding the sparsely settled portions of its area west of the 100th meridian, has 1.9 mi. of railway to each 100 sq.mi. of area. Russia has only ½ mi. of railway to each 100 sq.mi. of area. The United States, again, has 29 mi. of railway for every 10,000 of population. Russia has only 3.2 mi. of railway. In order to build these railways Russia must import at least half of the steel rails and rolling stock that will be required.

⁂

Repetitious Road Discussions

One who attends many road congresses—and there is one being held somewhere every week—or reads the voluminous proceedings of these meetings, must be struck with the monotonous sameness of practically all the papers presented. Almost invariably they deal with elementary principles, and then launch out into the author's theories and recommendations—which are likely to be common knowledge. An engineer who has not had recent experience in roadbuilding, and who is suddenly called upon to assume responsibility for selecting a type of pavement to meet conditions which are reasonably ascertainable, finds mighty little to help him in such discussions.

It may be argued that the inexperienced engineer should have recourse to some paving expert for advice. But who are the highway experts but the identical authors of these voluminous proceedings? And in reading their papers and discussions, our seeker-after-information speedily finds out that these experts seldom clearly present any deciding factors in pavement design.

What the seeker-after-information wants is not repetitions of elementary matter which may be found in any standard textbook, but frank and honest expressions of experience with this or that type of pavement. Was it a success, or was it not a success? If it failed, how, why and under what conditions; if successful, why and against what odds? From a symposium of succinctly stated frank expressions of experience, something definite could be concluded.

There are many reasons why such experiences are but rarely given. Engineers are reluctant to get up before their fellows and acknowledge errors, mistakes, and failures; they dislike to pass judgment on this or that material, for politic or other reasons; and there is the proverbial tendency of man to believe he has cornered all knowledge on some subject to which he has given particular attention, and to wish to keep it cornered.

If the proceedings of road congresses are to be of practical value to engineers, if they are to do something more than to boom good roads, those who take part in them must "get down to brass tacks," be frank with one another, and tell what they do not know as well as what they do. Attention will then be concentrated on the real problems of modern roadbuilding, which are many as well as real.

⁂

Applications of Powdered Coal Fuel Steadily Increasing

A quarter of a century ago numerous inventors worked on the problem of using powdered coal as fuel and some of them achieved a fair degree of success. The advent of cheap fuel oil about that time, however, prevented the invention from being successful commercially except in the field of cement burning. Here the use of powdered fuel was a very important factor in the success of the rotary kiln. It effected a large reduction in the cost of burning compared with the fuel oil which was used at first. The use of powdered fuel for other purposes was abandoned until three or four years ago, when it was successfully applied to metallurgical furnaces. Since then the use of powdered coal has been experimented with in various other directions, notably as a locomotive fuel.

Those responsible for the use of powdered coal in the cement industry early learned, through some very costly and fatal accidents, that certain precautions were necessary in its use to guard against disastrous explosions.

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[1] The American-Russian Chamber of Commerce has offices at 60 Broadway, New York City. Charles H. Boynton is its President, and among its directors are Samuel McRoberts, Vice-President of the National City Bank; Charles H. Sabin, President of the Guaranty Trust Co.; Charles Hayden, of Hayden, Stone & Co.; William J. Chalmers, of Chicago; and William Butterworth, President of Deere & Co., of Moline, Ill.

When it is recalled how frequently bituminous coal in place in the mine gives off inflammable gas, it can readily be understood that when bituminous coal is ground to an impalpable powder it is much more likely to give off a gas, which mixed with air in any confined space only needs a chance spark to produce a heavy explosion. Fine coal dust itself when floating in the air is also well understood to be a dangerous explosive. Further than this, any considerable bulk of powdered coal held in storage for a few days is apt to develop spontaneous combustion.

At the recent Master Mechanics Convention, Mr. Chambers, who has been in charge of experiments with powdered fuel on a locomotive on the Chicago & Northern Ry. declared that it was not safe to store a quantity of powdered coal exceeding 10 to 15 tons longer than three or four days at a time.

Anyone familiar with the chemical constitution of coal will readily understand that its liability to spontaneous combustion when powdered will vary greatly with different coals. If a consignment of coal happened to have an especially large percentage of pyrites in it, someone might be disagreeably surprised at the rapidity with which it would develop heat after being ground.

The question was raised in the discussion as to what a railway would do should it adopt powdered fuel for general use on its locomotives. At large railway coaling stations it is common to deliver to locomotives 2,000 tons or more of coal in 24 hr. The answer to this question is that in handling powdered coal the thing to do is to avoid storage as much as possible. Coal-pulverizing machinery should be of sufficient capacity to handle the coal as fast as it is used, with a sufficient margin for extraordinary demands and for breakdowns. A minimum storage and no dust are the standing rules that must be observed to obtain safety in the use of powdered coal.

Many have predicted the commercial failure of powdered coal burning systems on the ground that present methods of using coal are so efficient that any increased saving in fuel through pulverizing will be more than offset by the cost. The advantages from the use of powdered coal, however, come from other sources than a mere increase of efficiency in burning the fuel. Those who are promoting its use in locomotives, for example, hope to make the powdered coal burning locomotives so free from smoke and sparks that they can be used inside city limits for switching locomotives to offset the public demand that the railways shall expend enormous sums for electrification, in order to get rid of locomotive smoke. Locomotives burning powdered coal could also be used in forested regions where the railways are now in some cases compelled by public authorities to burn oil fuel to avoid the risk of setting fire from scattered sparks.

Probably the greatest field for the burning of powdered fuel, however, will be in aiding the economical utilization of fuels which are difficult to burn efficiently by ordinary methods. For example, there are in the far West deposits of lignite of almost unbelievable magnitude. The United States Geological Survey has just issued a bulletin reporting surveys of the quantity of lignite in Perkins and Harding Counties in the northwest corner of South Dakota. The Geological Survey estimates that in these two counties alone there is more than one billion tons of lignite available for mining, and this estimate was made without including any beds less than 2 ft. 6 in. thick. The Dakota lignites contain nearly 50% of volatile matter and have shown remarkably good results as a fuel for gas producers and as a material for briquettes. The cheapest way to use this fuel, however, is in the form of powdered coal. The high content of volatile matter is especially favorable to firing in this way.

Another fuel which seems capable of use in powdered form is peat. Sweden, which has no coal deposits, possesses large peat bogs. A recent report of the Department of Commerce states that the Swedish state railways have been experimenting with powdered peat as fuel for locomotives, and the railway directors have recommended an appropriation of $350,000 for a factory to produce sufficient powdered peat to supply all the locomotives on one of the state railway lines.

⁂

Using the Tremie for Placing Concrete in the Dry

The tremie has become an indispensable tool in underwater concreting because it is thoroughly recognized that concrete freely dropping through water easily separates into its components, thus destroying its purpose and value. That a similar though less pronounced action takes place when air instead of water is the medium is sometimes admitted but as a rule the drop has to be very great before any precautions against segregation are thought worth while. One case where this uncommon admission is tacitly made is noted on another page of this issue, where the use of a tremie in depositing concrete in the dry coffer-dam at the Bear Lake pumping station is described.

The practice there used is worth copying in many pieces of concrete work. Too often concrete is laboriously conveyed over a considerable distance with every care to prevent segregation only to be dropped to its final position in a free fall that tends, at least, to nullify all of the other precautions. The tremie is designed to cure just such an evil, to preserve, at some loss of speed, the integrity of the mass. In heavy work, where entrance to the opening to be filled is uncongested, chutes and buckets can readily be brought close to the place of deposition, but in thin walls or columns, not too cluttered up with interfering rods, or in large mass work where forms and braces prevent entrance, it would seem that the additional aggregation of the concrete gained by tremie placing would weigh heavily against the undoubted added expense and trouble of such an innovation.

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Elementary Acoustics for Outdoor Speaking

Why is it that when a great educational institution celebrates some important event and invites distinguished men to deliver addresses, no attention whatever is given to producing acoustic conditions that will enable the audience to hear? A notable instance occurred at the recent dedication ceremonies at the Massachusetts Institute of Technology.

The dedication of the new buildings was the crowning event of Technology's celebration week. No pains and expense were spared to make the affair a success. In order that the great central court might be ready for the dedication ceremonies, a large force of workmen labored all night long, removing the grand stand, which on the evening previous had accommodated 7,000 spectators of the pageant. The speakers' platform was placed in front of the central portico, and in front of it were ranged thousands of chairs for the alumni and the invited guests.

The eminent men who addressed the audience were experienced public speakers, familiar with all the arts that assist in making the spoken word audible to an audience; yet to probably two-thirds of those present the speakers might as well have been the actors in a moving-picture scene, for all that could be heard.

It needs only the most elementary knowledge of acoustics to understand why the speakers' voices were ineffective. Back of the platform on which they stood was the double row of huge columns which extends along the main entrance to the building. The voices of the speakers, reflected from the curved surfaces of these columns, were broken into a confused mass of echoes.

Conditions almost exactly similar occurred at another famous educational institution a year ago, when President Frank J. Goodnow was installed at Johns Hopkins University. Here also, an audience numbering several thousand was gathered in front of the main building of the university; the speakers stood on the portico of this building, and behind them was the series of columns which forms the chief architectural decoration of the entrance. To make the acoustic conditions even more difficult, the audience was separated from the speakers by a broad terrace, a flight of steps and a driveway some 20 ft. in width. The inevitable result was that three-quarters of those who came to hear the distinguished men saw their gestures, but had not the faintest idea what the speakers said.

Still another case is worthy of record here. In a certain large Eastern city a few months ago, the local engineers' club invited all the engineering and scientific organizations of the city to join in a "get-together" dinner. The dinner was held in the roof garden of one of the principal hotels, an area decorated with pergolas and with part of it roofed over and a part open to the sky above. The speakers' table was placed directly under one of these open spaces, with the result that the after-dinner speeches floated harmlessly up to the blue vault of heaven and were inaudible to those seated 25 or 30 ft. away.

Now, it will surely not be disputed that if it is worth while for a distinguished man to go to the trouble of preparing an address and making a journey to address an audience and worth while for the audience to take the trouble of going to hear him, then it is certainly worth while to surround the speaker with whatever reasonable accessories will enable his voice to be heard.

Anyone familiar with the laws of sound set forth in any elementary treatise on physics can easily understand why the speakers' voices at the Technology celebration and at the other places mentioned reached only a small part of the audience; and with the same elementary knowledge it is easy to understand why simple accessories, which have been used for centuries, are an effectual aid to a speaker addressing an audience out of doors.

One can see in cathedrals built in the Middle Ages reflecting sounding boards, often of great architectural beauty in their design, placed over the pulpit in such a manner as to reflect the speaker's voice toward the audience and prevent it from being dissipated in the upper part of the edifice. Devices of a similar order, although of the crudest construction, have been used for generations on the speakers' stands at country camp meetings. The care with which Billy Sunday designs the pulpits in the tabernacles which he builds so as to make what is said on the platform audible all through the edifice has been widely published by the newspapers. In Germany one sees the same principles carried out with scientific thoroughness in the band stands erected in some of the municipal parks. Here the roof that shields the stand from the weather is carried down to close it entirely on one side, and on the other it is entirely open. The smooth interior of this inclosing structure is of such a form as to reflect the sound outward over the garden where the audience is seated.

Many other instances could be cited to show the great advantage it would have been to the speakers and to the audience at Cambridge and at Baltimore if some simple sound-reflecting structure had been provided over the speakers' stand.

That it is possible to produce acoustic conditions that will enable an audience out of doors to hear a speaker as perfectly as indoors is admirably illustrated by the Greek Theater at the University of California. Of course all the conditions there are not reproducible in an auditorium for temporary use; but well-arranged sound-reflecting surfaces around the speaker will accomplish a great deal.

The most puzzling problem in connection with the whole matter is the principle involved. Why did these two great scientific institutions, justly eminent for their achievements in original research, fail to apply the elementary principles of science in the conduct of a great celebration? Still another instance of a similar sort is the auditorium built by the University of Illinois a few years ago, which has become famous because of its phenomenally bad acoustic properties.

It is altogether probable that the men responsible in each of the cases discussed had at least an elementary knowledge of the science of physics. The failure lay in not applying this knowledge in a practical way. It is a question worth serious consideration whether the situation of which the foregoing cases are typical does not show a defect in our modern educational systems. It is not the knowledge which a man possesses in an abstract way that enables him to do his part in the world's work, but the knowledge of which he is able to make practical application. In the competition to lead in original research, has the fact been lost sight of that the business of the school laboratory is first of all to enable the student to become practically familiar with elementary principles of science?

There is now pending in Congress a bill to grant a Federal appropriation of $15,000 a year to each state to aid original research in mechanical science carried on at some educational institution. That such an appropriation might produce some measure of benefit will not be denied; but is original research at scattered schools and colleges after all the great need of technical education? Is there not vastly greater need at the present day of a better application of existing knowledge and often of elementary knowledge? In other words, are not the mistakes and blunders and inefficiencies in all departments of life, in both public and private business, due to ignorance of and failure to apply the well-known principles of science, rather than to a lack of the facts which original research might reveal?

Letters to the Editor

Pump Tests with Pitot Tube

Sir—The writer has read with great interest the article in *Engineering News*, July 6, 1916, entitled "Difficult Pump Test Made with Pitot Tube." The most startling part of the paper is the author's statement that "the possibility of using a Pitot tube was affected by the common assumption that this instrument cannot be used except where the water is under pressure."

It would be of interest to know where this "common assumption" originated and the reason for it. If Mr. Grunsky knows of any laws of mechanics or hydraulics that prevent the use of a tube under negative pressures or that detract from the accuracy of the results when so used he ought to give the information to his brother engineers.

During the last twenty years the writer has conducted tests of about two hundred pumping plants and in a majority of cases has used the Pitot tube to measure the quantity of water. In scores of cases the tube has been used in the suction pipe because the velocities in the suction pipes are usually less turbulent than in the discharge pipe. Often when the tube has been used in the discharge pipe it has been under a vacuum, for in this section the discharge pipes are made to discharge under water in drainage plants.

Given good instruments and careful work, the writer has never been able to discover any difference in the accuracy of the Pitot tube whether under pressure or vacuum. Primarily it depends on the difference of head at static and impact openings and it is difficult to imagine any fundamental difficulty whether the static head is positive or negative.

Another interesting point is Mr. Grunsky's elaborate manometer for reading the difference of head on the Pitot tube. The results obtained, as shown by the sample curves, were uniform and satisfactory. It seems to the writer, however, that it would have been much simpler and easier had a water column been used (instead of tetrachloride of carbon) in a plain inverted U-tube the two legs coming straight up from the top of the tube.

The velocity of 10 ft. per sec. does not seem excessive as it is an easy matter to measure velocities that are much greater by means of a mercury column in a U-tube. The writer has measured velocities as great as 26 ft. per sec. in this way. If the head on the Pitot tube had been read directly in feet of water, as suggested above, when the velocity was 10 ft. per sec. the difference of head would have been 1.55 ft. Heads of 3 ft. or more are often read in the way suggested. The advantage of the inverted U-tube manometer with water as the fluid is that there is no correction to be made for the specific gravity of the liquid and that air bubbles rise to the top revealing leaks and thus make it possible to be absolutely sure that the condition of the tube is satisfactory before observations are begun.

In regard to measuring the head on the pump—the method used seems to be correct provided the true average pressure in the suction pipe may be observed at *I* (Fig. 2, p. 9, July 6, 1916) and the true average pressure in the discharge pipe is at *K*. The correctness of this assumption can only be proved in a given case by experiment. Other openings in the same cross-section need to be made and observations taken. It is supposed, of course, that observed head read from manometer was corrected for difference of velocity head in suction and discharge pipe in case such a difference existed.

W. B. GREGORY.

Tulane University, New Orleans, July 18, 1916.

* * *

Government Engineering Not Offered in Competition

Sir—Several letters appearing in your columns, and your recent editorial, relative to "free government engineering services,"[1] have been noted with much interest; and inasmuch as there has been direct reference made to the Lexington, Ky., sewage treatment case, with which I am entirely familiar, I believe a few statements regarding it will be of interest to your readers.

Preliminary plans and recommendations for a method of sewage treatment for Lexington were prepared by the writer's firm, under a contract entered into with the city officials. Bonds were voted for the installation of sanitary improvements and at the same time a new set of City Commissioners was elected. To these latter was submitted the plan proposed by my firm, and certain suggestions and recommendations by promoters who claimed that they could by an improved method of treatment of the city's sewage save Lexington thousands of dollars. Obviously there arose in the minds of the new Commissioners a question as to which of the proposed methods would be the best for the municipality.

The United States Public Health Service, a nonpartisan, nonpolitical department of the Government, having in its employ officials of broad experience, wide reputation and sterling integrity was appealed to. This department sent two of its most competent and experienced representatives to advise with the city. Doctor Frost, Passed Assistant Surgeon, who is in charge of the Government sanitation and drainage investigation work at Cincinnati, advised the Lexington authorities that it was "not the province of the Government engineers to make surveys and detail reports, looking to the preparation of the working plans and specifications, as those things belonged to the duties of the consulting engineer engaged by the local authorities."

The foregoing statement is of record, and can be verified. These specialists investigated the different plans and processes recommended and suggested. Their report analyzed the accumulated data and in conclusion advised the city as to the method that was best adapted to local requirements, and specifically recommended that the city retain a consulting engineer to render the necessary detail engineering service.

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[1] "Engineering News," June 1, 1916, pp. 1052, 1056; July 6, 1916, p. 36.

Having come in direct contact with the methods of this department and realizing that the United States Public Health Service is not only rendering the cities and states invaluable service but is also endeavoring to coöperate with the engineering profession, it gives me much pleasure to indorse the work they perform and to suggest a closer affiliation between engineers and this branch of the Government service. P. H. Norcross.

Atlanta, Ga., July 11, 1916.

Most Philadelphia Sewers New

Sir—In *Engineering News*, of July 6, p. 17, is an article entitled "Regular Inspection of Sewers Part of Maintenance."

In the beginning of the article you state, "As in all the older Eastern cities, the sewers of Philadelphia are wearing out."

I cannot let this statement pass without calling attention to the fact that 20% of the main and branch sewers have been built since 1904, 50% since 1894 and 80% since 1884, so that three-fourths of the present mileage is of modern design and construction and is calculated to stand from one to 300 years. Therefore, I think your statement is not justifiable.

George E. Datesman,
Director, Department of Public Works.

Philadelphia, Penn., July 14, 1916.

[The editor admits that the general statement, so far as it concerns Philadelphia, does not apply. Apparently most of the old sewers of Philadelphia have already worn out and have been replaced by a second generation of sewers.—Editor.]

Brakes for Hydraulic Turbines

Sir—The matter of providing brakes for hydraulic turbines equipped with pivoted or Fink gates seems to have received little attention. Several instances have occurred recently where such turbines not equipped with brakes could not be stopped by closing the gates. At least one firm of turbine builders is strongly of the opinion that a brake should be provided as a regular equipment on every turbine of this type. However, they find that engineers seldom specify that such brakes be included except in special cases where the head is relatively high.

The pivoted gates of a hydraulic turbine commonly serve two functions: (1) To regulate the quantity of water supplied to the turbine as the load varies; (2) to shut off the flow through the turbines when the turbine unit is shut down.

The Fink pivoted type of gate is admirably adapted to the first of these uses. It is by no means as well adapted for the purpose of shutting out the flow through the turbine. In some cases it appears probable that the design might be approved and the efficiency increased if the gates are so constructed as to serve the first purpose only, and separate means are used to shut off the flow through the turbine. For large turbines under relatively high heads it is practically impossible to make the points of the vanes swing against the sides of the adjacent vanes with a sufficiently accurate fit in all cases to prevent some water spurting or leaking through into the runner of the wheel. As a rule, some of the vanes will be much tighter than others. Furthermore, if an obstruction, however slight, is lodged between two of the vanes, near their points, it will prevent a tight closing of the turbine gates. With a modern hydraulic turbine of efficiency 90% or over, with roller bearings, a surprisingly small jet of water is sufficient to keep the turbine in motion when it is once started, especially when it operates under relatively high heads.

In view of these conditions and to facilitate stopping of the turbines to remove obstructions from the gates, it seems desirable that brakes should be provided, and I am writing this letter to call the attention of engineers to the matter with the hope of obtaining their opinions in relation thereto. Robert E. Horton.

57 No. Pine Ave., Albany, N. Y., July 20, 1916.

"Inventories and Histories"

Sir—At the time that the editorial under the above heading (*Engineering News*, June 29, 1916, p. 1213) was being written, the writer was standing on an eminence in Wylandville, Washington County, Penn., gazing on what might be called a "graveyard of railways."

The editorial says: "There are many miles of abandoned railway roadbed, or the site of former roadbed, along the present track of our more prosperous railways."

At the village mentioned can be seen the partly completed immense cuts and fills of the famous old Hempfield railroad which was under construction in 1857 between Wheeling (then in Virginia) and Greensburg, Penn., leaving the City of Pittsburgh to the north. This partly finished railway, now utterly forgotten, was a cross-country line and for its utter disregard of the obstacles of topography and its directness of alignment, rivaled the famous line between Petrograd and Moscow.

The unfinished cuts and fills and other works stand as mute examples of the temerity of former civil engineers, and to paraphrase the editor: "The future student of railway-location economics could learn much from an inspection of this line, from which to deduce sound principles of location or relocation."

In 1878 the writer, when locating the Pittsburgh Southern R.R., utilized some portions of the abandoned roadbed. Later on the Baltimore & Ohio R.R. absorbed the Pittsburgh Southern for its Pittsburgh-Chicago line, and later still in revising the line between Wylandville and Clokeyville took up the track which had been laid on the old Hempfield grade, and which now is grown up with trees and undergrowth, and used the grade as a right-of-way for telegraph and telephone lines. A few years ago another railway line was partially built through the village, the Chartiers Southern R.R., owned jointly by the Pennsylvania, Vanderbilt and Baltimore & Ohio interests. Much of the grading and masonry was done but no track was laid.

The writer knows no place in the United States where "The rise and fall of railroads" is illustrated to better advantage. Leading out of Wylandville the old roadbed of the Pittsburgh Southern is now occupied for a distance of several miles by one of the principal Washington County highways. Emile Low.

Buffalo, N. Y., July 9, 1916.

Don J. Whittemore's Services to Engineering

By E. E. R. Tratman*

Don J. Whittemore's life work was in the development of the Chicago, Milwaukee & St. Paul Ry.—its development from a small local line into one of the greatest railway systems of the West, aggregating over 10,000 mi. in length and extending from the Great Lakes to the Pacific Coast. His connection with this work may be said to have begun in 1860, when he became Chief Assistant Engineer of the La Crosse & Milwaukee R.R. The western division of the road (Kilbourn to La Crosse) was sold at foreclosure in 1863 and its purchasers organized the Milwaukee & St. Paul R.R., which also acquired control of the whole line. Mr. Whittemore was made Chief Engineer of the company, which had then 275 mi. of line.

The Milwaukee-St. Paul line was completed a few years later, and the Chicago-Milwaukee line in 1872, to give adequate connections with the East and South. In 1874 the company changed its name to the Chicago, Milwaukee & St. Paul Ry., and at that time it had built and acquired a total of about 1,400 mi. of line. It reached Omaha in 1882 and Kansas City in 1887. The annual mileage of new construction for several years ranged from 50 to 500 mi., and the total mileage increased to 5,657 mi. in 1890 and 7,511 mi. in 1912.

The company was one of the most active in the development of the central Northwest, building and acquiring lines to form a network of main and local lines, so that its chief engineer had extensive and varied duties and responsibilities, to say nothing of difficulties. All of the many notable features were constructed under Mr. Whittemore's supervision, and these included many large bridges, particularly those over the Mississippi and Missouri Rivers.

About 1905, the company decided to build an extension from the Missouri River to the Pacific Coast. Separate companies were organized in each state, but in 1908 these were all combined under the name of the Chicago, Milwaukee & Puget Sound Ry. This was opened in 1909, and in 1913 the line (2,081 mi.) was absorbed into the Chicago, Milwaukee & St. Paul Ry. system. Mr. Whittemore remained as Chief Engineer until his resignation in December, 1910, at which time he was made Consulting Engineer of the company in recognition of his long and distinguished career in its service.

The preparation of an adequate or detailed biography of Mr. Whittemore is rendered difficult from the fact that he outlived his contemporaries. It may be said that since he began his engineering career, in 1847, two generations of engineers have passed away. Such men as Shaler Smith, Charles Paine, Willard S. Pope and others could have testified to his qualifications and would have delighted in paying tribute to his talents. The present source of information is in the younger engineers who were associated with him during his later years, but they could not enjoy the intimacy and consequent knowledge of him as a man that belonged to his friends who were more nearly equal to him in age. In fact he was numbered among the fathers of the profession when men now elderly were among the youths looking up to him for counsel and help. It is to be noted that it is 44 years since he became a member of the American Society of Civil Engineers, and 32 years since he was President of the Society.

The foregoing relates to the professional career of Mr. Whittemore as a factor in the development and growth of the country, but this biography would be incomplete without appreciative reference to the human or personal side of his nature. He was a man of strong character, self-reliant, confident and able to cope with difficulties. Such elements as these were necessary in the early days of pioneer railroading, and were no less useful during the years that he was chief engineer of a strong railway system. But with his strength of character he combined a quietness and reserve of manner which led him to retirement rather than to activity outside of his regular work.

He was devoted to his profession and his friends, and loyalty was one of the marked elements of his character. His advice, which was always sound and to the point, was given to younger men more for their own general good and future development than for the immediate results to be shown in their work. He had an unusual faculty of giving advice in short pithy terms, and in such a way that the hearer would remember and practice it. Undoubtedly all of the numerous members of his staff during his long career must have benefited through this kind of advice, perhaps without realizing the extent of his influence.

He was always a student. He was fond of mathematics, and on an inspection trip it was common for him to propose some sort of a puzzle composed of figures. He was naturally inclined to be an investigator, and was greatly interested in discovering some cheap process for the manufacture of aluminum at a time when it was a very expensive metal to produce. In the same way he took great interest in the manufacture in this country of portland cement, and with both of these materials he contributed by experimental work to an extent that would have been recognized had not the development in manufacturing these products been so rapid as to throw into the shade the early experimentation. Being somewhat reserved in temperament, he conducted his investigations privately, and said little as to his own work and accomplishments. Mr. Whittemore was one of the first to see and develop the possibilities of the cement rock found near Milwaukee, Wis. He was prominent in the establishment of the Milwaukee Cement Co., which flourished for several years and furnished the cement for many large structures. In railway work, one of his striking ideas was that of using flat-topped rails and flat-tired cylindrical wheels, in place of the round-top rail and coned wheel. This he advocated in a paper before the American Society of Civil Engineers in 1889.

He was a great reader as well as a thinker, and it has seemed to many of his intimate friends that but for his characteristic reticence and reserve he might have done more than he did for the promulgation of engineering knowledge. His experience and his retentive memory qualified him to have made contributions to engineering literature which would be extremely valuable to the profession. It is to be regretted also that he did not write more in the way of experiences and reminiscences, for he could have written in a way that would have been profitable and would have encouraged the younger men in their professional work. This is a point of view which might well be given consideration by engineers of long experience. Although reserved, and in recent years living a retired life, he was a genial companion.

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*Resident Editor of "Engineering News" at Chicago.

Phenomenal Rains the Cause of Southern Floods

SYNOPSIS—Weather Bureau records of heavy July rainstorms and views of destroyed bridges in southeastern United States.

Rains of extraordinary intensity as well as extraordinary duration in the southeastern section of the United States occurred throughout the first three weeks of July and culminated in the third week in downpours of unprecedented extent. As a result practically every river was in flood and the consequent damage very great. Had he territory been as thickly settled as that in Ohio, the lood losses of 1913 in that locality would have been luplicated. As it is, the slowly accumulating reports how loss of property of about $12,000,000 and of 80 ives. Meteorological data of approximate accuracy have een collected by the United States Weather Bureau and ome reliable statements are avaliable as to structural lamage. These together with some photographs of detroyed bridges are presented herewith.

A tropical storm moved inland over extreme western lorida and southern Alabama on the night of July 6-7. t continued to move very slowly northward and passed eyond the confines of the state on the 10th. Meanhile large amounts of moisture were precipitated over he state and in the regions to the eastward. By the norning of the 11th rain over Alabama had practically eased, but it continued intermittently over the neighoring state of Georgia, eastern Tennessee, western North arolina and South Carolina, during the 12th and 13th. y the morning of the 14th a fresh disturbance from the tlantic passed inland over South Carolina, and gave rrential rains over the watersheds of the Atlantic draine, especially in the Carolinas on the 14th, 15th and 6th. The great loss of life and destruction of property the south, especially in the Carolinas, was due to the cond disturbance, which as above stated, was separate nd distinct from the Gulf storm of July 6-10.

Although this second storm could not be charted after uly 17, rains have continued in the South, especially in e Carolinas. The continued heavy precipitation over is area is well shown in the accompanying table of eather Bureau stations and by the map in Fig. 1, which ives rainfall contours for the two weeks ending July 18. n addition to the distributed rainfall noted in these mmaries, on July 15 the 24-hr. records for some ountain stations in South Carolina were as follows: Effingham, 13.24 in.; Cheraw, 9.38 in.; Kingstree, 12.60 in. Complete accounts of the rainfall and river stages cannot be compiled until the mailed reports are all received at Washington.

These rains caused the most destructive floods in the Catawba, Broad and Yadkin Rivers in the mountains of North Carolina and the Santee River, below Columbia, S. C. The worst destruction was along the Catawba River, all bridges on that stream being destroyed. The tributary mountain streams became raging torrents; valleys of creeks and rivers from Marion to Rutherfordton, Blacksburg and Gastonia are scenes of ruin and devastation.

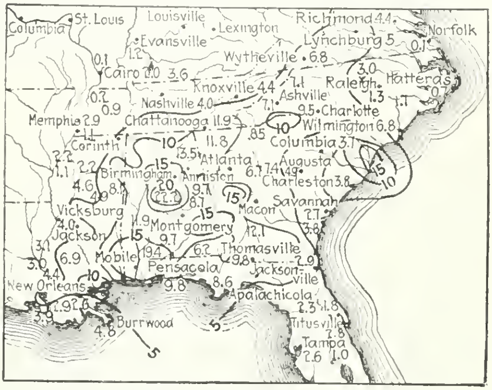


FIG. 1. RAINFALL CONTOURS IN SOUTHEASTERN STATES, JULY 5-18, 1915

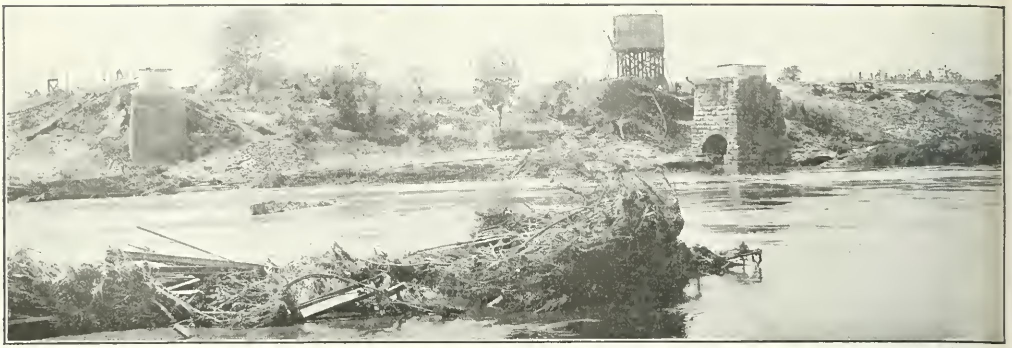
The floods on the Catawba and connecting streams reached a crest height that exceeded all previous records by several feet. Exact figures are difficult to obtain at this early date and it is impossible to state comparative elevations in all cases. The oldest inhabitants, however, cannot recall anything comparable in the flood line and history must be called upon to tell of former inundations. It is recorded that a flood occurred early in 1701 that raised the Santee River to a height of 36 ft. above normal. A similar flood is described as occurring on the Broad and Catawba Rivers in January, 1796.

River heights are still hard to get. At Granite Falls, N. C., the Catawba River was from 10 to 12 ft. higher

TABLE SHOWING DAILY PRECIPITATION IN INCHES FOR JULY 6-24, 1916

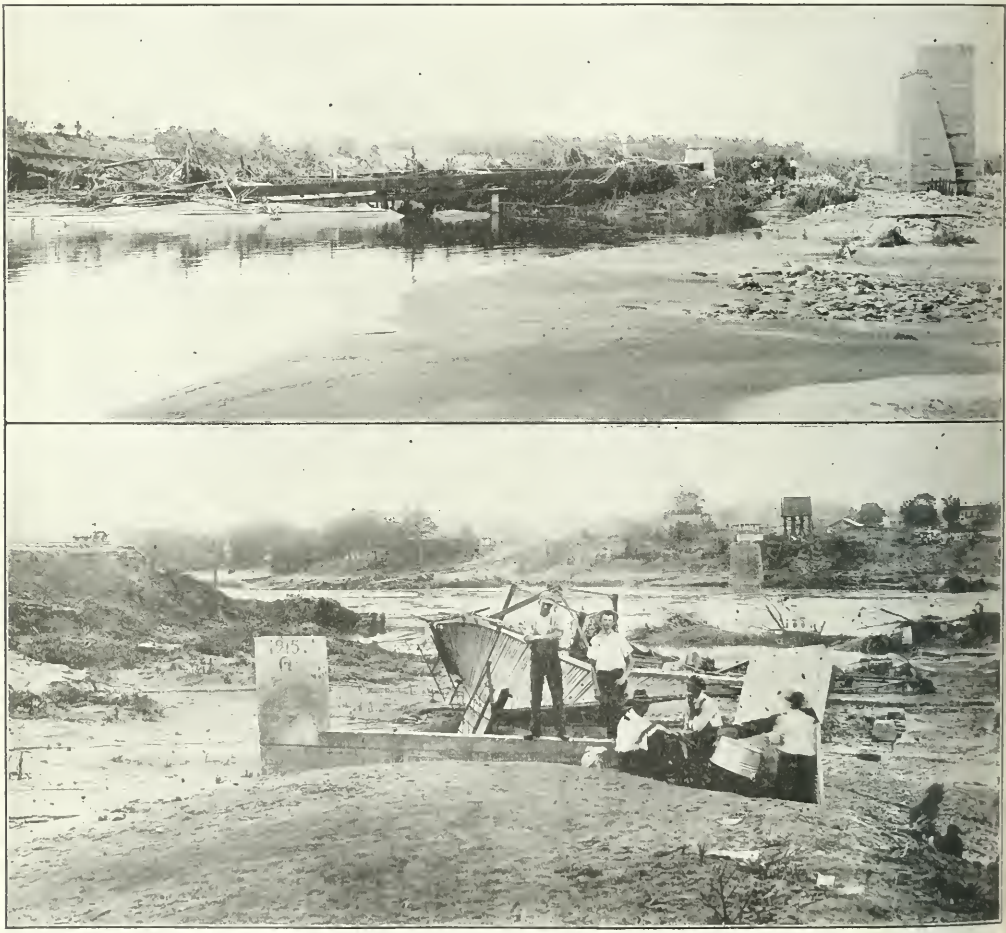
(United States Weather Bureau)

	Day of Month																			
Stations	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total
obile, Ala.	6.64	1.40	4.82	0.34	0	0.08	1.90	0.02	0.22	2.10	0.06	0	0	0	0.04	0.08	0	0.16	0.92	18.78
nsacola, Fla	2.46	0.21	1.38	2.91	0	0	0.48	0.10	0.20	0.08	0.74	0.40	0	0	0.68	0.92	1.16	0.34	1.14	13.23
eridian, Miss	0.03	4.58	0.64	0.26	0	0.02	0.92	0.08	0	0	0	0	0.98	0.76	0.94	1.28	0.28	0	0	10.77
ontgomery, Ala.	1.08	5.08	1.96	1.18	0.06	1.11	0.52	0.08	0.02	0	1.48	0	0	0.04	0.70	0.14	0.02	0.06	0.16	13.72
rmingham, Ala.	0.54	6.70	5.00	0.38	0.78	1.10	0	0	0.06	0.80	0.18	2.60	0	0.12	0.12	0.38	0	0.60	0	19.36
igusta, Ga.	0.02	1.06	0.10	0.36	0.46	0.24	0	0	0.20	0.28	0.30	0	0.42	0	0	0	0	0.64	0.72	4.80
lanta, Ga	0.18	0.90	3.84	2.08	0.44	0.80	0.14	0	0	0.02	0.06	0.01	0.10	0.04	0.94	0.02	0.14	0.04	0.01	9.76
acon, Ga	0.34	1.60	1.82	0.36	0.54	1.02	0.32	0	0	0	0	0	0	3.34	0.32	0.02	0.18	0.80	0.66	11.32
omasville, Ga.	0.52	0.22	1.80	3.88	0.76	0.46	0.16	0	0.40	0	0.58	0.32	0.16	0	0	0.26	0	1.14	0.80	11.46
vannah, Ga	0.76	1.24	0	0.36	0.08	0	0	0	0.08	0.10	0	0	0	0	0	0.20	0	0.90	0.40	4.12
lumbia, S. C.	0	0	0	0.98	0.58	0.14	0.02	0	0.04	1.56	0.14	0	0	0	0	0	0.38	0.28	2.20	6.32
arleston, S. C.	0.66	0	0	0	0	0	0	0.08	2.04	2.28	0	0	0	0	0	0	0.06	0.84	3.40	9.36
arlotte, N. C.	0	0	0	1.28	1.48	0.16	0	0	0	3.62	1.50	0.01	0	0	0	1.02	0.44	0.96	3.06	13.53
heville, N. C.	0	0	0.10	2.36	1.12	0.20	0.06	0	0.04	0.58	1.72	0.52	0.36	0	0.48	0	0.08	0.36	0	7.98
leigh, N. C.	0	0	0	0	0.08	0	0.36	0	0	0.80	0.01	0.01	0.01	0	0	0.28	1.36	0.60	0.98	4.49
noxville, Tenn.	0	0	0	1.08	0.54	0.16	0	0	0.01	0.01	1.54	0.01	1.02	0.11	0	0.32	1.02	0.26	0	6.11
attanooga, Tenn.	0	0.30	3.20	3.56	2.56	1.08	0.06	0.38	0.54	0	0	0	0.08	0.11	0	0	0.10	0.04	0	12.01



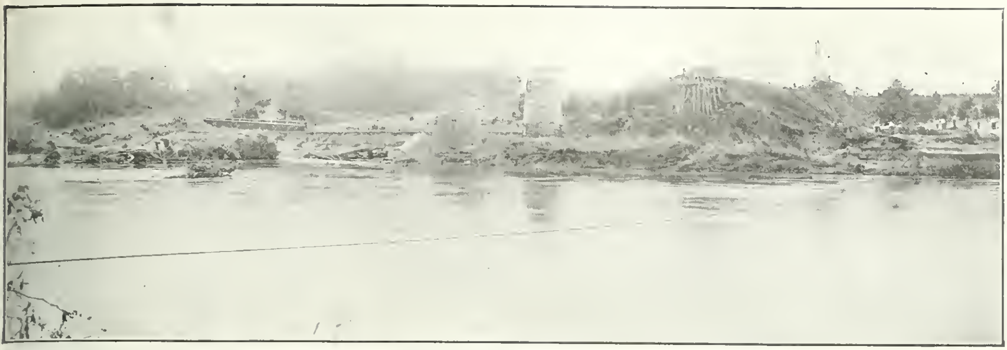
FIGS. 2 AND 3. THREE WRECKED CATAWBA RIVER BRIDGES AT

Left-Hand View—Mt. Holly side; P. & N. bridge at left, county bridge approach with automobiles at right

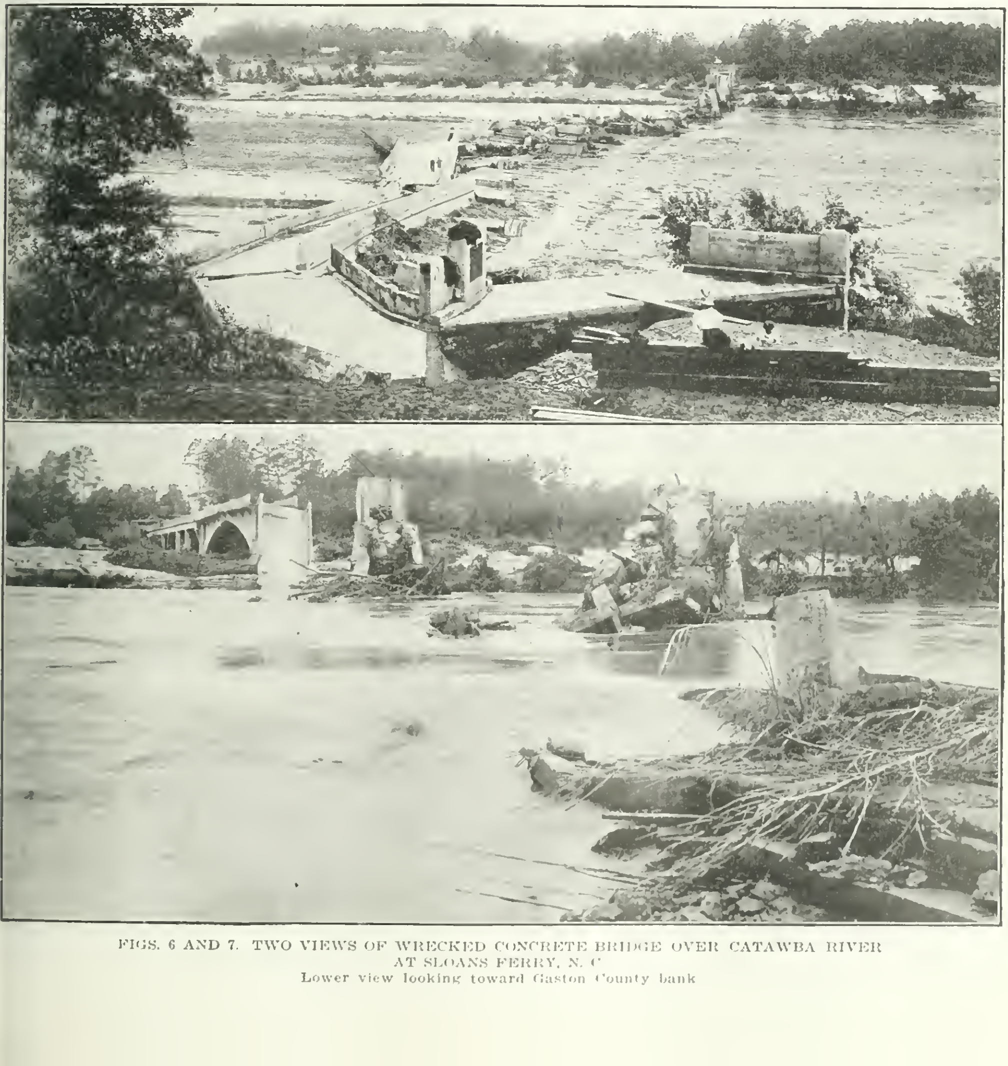


FIGS. 4 AND 5. UPPER VIEW—PIEDMONT & NORTHERN RY. BRIDGE. LOWER VIEW—COUNTY BRIDGE, BOTH TAKEN ON BANK OPPOSITE MT. HOLLY

Lower view shows Seaboard arch abutment on far bank near right



MT. HOLLY, N. C.; PIEDMONT & NORTHERN, SEABOARD, AND COUNTY
Right-Hand View—Bank opposite Mt. Holly; county bridge at left, Seaboard in center, P. & N. at right



FIGS. 6 AND 7. TWO VIEWS OF WRECKED CONCRETE BRIDGE OVER CATAWBA RIVER AT SLOANS FERRY, N. C.
Lower view looking toward Gaston County bank

than the flood of 1901. At Fort Mill, S. C., the records show that the flood was 42 ft. above low water and 15 ft. higher than that of 1912. The Broad River at Camden, S. C., reached a crest of 45.3 ft. above low water. The Congaree at Columbia, S. C., was 31.5 ft. above and the Catawba at Mount Holly, N. C., was 47 ft. above low water.

No large cities were in the way of the floods so the damage was confined to the smaller settlements, to washouts of mills in the riparian districts, and to destruction of bridges and railway embankments. Failures of dams of any size have not been reported nor have any hydro-electric projects been more than temporarily deranged. It is impossible at the present time to make a close estimate of the aggregate flood damage. The more spectacular instances, as for example the Armon Cotton Mills at Mountain Island and the Southern Ry. bridge at Belmont, will run into big figures; other individual cases are quite large.

The following figures were compiled by the Charlotte *Observer;* they are conservative and as nearly accurate as possible at the present time.

Damage to power stations and other vested interests of Southern Power Co. along Catawba and Broad Rivers	$1,000,000
Dravo power plant and other power stations along Broad River and tributaries	500,000
Yadkin River hydro-electric damage at Clemons, Whitney and other places	250,000
Textile interests along Catawba, South Fork, Broad, Yadkin and French Broad Rivers	750,000
Railway bridges across Catawba River of Southern, Seaboard, Piedmont & Northern and C. & N. W. railways	500,000
Railway bridges across Broad, Upper Yadkin, French Broad and tributaries	500,000
State and County highway bridges	1,000,000
Track and property damage to railroads exclusive of bridges and approaches	2,000,000
Damages sustained by Southern Bell, Western Union and Postal Telegraph companies	200,000
Damage to growing crops, livestock, farm buildings and other agricultural operations	5,000,000
Total	$11,700,000

The accompanying views show bridge washouts at Mt. Holly, N. C., and at Sloans Ferry, N. C., both on the Catawba River. At Mt. Holly there were three bridges, two railway and one highway, and they are all gone. At Sloans Ferry there was a long reinforced-concrete arch bridge which as the views show, has been completely destroyed. Here the river was 56 ft. above low water and 4 ft. over the bridge balustrade. The Southern Ry. bridge over the Catawba at Belmont, N. C., a 1,400-ft. steel-truss structure, is completely out.

⁂

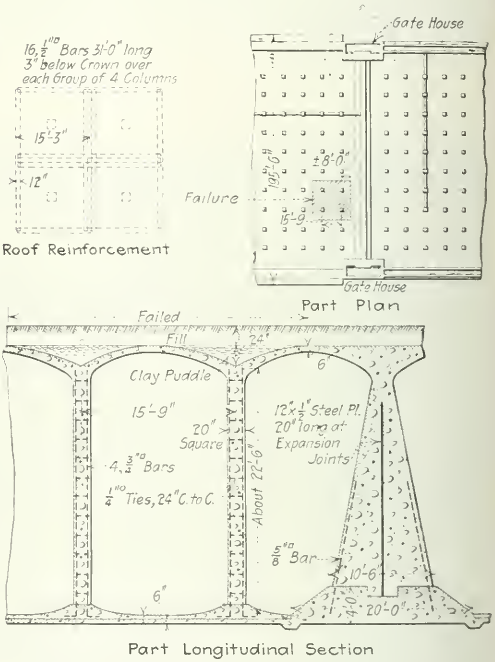
Cleveland Filter Roof Collapse Under Investigation

The collapse of four bays of the groined arch roof of the clear water basin at the new West Side filters, Cleveland, Ohio, on July 16, as briefly noted in last week's issue, is still under investigation and no official report is as yet available. The general nature of the design and of the collapse, however, are presented herewith.

The clear water basin of the filtration system is located northwest of the main plant which was completed about a year and a half ago. This basin, a covered reservoir 938 ft. long and 195 ft. 6 in. wide, is of the customary reinforced-concrete groined arch roof and base design, as shown in the accompanying details. The roof is supported on reinforced-concrete columns spaced 15 ft. 9 in. each way, about 22 ft. 6 in. high, 20 in. square and reinforced with four ¾-in. rods tied together every 24 in. with ¼-in. wire. These columns rest on a 6-in. floor with a groined arch distribution 6 in. thick at the crown. The roof units are also groined arches with elliptical intrados and parabolic extrados. This arch is 6 in. thick at crown and about 12 in. at spring. The roof will eventually carry a 24-in. clay fill over the columns plus a 24-in. earth fill over all, but no fill has as yet been placed.

Reinforcement of the roof consists in the rod grouping shown in detail in the drawing. This system, it will be seen, separates the roof into panels over four columns with expansion joints at the crowns of the border arches.

The collapsed section was one of these panel groups located (as shown hatched in the accompanying drawing) at the cross wall which separates the reservoir into two basins. The collapse is complete over these four columns. No one was around the work at the time. The concreting had been completed some time and the centering was all out.



Roof Reinforcement

Part Plan

Part Longitudinal Section

DETAILS OF CLEAR WATER BASIN, CLEVELAND WEST SIDE FILTERS

There is criticism both of the concrete and the foundations and investigators for both city and contractor (Walsh Construction Co.) are at work. It seems evident, however, that the primary failure was in the columns, but whether it was due to collapse from pure weakness, from movement due to side pressure or from foundation sinking is not now certain.

⁂

Bids on Ohio State Road Work, to the amount of $1,240,495, were opened on two days, July 20 and 21. About 108 mi of roads are to be improved under these contracts. On four contracts opened July 20 no bids were received—an unusual occurrence in these days of roadbuilding. Most of the bids were below engineers' estimates.

News of the Engineering World

Disastrous Gas Explosion in Cleveland Tunnel

Inflammable gas in pockets and veins of the clay soil through which the new water intake tunnel of Cleveland, O., under Lake Erie is being driven exploded on Monday, July 24, 1916, and killed 10 men working in the tunnel. Two rescue parties were overcome, and 10 of their number died. The accident occurred in the lake heading, now 1,400 ft. long, which is being driven landward from the future intake crib, located 5 mi. from shore. Both this and the land heading are driven by shield under compressed air at 20 lb. per sq.in. The airlocks are near the entrance shafts, and in both headings practically the whole length of tunnel is under air pressure in a single unbroken length—lengths 1,400 and 13,000 ft. for the lake heading and land heading respectively.

The tunnel, 10 ft. in inside diameter and 120 ft. below lake surface, is to have a completed length of 16,000 ft., starting at Crib 3, an old crib in the lake, 8,000 ft. from shore off the foot of West 50th St. Most of the work has been handled from a short shaft through an old 7-ft. tunnel extending out to Crib 3, but there is also a hoist shaft at the latter crib. The new intake crib, sunk in 1914, was subsequently also used for starting a heading, a shaft being sunk through its center to tunnel level. This lake heading has advanced slowly, while the shore heading drove forward at consistent speed of 15 to 22 ft. per day.

The soil is clay, hard enough to support itself without serious deformation for some hours, though squeezing perceptibly in the course of a day or more. Throughout the work, small pockets of inflammable gas have been struck, as has been the case in nearly all prior Cleveland tunneling in the clay. Generally the gas in the tunnel air if present at all was in very small amounts and could not be detected by the senses. Most rigid rules against use of matches or open lights and against handling electric circuits in a way to produce sparks were in force.

The gas-carrying pockets were small, and often were mere porous spots or sand streaks. The gas in them was under pressure, and was usually noticed by the hiss of its blowing out. In other respects the soil was absolutely tight, and there was no escape of air or inflow of water, except the slight drip from the moisture of the soil. There was no ventilation system, but a 4-in. blowpipe was available for blowing off either water or air.

A distinguishing feature of the tunnel is the character of the lining. This is of concrete blocks, in rings 18 in. wide by 10 to 11 in. thick, six segment blocks to the ring, each block weighing 1,200 lb. The tongue-and-groove joints of the blocks are laid up in cement mortar, and are pointed up some hundred feet or more back of the face. In spite of the pointing, the lining as a whole probably remained permeable to gas.

The tunnel is being built by city day labor, under the management of the city's water department.

Investigating Road Conditions in New Jersey

New Jersey divides with Massachusetts the honor of being the first state in the Union to undertake improved road construction on a large scale. For fully twenty years, from 1890 to 1910, New Jersey's macadam roads were held up as a model of good practice and were visited by highway engineers from all over the country.

The enormous development of automobile traffic that has taken place during the past half-dozen years has revolutionized road traffic conditions everywhere, but nowhere more so than in New Jersey. New Jersey roads are used not only by the state's own dense population, but by residents of the great cities of New York and Philadelphia, which lie adjacent on either side. Under the stress of this heavy automobile traffic the wear and tear on New Jersey improved roads has far outrun the provision for maintenance, and it is necessary for the state to take radical measures for the improvement of its entire system of highways. The recent legislature provided for a state bond issue of $7,000,000 for roadwork, subject to approval by popular vote at the November election.

Further, and not less important, the legislature created a State Commission on Road Legislation to investigate the whole matter of improved highways and formulate a policy for the state. The members of this commission are John W. Herbert, chairman; Joseph H. Wood, Horace A. Bonnell and Edwin A. Stevens, State Highway Commissioner. The commission issued on July 14 a circular letter addressed to a number of prominent citizens of New Jersey, containing various suggestive questions regarding road conditions and road reforms. The questions, which are of interest in other states besides New Jersey, are given herewith:

> The main trunk highways of New Jersey are breaking down under the terrific strain to which they are subjected by modern traffic. Many of the feeder roads to these trunk highways are in bad shape. The roads running through the outlying districts of the state and connecting with these "feeders" have never been in satisfactory condition. The construction of much-needed new roads is coming to a standstill, the maintenance of old roads even at enormous expense is not keeping pace with the daily wear and tear of travel. Transportation, which is the life blood of civilization and prosperity, is thereby hampered, and the development and improvement of New Jersey are being retarded
>
> What is the trouble? Does the fault lie with a tangled mass of unintelligible road laws? Are we struggling hopelessly to administer the road laws in township, county and state by numerous undefined and varied types of road organizations? Are many of the employees of these road organizations indifferent, untrained or inefficient? Do these employees, elected by the people or appointed for political reasons, hold office for such short periods of time and under such conditions that they cannot become effective in their work?
>
> Are we building and maintaining our roads by unsound or unbusinesslike measures of finance? How much interest are we paying on bonds issued to build poor roads which have gone to pieces or will go to pieces before the bonds mature? How much money have we saved in our funds to pay off these bonds at maturity? Does our money go into roads or into unnecessary and wasteful charges?

Do we foolishly try to save money by building cheap roads that will last months when we ought to practice true economy by laying down roads that will last years?

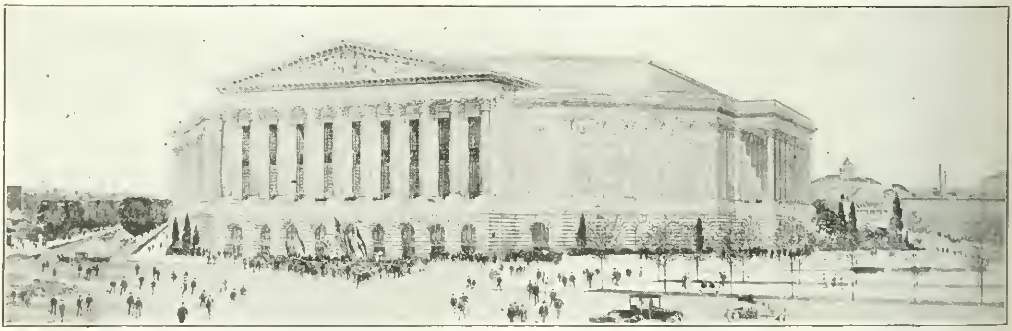
Are we getting full and honest returns on every road contract into which we enter? Are we selecting the right materials and the proper sort of road construction and maintenance for the several diversified localities of the state? Should we limit the traffic on highways as to the weight of vehicles and load, and if so, what should be the limit, and should we make regulations as to the width of tires?

In a word, do we have a scientific, efficient and far-sighted road policy, capable of automatic expansion and application to meet increased growth and change of traffic conditions, or do we act only under the stress of necessity, striving to get good roads by passing an annual installment of road legislation?

Please bear in mind that the commission is interested in every phase of the road situation and is not committed to any preconceived ideas of road construction, road maintenance, road administration or road finance. It is believed, however, that there are certain fundamental principles of law, finance, administration and operation underlying this whole subject of good roads.

New Municipal Auditorium in Philadelphia

A new municipal auditorium or convention hall of extraordinary size is about to be started by the City of Philadelphia. A fund of $1,500,000 was provided for by city vote some years ago, but construction has been held up by some technicalities which have recently been overcome so that the project can now be carried to a successful conclusion. The auditorium, an architect's perspective of which is shown herewith, is to be located on the new Parkway, the wide boulevard extending from the City Hall northwesterly to the entrance of Fairmount Park. The building will be between 21st, 22nd, Hamilton and Callowhill St., in the immediate vicinity of the proposed library and art museum.



THE PROPOSED NEW MUNICIPAL AUDITORIUM ON THE PARKWAY IN PHILADELPHIA

The building fronts on the Parkway 248 ft. and is 362 ft. deep. It will have an auditorium 225 ft. square provided with two galleries, so that the total seating capacity will be about 15,000 people. When used for exhibition purposes only, there will be a capacity of 91,000 sq.ft. In addition there is a stage 50 ft. deep with a proscenium opening of 100 ft. with a seating capacity of 1,000 people. A special arrangement for exits, both in number and provision for inclines, makes it possible to empty the entire auditorium in about five minutes. The project is under the direction of the Mayor, and of the Director of the Department of Public Works, George E. Datesman. The architect is John T. Windrim.

St. Louis County Road Bonds Declared Valid

The $3,000,000 issue of bonds for improving the roads of St. Louis County, Missouri, has been declared valid by the supreme court of the state. The entire amount need not be issued at once, but may be issued in installments. One-half the issue must be in denominations of $100 and the bonds are redeemable at any time within 20 years. The ruling of the court applies to the proposed issue of $500,000 in exactly the same manner, and the decision means that county road work in Missouri will soon begin in earnest.

One result of the court's interpretation of the bond-issue statute is to cause James C. Travilla, former Street Commissioner of St. Louis, to lose his position as Assistant to the County Highway Engineer, to which he was appointed last April at a salary of $4,800 per annum. The section of the statute under which he was appointed is declared invalid. It is reported, however, that a way will be found to retain his services.

City Replanning in St. Louis

The City of St. Louis is in the shape of a fan, the business district being in the center and the portion which would be the sticks of a fan representing the blighted or depreciated district.

On account of inadequate traffic arteries toward the north and south, most of the traffic passes directly west across this depreciated district. This travel has been concentrated on Locust St. and has resulted in the complete rebuilding of this street, largely by the automobile industries. The property values along Locust St. have again reached a high point. The congestion of traffic on this street has been so great that in connection with the resurfacing of the street, which is required this year, the curbing will be set back 3 ft. on each side.

Parallel and next adjoining Locust St. is Olive St., which carries a very heavy street-car traffic and is paved with granite. Although only a block from Locust St., the property along Olive St. has failed to appreciate in value. This has been a matter of serious concern to the property holders, and at a recent meeting of the owners in the office of the Director of Streets and Sewers a large majority expressed themselves as favoring a repaving of wood block and the widening of the roadway in the same manner as will be applied to Locust St. In this way it is hoped to attract some of the present congested traffic on Locust St. to Olive St. and thereby secure a revival of business along the latter street.

The City Plan Committee of the Business Men's League is urging an appropriation of $15,000 for a districting study in St. Louis. The St. Louis City Plan Commission some time ago requested the various civic organizations to appoint committees on city planning. This has been done by a great number of organizations, among them the Business Men's League, Civic League, Institute of Architects and the Engineers' Club. These committees have een meeting at intervals with the City Plan Commission, nd certain phases of work have been assigned to the organization committees for study. The recommendation y the committee from the Business Men's League is a esult of its study of the districting question.

⁂

River Pollution Case Settled

Pollution of the Fox River, in Illinois, by Elgin, Aurora nd other municipalities, has been a source of complaint or some years, and in June, 1914, the Illinois Rivers nd Lakes Commission issued an order to the cities to ease this pollution. Appeals against the enforcement of he order have been pending since then, but were dismissed by the Sangamon County Circuit Court on June 26, 1916. The dismissal is by voluntary agreement with he cities of Elgin and Aurora, and means that primary edimentation tanks or sewage-treating apparatus must e installed by Jan. 31, 1917.

⁂

Pennsylvania Water Companies Cannot Require Meters

A ruling last week of the Pennsylvania Public Service ommission is of interest to water-works men. A consumer complained because he had been required to install meter when some other consumers were not required o do so. Investigation showed only about one-third of he consumers' services were metered, and it was decided hat the company "having no pronounced policy in favor f the complete metering of its system" must make the omplainant a flat rate. Another decision refuses to nd injustice in the action of a water company in shutting off the water-supply for nonpayment of water rents, fter reasonable notice.

⁂

City Board of Survey in Massachusetts

A slight advance in the control of city planning in Massachusetts is made possible by an act of the Massachusetts legislature, approved May 10, 1916 (Chap. 190). Several years ago the legislature passed an act providing that all cities and every town of 10,000 population nd upward must create planning boards. These boards ad few but advisory powers and powers of investigation.

The act of 1916 provides that the mayor of any city, ith the approval of the city council or board of aldermen, may appoint a board of survey of three members n January of any year and fix their compensation. The ity engineer is to act as clerk of such a board.

Beyond the permissive power to create boards of survey, the act contains one mandatory and one permissive eature. The mandatory provision is that where a board of survey has been created no person, firm or corporation shall open a street without submitting to the board of survey "suitable plans and profiles" showing "also the method of drainage of the adjacent or contiguous territory." Provision is made for public advertisements and hearings and for the approval or modification of the plans by the board and their filing in the office of the city engineer. After all this has been done, "no street or way in the territory to which the plans relate shall be laid out or constructed except in accordance therewith or with such further plans as may subsequently be approved by the board."

The permissive power of boards of survey under the Massachusetts act gives the board a considerable degree of city-planning latitude, when directed to exercise it by the local planning board and the city council. The first part of the section conferring this power is as follows:

> Section 3. The board of survey may, and upon the vote of the local planning board and the city council or board of aldermen shall, from time to time cause to be made by the city engineer, under its direction, plans of such territory or sections of land in the city as the board of survey or the said planning board may deem necessary, showing thereon the location of such streets or ways, whether already laid out or not, as, in the opinion of the board, the interest of the public may or will require in such territory, showing clearly the direction, width and grades of each street or way, and a plan of drainage, and said board may incur such expenses as it may deem necessary therefor, not exceeding the amount of money appropriated for the purpose.

Provision is made for public advertisement, hearing and approval, as already outlined, for private street openings.

⁂

Harahan Bridge Opened to Railway Traffic

The new Mississippi River bridge at Memphis, the Harahan Bridge, was opened for traffic on July 15, 1916, and a day or two afterward the trains of the three roads which joined in building the bridge, the Cotton Belt, the Iron Mountain, and the Rock Island were diverted to the new bridge. The bridge is double-track, but only one track can be used over the south approach which is as yet not completed. The vehicle roadway of the bridge is also not completed, but this is expected to be ready for traffic in the fall of this year. Crittenden County, Ark., will build a two-mile viaduct to connect with the highway bridge. The bridge was built by the Pennsylvania Steel Co. on substructure built by the Union Bridge and Construction Co. The total cost was about $5,000,000, exclusive of approaches. Ralph Modjeski was consulting engineer for the superstructure. M. B. Case was resident engineer.

⁂

Clarifying San Diego Water

An increase in the period of coagulation before mechanical filtration was necessary to free the water supply of San Diego, Calif., from a load of very finely divided clayey matter resulting from the floods of last winter and decreased storage and settling capacity due to the destruction of the Lower Otay dam. The story is concisely told in the May report of F. M. Lockwood, Manager Operating Department of San Diego, as follows:

> Much attention has been given to the question of clarifying San Diego's water-supply. During the floods, the runoff into the Upper Otay reservoir, which supplies the greater portion of the water now being used in San Diego, contained an unusual amount of clayey silt, which, contrary to all precedent, still remains suspended, practically no settlement having oc-

curred, even to this date. A coagulating plant near the filter at Lower Otay remedied this to a great extent, but a slight discoloration still existed, even after passing through the filters. This, however, has now been corrected by installing a coagulating plant about half-way between the Upper and Lower Otays, some two miles above the filter. This plant consists of two 2,000-gal. redwood tanks, with their accompanying regulating tanks; a 3-hp. gas engine and a 2-in. centrifugal pump, and, being placed at this point, gives the coagulant from 1 to 1½ hr. to act on the water before it enters the filter instead of from 1½ to 2 min., as was the case with the old coagulating plant. The water now flowing from the filters is absolutely clear, and, being treated with chlorine at the University Heights reservoir, into which all water empties before being turned into the mains, is, according to bacteriological tests, of a safe, healthful quality.

⁂

New Bridge Company Formed

In connection with the merger of the Pennsylvania Steel Co. and the Maryland Steel Co. under the general direction of the Bethlehem Steel Co., it is announced that the bridge and structural work of the combination will hereafter be handled by a new company, to be known as the Bethlehem Steel Bridge Co. of Delaware. G. H. Blakely, who has been in charge of the structural department of the Bethlehem Steel Co. becomes president of the new company and Thomas Earl, formerly superintendent of the bridge and construction department of the Pennsylvania Steel Co., will be made vice-president.

This company will operate hereafter on bridge work and there will be no competition in steel structural work between the bridge company and the various fabricating interests to which the Bethlehem company has long supplied material. The new company will handle all estimating work, secure contracts and direct erection work. The headquarters will be at South Bethlehem, Penn.

⁂

The Public Buildings Appropriation Bill has been abandoned for the present session of Congress and with it goes the proposed Bureau of Public Buildings, which was to supersede the office of Supervising Architect of the Treasury.

Investigations for the Government Nitrate Plant provided for by the Army Appropriation Bill are being made by Colonel Newcomer and Major Kelly, of the Corps of Engineers, so far as all questions regarding the proposed site of the plant and its construction are concerned. A committee representing the Nashville Section of the Engineering Association of the South is to urge the selection of the Muscle Shoals site on the Tennessee River. John Howe Peyton, President of the Nashville, Chattanooga & St. Louis R.R., is chairman of the Committee and Prof. W. G. Waldo, of Vanderbilt University, is the Secretary. Investigations with respect to the process to be used in the manufacture of nitrate are being made by Colonel Hoffer of the Bureau of Ordnance.

A Brick Chimney Settled 8 Ft. killing two men and injuring three others at Corning, N. Y., on July 14, at the Corning glass works. The men, employed by the H. L. Dixon Co., of Pittsburgh, were engaged in repairing a furnace when the collapse occurred. The chimney was supported on brick arches, which were built over the openings in the base of the furnace, which give access to the glass pots. It is supposed, locally, that the foundation or arches had been weakened during repairs and had not been properly shored. As the chimney sank it also tilted, so that its top was 4 ft. out of plumb. Two cracks appeared in the side. The chimney is too badly damaged to be repaired, but its removal was difficult owing to the danger of damaging two new tank furnaces nearby, valued at $100,000 each.

Whether Water-Power Legislation by the present Congress will be effective in reviving activity in water-power development is still in doubt. The bill relative to water-power sites on the public lands appears to have been abandoned for the session. The Adamson bill, relating to the construction of dams across navigable rivers, which passed the Senate some months ago, has been radically amended by the House to permit the Secretary of War to assess an annual charge as a rental for the use of water-power privileges, this rental to be subject to adjustment at the end of twenty years and every ten years thereafter by the then Secretary of War. The House also inserted a clause providing that if the government take over the property at the expiration of the lease, it need take only the generating plant and the transmission line and is not obliged to take any distribution system therewith connected. Both bills have been referred to a Conference Committee, and the House Conferees are Messrs. Adamson, Simms, and Esch.

The Military Engineering Committee of New York City has prepared a circular directing the attention of 4,000 engineers, who enrolled last winter for the military engineering lectures, to the 22nd Engineers of New York, as a means of gaining some military knowledge. This circular is being sent out this week. The two battalions of the New York Engineers have been mustered into Federal service and a depot battalion is being organized, under Sec. 120 of the Military Law of New York, which states in part that such depot units shall not be called on for duty outside the state, except in case of emergency to be determined by the Governor, but the members thereof may be transferred by him to fill temporary or permanent vacancies or make up a deficiency of strength in the organization for which the depot unit is formed. The enlisted personnel of depot units is divided into classes designated respectively as Class A and Class B. The former consists of men available to fill vacancies in the organization of the National Guard in the service of the United States. Class B consists of all other enlisted men of such organizations, and they will take an oath to serve the state only. Engineers enlisting in the depot battalion will be given a course of instruction covered by a drill one night per week from 8:15 to 10:30, and lectures, quizzes, and practical work on the drill floor in the various branches of military and engineering work. Enlistment in Class A for active service is in the National Guard of the United States and of the State of New York for a period of three years in service and three years in reserve; while the enlistment in Class B is in the National Guard of New York only, for a period of three years unless sooner discharged by proper authority. Class B men will be discharged upon the return of the active battalions. Enlistment in Class B will not interfere with attendance at the training camp at Plattsburg. It will not preclude one from joining the Volunteers or transferring to another military organization, nor will it prejudice one's standing in the Reserve Corps of Engineer Officers. To enlist in either class report at 8:20 p.m. to Major John F. Fairchild, at the Armory, 168th St. near Broadway.

PERSONALS

Frank Minkler has resigned as Street Commissioner of Carthage, Mo., to accept a position with Carthage special road district.

F. A. Torkelson has been appointed City Engineer of Green Bay, Wis., to succeed August Brauns. He is a graduate of the University of Wisconsin.

I. H. Piotrowsky, formerly with the Akron (Ohio) city water-works, has been appointed Superintendent of the Barberton (Ohio) city water-works.

F. E. Howells, M. Am. Soc. M. E., Superintendent of Shops of the Steelton plant of the Bethlehem Steel Co., has been promoted to be Assistant Mechanical Engineer.

Leander Dorsey, Assoc. M. Am. Soc. C. E., has resigned as Superintendent of the Whiting-Turner Construction Co., Baltimore, Md., to become Manager of the contracting department of the Cram Engineering Co., also of Baltimore.

E. E. Entwisle, Superintendent of the Maintenance Department of the Steelton plant of the Bethlehem Steel Co., has been made Mechanical Engineer in charge of construction work, as Assistant to the Chief Engineer, C. P. Turner.

G. F. Nicholson, District Engineer of Terminals on the East Waterway, Seattle, Wash., has been appointed Acting Chief Engineer of the Port of Seattle, to succeed J. R. West, whose resignation was noted in these columns July 13.

George Kuhrts, Chief Engineer of the Los Angeles Railway Corporation, Los Angeles, Calif., has been appointed Assistant General Manager of the company. He is succeeded as Chief Engineer by Thomas Bulpin, former Assistant Chief Engineer

D. W. Thrower, District Engineer of the Yazoo & Mississippi Valley R.R., at Memphis, Tenn., has been appointed Assistant Valuation Engineer of the Illinois Central R.R and the Yazoo & Mississippi Valley R.R., with headquarters at Chicago, Ill.

Milton B. Morgan, former Assistant Engineer of Maintenance-of-Way of the Illinois Central R.R. and the Yazoo & Mississippi Valley R.R., is now District Engineer of Yazoo & Mississippi Valley R.R., with headquarters at Memphis, Tenn., succeeding D. W. Thrower, transferred as noted elsewhere.

D. G. Conningham has been appointed Superintendent of Motive Power of the Denver & Salt Lake R.R., with office at Denver, Colo. He is a graduate of the Virginia Polytechnic Institute, class of 1898, and has been with the motive-power departments of the Norfolk & Western R.R. and the Atchison, Topeka & Santa Fe Ry.

C. O. Doughaday has resigned as Division Superintendent of the Pittsburgh, Penn., Bureau of Water to accept a position with the British-American Chemical Co., New York City. The mechanical division of the Bureau of Water, of which Mr. Doughaday had charge, is now in temporary charge of F. W. Lyon, Assoc. M. Am. Soc. C. E.

A. W. Johnston, M. Am. Soc. C. E., General Manager of the New York, Chicago & St. Louis R.R., has been appointed Assistant to the President. The office of General Manager will not be filled immediately, and the duties of the office will continue to be performed by Mr. Johnston. He is a graduate of the Massachusetts Institute of Technology and entered the railroad service in 1875.

A. C. Garrison, only son of the late D. E. Garrison, whose leath was noted in the obituary columns of last week, has een elected President of the Corrugated Bar Co., Buffalo, N. Y., to succeed his father. **A. L. Johnson,** M. Am. Soc. C. E., has been elected Vice-President and General Manager and **W. H. Kennedy** has been elected Vice-President and Treasurer. **W. M. Armstrong,** formerly Vice-President and Sales Manager, has resigned.

OBITUARY

Charles William Henry Kirchhoff, twice President of the American Institute of Mining Engineers, for many years Editor-in-Chief of the "Iron Age," died July 23 at his summer home at Asbury Park, N. J. He was born in San Francisco, Calif., Mar. 28, 1853. He was graduated from the Royal School of Mines, Clausthal, Germany, in 1874. He returned to this country as Chemist of the Delaware Lead Refinery, Philadelphia. His editorial work began in 1877 as Assistant Editor of the "Metallurgical Review." The following year he joined the staff of the "Iron Age." From 1881 to 1884 he was Managing Editor of the "Engineering and Mining Journal," after which he returned to the "Iron Age" and in 1889 became its Editor-in-Chief, retiring in 1910. He was also Vice-President and General Manager of the David Williams Co., publishers of the "Iron Age." Mr. Kirchhoff was President of the American Institute of Mining Engineers in 1898-99 and again in 1911-12. He was a member of the American Society of Mechanical Engineers, the American Iron and Steel Institute, the Iron and Steel Institute of Great Britain and of other learned societies.

CHARLES W. H. KIRCHHOFF

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M Gunn, Boston, Mass.

The American Association of Engineers, through its national board of directors, has "resolved that all applications for membership received prior to Sept. 1, 1916, be accepted (provided the applicant has the required qualifications) at the present rate of no initiation fee and $10 per annum membership dues." According to an amendment to the constitution adopted at the May convention, an initiation fee of $2 will be charged after 1,000 applications have been received. It is estimated that this figure will be reached before Sept. 1. The initiation fee will be increased $2 for each 500 members secured above 1,000. The association has grown from 30 members to 891 in fourteen months, and it is now proposed that future members shall be required to possess higher qualifications.

Appliances and Materials

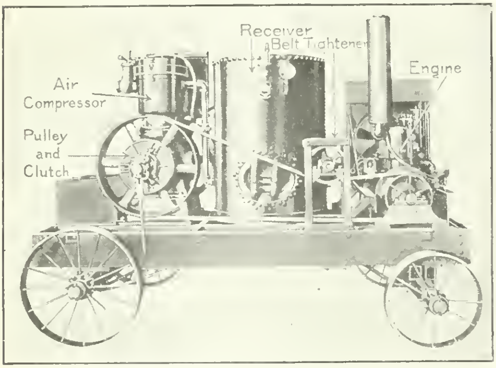
Portable Electric Inspection Lamp

A portable electric lamp outfit especially for inspection work in manholes, sewers, tunnels, car- and barge-loading stations, distilleries, etc., has been developed by the Hirsch Electric Mine Lamp Co., 314 N. 12th St., Philadelphia. It consists of a dry storage battery in case, a red warning-signal lamp on the case for use outside manholes, and a socket into which an incandescent lamp and reflector unit or a flexible-cable plug can be screwed.

* * *

Portable Air-Compressing Outfit

A portable air-compressor plant for use in construction work, bridge and structural-steel erection, and similar service, is shown in the accompanying illustration. It consists of a gasoline or kerosene engine (or electric motor), belted air-compressor, receiver and cooling apparatus, all mounted upon a steel frame carried by four wheels. When a gasoline engine is used it is of the four-cylinder automobile type but built specially for this work, with ample lubricating and cylinder cooling equipment. It can be disconnected from the compressor and used to operate other machinery. The compressor is of the Gardner-Rix high-speed vertical type, and is equipped with a water-cooling device independent of that for the engine. The outfit is built in various sizes, with capacity ranging from 21 to 450 cu.ft. of air per minute. The smallest size has a 7½-hp. engine, a single-acting compressor with 4½x4½-in. cylinder, and an 18x48-in. receiver. The largest size has a 120-hp. engine, double-acting compressor with 14x12-in. cylinder and two receivers 2½x6 ft. The former has a platform 2½x6 ft. and weighs about one ton. The latter has a platform 5½x13½ ft., and weighs 6½ tons. The plant is shown uncovered, but may be fitted with a canopy roof or enclosed entirely by a steel housing with removable panels in the sides and ends. The smaller sizes may be mounted on skids instead of wheels. The Chicago Department of Public Works has used one of these outfits, of 80 cu.ft. capacity, for calking water mains, and another of 140 cu.ft. capacity on bridge repair work. These plants are built by the Zin-Ho Mfg. Co., of Chicago.



PORTABLE AIR-COMPRESSOR OUTFIT

* * *

Electric Dump-Car

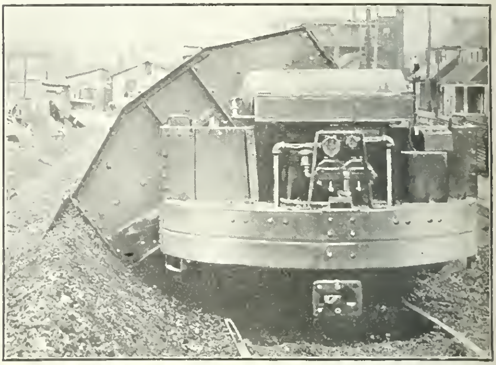
A new design of tilting dump-car having a low body but discharging its contents clear of the track is built by the Differential Car Co., of Nashville, Tenn. This combination of low center of gravity and clear dumping is effected by giving the body a lateral or traversing movement on the underframe. The inventor and designer is H. Fort Flowers, of New York.

The car is intended specially for street and electric-railway work, and its mechanism is electrically operated. It is so designed that when dumped from track below street paving (in the trench opened for track reconstruction) the pile of material will stand clear of the trench. With the track in normal position at the street level, the edge of the pile of material is about 12 in. from the rail.

When delivering material for ballasting or concrete the car usually moves forward while being dumped, in order to distribute the material in required proportion. The view shows one of its trailers in dumped position, making a fill on the Cleveland Electric Ry. The cars are 35½ ft. long, the capacity 18 cu.yd. The motor car weighs 23 tons, the trailer 15 tons.

The tilting body is divided into three compartments, each with its own side doors. Thus the contents of the compartments may be discharged at different points, or the entire load discharged at once. The car is mounted on trucks with 26-in. wheels.

The low position of the body is convenient for loading by hand or by steam shovel. The total height is 5 ft. 4½ in., but 75% of the loading may be done with the side doors raised, and the material shoveled directly onto the floor, which is only 3 ft. 6 in. above the rail. With the doors closed, the body may be partly tilted to make the loading more convenient. In full tilted position, at an angle of 45°, the top of the side is only 2 ft. 6 in. above the rail.



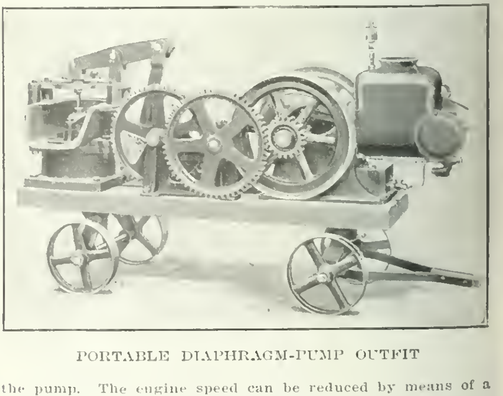
DUMP-CAR WITH TRAVERSING BODY

The shifting and dumping of the body can be done in 17 sec. The traversing mechanism includes a motor-driven worm shaft, a worm wheel and chain drum and chains going over sheaves on each side of the body and joining at a center anchor pin.

* * *

Power-Operated Diaphragm Pump

The contractors' portable pumping outfit shown in the accompanying view has a diaphragm pump and gasoline engine mounted on a truck and weighs complete about 725 lb. The pump has a 3-in. diaphragm and guides on the piston rod insure vertical motion, thus eliminating side strains on the diaphragm. The horizontal engine, with cylinder 3¾x5 in., is rated at 1½ hp. It runs normally at 500 r.p.m. and is double-geared to the shaft from which the pump rod is operated, the gearing being such as to give 60 strokes per minute on the pump. The engine speed can be reduced by means of a speed-changing device. An oscillating magneto is used, no batteries being required. The outfit is said to be capable of handling 3,000 to 4,500 gal. per hr. (depending on conditions of working) at a cost of 3c. per hr. Its overall size is 63x21 in., with a height of 38½ in. The builders are D. A. Hinman & Co., of Sandwich, Ill.



PORTABLE DIAPHRAGM-PUMP OUTFIT

Engineering News

VOLUME 76 AUGUST 3, 1916 NUMBER 5

Hydrolytic Sewage Tanks at Luton, England

By J. W. Tomlinson*

Luton, with a population of 60,000, is an industrial town situated some 30 mi. due north of London. The staple industry is the manufacture of straw and felt hats. There are also a number of industrial engineering works.

Some six or seven years ago it became evident to the authorities of Luton that the existing means of dealing with sewage of the borough were inadequate and unsatisfactory, and steps were taken to put this municipal service upon a better footing. After an investigation extending over a period of two years it was decided to adopt a scheme, prepared by the Borough Engineer, that included tank settlement and double bacterial filtration followed by exposure in large shallow lagoons before discharge to the river.

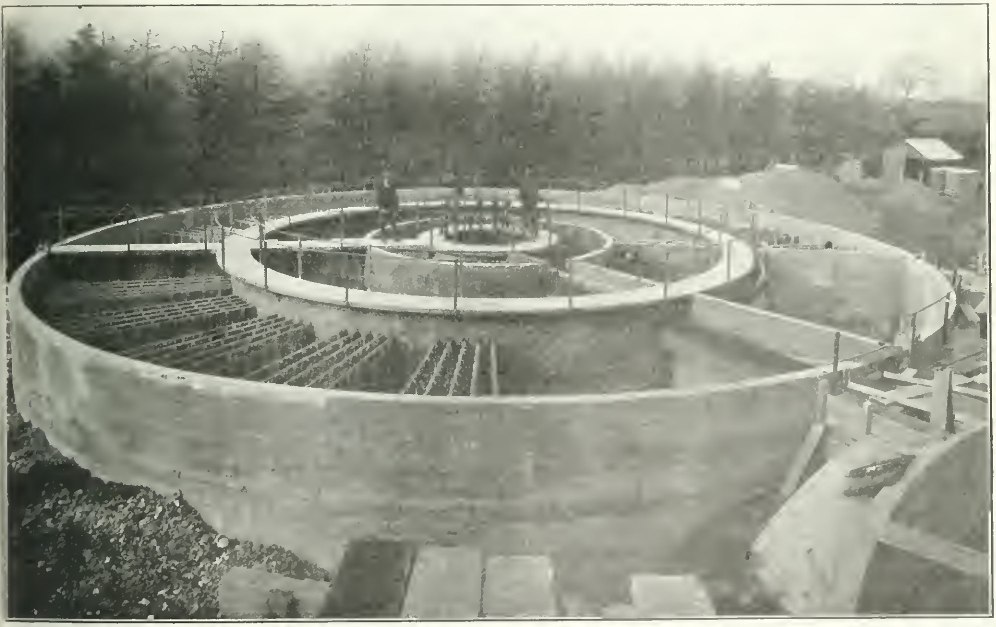


FIG. 1. HYDROLYTIC SEWAGE-TREATMENT TANK, BOROUGH OF LUTON, ENGLAND

The consideration given to the question was particularly thorough and careful in view of the fact that the only possible discharge for the final effluent was into the River Lea, from which river, some 30 mi. below Luton, a large quantity of water is taken for the supply of drinking water to the northern parts of London.

So far as the filter beds are concerned, there is but little to distinguish the works at Luton from a large number of others; the shallow lagoons for the exposure of the effluent immediately before discharge into the river are, perhaps, an unusual feature and have justified themselves in quite a marked degree in working, but the settling tanks adopted are of unusual design.

At the present time five of these tanks have been constructed—three for the primary settlement of the sewage as it is delivered by the pumps after no further treatment than passing through a $\frac{1}{2}$-in. screen, and two for the settlement of the effluent from the primary set of filter beds so as to eliminate all solid matters before it passes onto the secondary set of filter beds.

The tanks for the two varieties of duty are not identical in design, the secondary tanks being smaller and simpler in type, but the main features are similar and it will be sufficient if one of the larger tanks is described in detail.

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*Borough Engineer and Surveyor, Luton, England.

The governing object of design was to separate as quickly as possible the sludge deposited by the sewage from the main flow of the liquid so as to carry out the settlement continuously without septic action being set up.

The tank (Figs. 1 and 2) has an outside diameter of 65 ft. and a maximum depth of 27 ft. 5 in. At the center is a sludge well, 9 ft. in diameter, which contains no sewage during working, extending below the other compartments of the tank, into which, by means of valves, it is possible to discharge sludge from any chamber. Around this central sludge well is a series of nine chambers arranged in three annular rings and divided from one another by radial and annular walls. The chamber adjoining the sludge wall is only 5 ft. in radial width, and extends for the full circle around the sludge well. The two rings of chambers outside this are separated by a circular wall that is vertical for a distance of 9 ft. down from the top and then inclines outward at an angle of 45°. At the point where this wall reaches the outside wall of the tank there are a series of openings through which the sewage can pass from the outer chamber to the inner one. These chambers are of unequal size, measured circumferentially, the one into which the sewage first enters being smallest and the size increasing so that the last chamber is more than twice the size of the first one. The radial division walls are for the most part hollow and form channels or trunks through which the sewage flows from the surface of one chamber to a point near the bottom of the next.

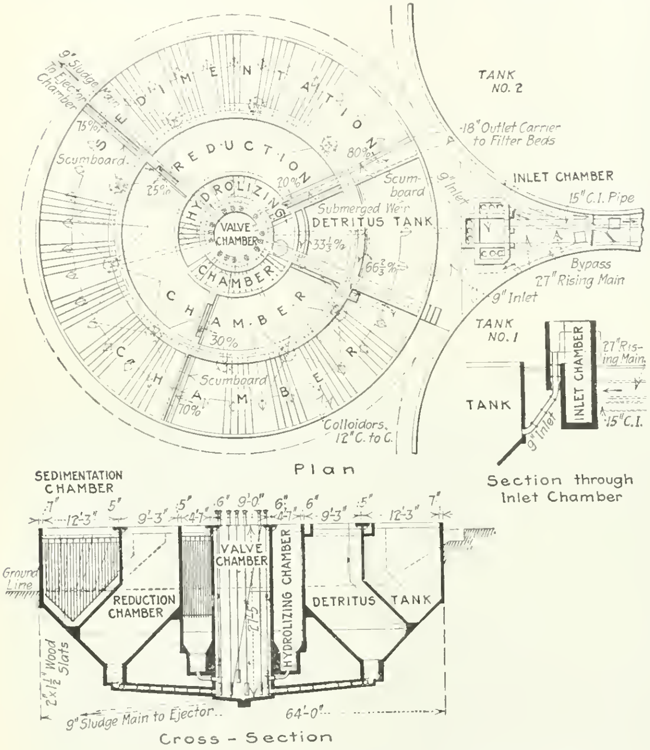

FIG. 2. PLAN AND SECTION OF HYDROLYTIC TANK, LUTON, ENGLAND

The sewage enters the smallest of the outer chambers of the tank some 10 ft. below water level. From this chamber a proportion of the flow passes over a weir, down a trunk in the adjoining radial wall, and is delivered well under water level into the next outer chamber. The remainder of the flow passes through the openings at the bottom of the circular division wall into the inner chamber and subsequently overflowing a weir on the wall of that chamber it passes down a trunk in the radial wall, unites with the overflow from the outer chamber and is discharged into the second outer chamber. In this second chamber the flow is similarly divided, part passing directly forward and part passing, as before, under the dividing wall into the inner chamber. Also, as before, the overflows from both inner and outer chambers pass along trunks in the next radial wall, uniting once more and being delivered into the next outer chamber. The same thing happens in the third chamber, while in the fourth and last of the series, part of the flow passes directly from the outer chamber to the effluent carrier, while the portion from the inner chamber passes into and around the central annular chamber, joining the sludge well before it leaves the tank. The result of this repeated division of flow is that all solids deposited in the outer chambers are carried promptly forward by the flow into the inner chambers, which are deeper, and in the floors of which are situated, at convenient distances, sumps for receiving the sludge. The proportion of flow passing from the outer to the inner chambers is regulated by the comparative lengths of the weirs forming the outlet from the two chambers and is varied to suit the probable quantity of sludge that will be deposited. Thus in the first chamber one-third of the flow passes to the inner chamber; in the second chamber 30%; in the third 25%, and in the fourth 20%.

The floor of the tank is arranged on a ridge-and-furrow principle carried out so completely that there is no portion of it that does not incline at an angle of 45° at least with the horizontal. In consequence of this method of flooring, the sludge deposit quickly finds its way into the several sludge sumps in the floor of the inner chambers.

These sludge sumps are connected by 9- or 6-in. pipes with the sludge well into which the sludge is forcibly discharged when one of the valves in the sludge well is opened.

To aid the collection and settlement of flocculent matter, vertical wooden grids or colloidors (see Figs. 1, 2 and 3) are fixed in the second, third and fourth outer chambers and in the chamber next the sludge well.

These grids are formed of 2x1½-in. slats suspended from a joist crossing the chamber in a radial direction. The suspended matter strikes these rods and forms a slimy deposit on them that in a short time slips off in pieces large enough to settle readily. The grids are wholly under water. They are fixed in groups of five, 12 in. c. to c., and the groups are spaced about 3 ft. apart.

In each compartment a wooden scum board is fixed in front of the overflow weir.

The sludge that is drawn off into the sludge well from the sludge sumps in the different chambers of the tank passes from thence by gravitation along a 9-in. outlet pipe to a 100-gal. (Imp.) automatic ejector, operated by compressed air, by means of which it is raised onto the surface of the land at some distance from the tanks, where it is dealt with. The air compressor is motor driven.

There is thus no need to empty the tank after it commences work and its operation is continuous. As a matter of fact, three of the tanks at Luton have been in operation for five years, during which time they have never been emptied and they work quite as efficiently now as ever.

Each of the primary tanks at Luton has a capacity of 260,000 gal. (Imp.), and two such tanks deal quite efficiently with a daily flow of 1,500,000 gal. (Imp.).

The tanks are constructed of reinforced concrete throughout. The outer wall is 7 in. in thickness, the wall round the central sludge well 6 in. thick and the other walls mainly 5 in. The reinforcement is square indented steel bars, the sizes used being ⅓, ½, ⅝ and ¾ in. The vertical reinforcement is of ⅓-in. bars throughout, about 18 in. c. to c. The horizontal reinforcement, 6 to 9 in. c. to c., varies in size from ⅓ to ¾ in. according to depth, size of circle and weight to be carried. The concrete used was mixed in the proportion of 6 to 1, the cement being of British standard quality and the aggregate consisting of 50% ⅝-in. Leicestershire granite chips, 25% ¼-in. chips of the same material and 25% of coarse local sand.

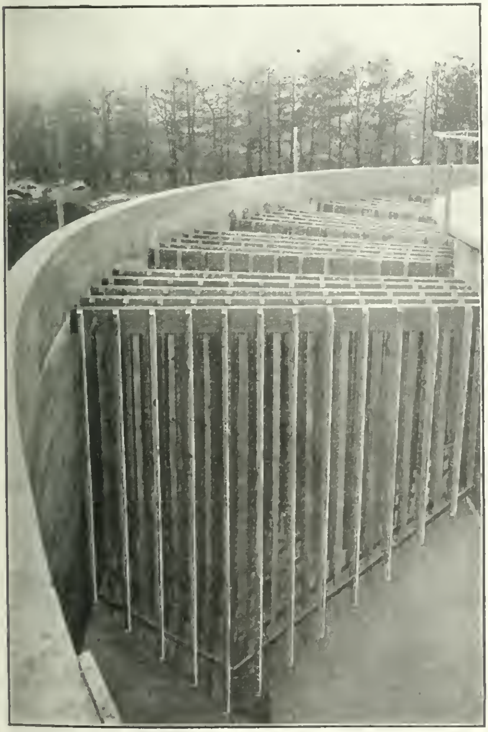

FIG. 3. WOODEN COLLOIDOR GRIDS IN LUTON TANK

The earth was excavated to the configuration of the floor of the tank and the 6-in. concrete floor laid. The outside and two innermost circular walls were then constructed, the same forms being used several times over; the radial walls were next formed and finally the shaped circular wall dividing the outer and inner chambers. When the boarding was removed any projecting ridges on the concrete were dressed off, the surface brushed over with a wash of neat cement and then plastered.

The workmen employed were not skilled. None of them had had any previous experience with reinforced-concrete work and yet no trouble was experienced in obtaining a thoroughly sound job, quite water-tight at the somewhat considerable pressure that occurs.

The efficiency of the design may be gathered from the following analysis of representative sewage and tank effluent, the samples being obtained by adding together equal quantities taken each hour for 24 consecutive hours.

	Parts per 100,000					
	Solids			Nitrogen		Oxygen
	In Suspension	In Solution	Chlorine	Ammoniac	Albumin	Absorbed in 4 Hr.
Crude sewage...	57	117.4	14.6	5.75	0.95	8.1
Tank effluent...	3	111	13.5	5.8	0.28	4.9

This shows a reduction of 94% in the suspended solids and of 70% in the albuminoid nitrogen—a very good result.

The crude sewage is generally colored by dye waste, often to a vivid degree, and the tank effluent in consequence is usually of a somewhat yellowish tint.

The cost of operating the tanks is very small, being confined to the cost of the daily removal of the sludge. With electrical current available at 1d. per unit the running costs, including man's time, are about 8 shillings ($2) per week per tank.

The original cost of the tanks is very small compared with the flow of sewage they will treat. Thus two primary tanks actually cost £3,405 or $16.550 (including patentee's fees) and deal with a flow of 1,500,000 Imp. gal. or 1,800.000 U. S. gal., which is equal to a cost of £2,270 per 1,000.000 Imp. gal., or about $9.200 per 1,000,000 gal. per 24 hr.

The sludge-lifting plant, comprising electrically driven air compressor, pipe lines, two automatic ejectors, chambers, engine house, etc., cost £1,409, or $6,850, and this plant is capable of dealing with double the present number of tanks.

The design of the tank has been patented and the holder of the patent is the Hydrolytic Tank Construction Co., 16 Victoria St., London, S. W., England.

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An Irrigation System for the Reeves County Irrigation District No. 1, Balmorhea, Tex., is to be built. Bids will be received June 24 for a diversion dam, two earth storage dams, and canals. There will be about 180,000 cu.yd. of excavation, 185,000 cu.yd. of embankment, 22,000 sq.yd. of dry paving and 4,000 cu.yd. of concrete. V. L. Sullivan in engineer and W. W. Stewart is Secretary of the district.

Tunnel Grouting in Brooklyn End of Catskill Aqueduct

By O'Kelly W. Myers*

SYNOPSIS—Methods of controlling water inflow while placing concrete lining and of grouting to stop subsequent leaks are described. Sequence of placing concrete lining is given; also method of controlling water by pans and piping and at worst place by steel lining to convey water to a drainage sump. Cost figures are presented.

The concrete lining of that portion of the city tunnel between shafts 23 and 24, a part of the Catskill Aqueduct located in Brooklyn, is of interest because of the amount of water inflow through the rock. It is believed that the methods used and the results obtained in handling the water while the concrete was being placed and in closing off this water by grouting are worthy of notice.

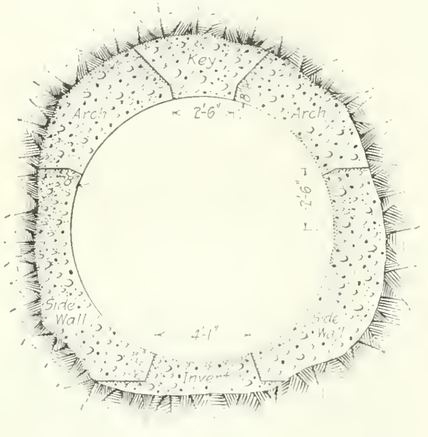

FIG. 1. SKETCH SHOWING CONSTRUCTION JOINTS IN CONCRETE LINING OF TUNNEL

The portion of tunnel considered here is 3,600 ft. long and 11 ft. finished diameter. The rock encountered in sinking the shafts and in driving the tunnels is known as granodiorite, being a somewhat similar formation to the gneiss. In shaft 23 and for the first 600 ft. of tunnel leading therefrom the rock was sound and dry, but in shaft 24 and the remainder of the tunnel frequent seams and crushed areas were encountered. From these seams and crushed areas water flowed, the leaks being numerous and varying from very slight seepage to a maximum of 240 g.p.m. (gallons per minute) from a seam in shaft 24 and a maximum of 600 g.p.m. from one in the tunnel near shaft 23.

The elevation of the finished invert of the tunnel is —269, the surface of the overlying rock varying from —73 to —105 and the ground water level —5. The water flowing into the tunnel was therefore under a head of 264 ft., or about 114 lb. pressure per square inch.

The maximum leakage recorded for the tunnels during the driving was 600 g.p.m., this coming from one seam. The leakage from the entire tunnel, upon completion of driving, amounted to only 475 g.p.m., although numerous large and small leaks were encountered, the reduction being due to silting; the 600-g.p.m. flow having reduced to about 300 g.p.m. is an example. This leakage was further reduced to 440 g.p.m. when the concrete lining had been completed.

The tunnels are lined with 1:1½:3 concrete, which has a minimum thickness of 15 in. with an average thickness of 2 ft. The lining was placed in four steps (Fig. 1), as follows: The invert, 4 ft. wide, was laid in stretches of about 200 ft.; the sidewalls were placed in 60-ft. stretches; the arch was placed in 60-ft. stretches; and the key, at the back end of the form, was a continuation of placing the arch concrete. This key was generally completed 6 hr. after finishing of the third step.

In the longitudinal joints no means were taken to insure tightness other than removing the laitance and finishing the surface, when forms were not used, with a wooden float or cement bag. In the transverse joints a key block made of short pieces of 4x4-in. timbers, beveled, was placed 8 in. or more from the face. It is doubtful if the key formed by these blocks has proved to be of any benefit.

Upon the removal of the forms transverse contraction cracks developed, there being one or two in each 60-ft. section. These cracks generally encircled the tunnel, including the invert.

The lining, so far as the body of the concrete was concerned, was tight; but there were numerous small leaks and seepage from the key joints, the transverse joints and particularly from the contraction cracks.

The handling of the water in shaft 24 was done in a somewhat different way and at a different time from that in the tunnel, so will be considered separately. Little trouble was encountered in handling the water in the shaft, except in one stretch of 40 ft., where one leak gave a flow of 240 g.p.m.

The shaft, which is circular and varies from 16 to 18 ft. finished diameter, was sunk, lined and grouted in

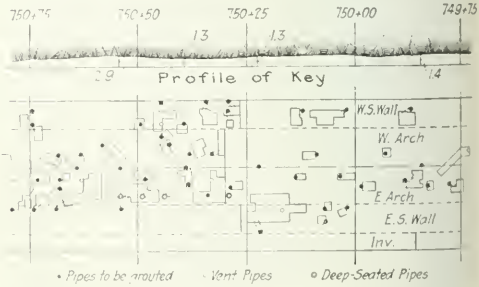

FIG 2. LOCATION OF DRIP PANS AND INSPECTION PIPES SHOWN BY DEVELOPMENT OF TUNNEL LINING

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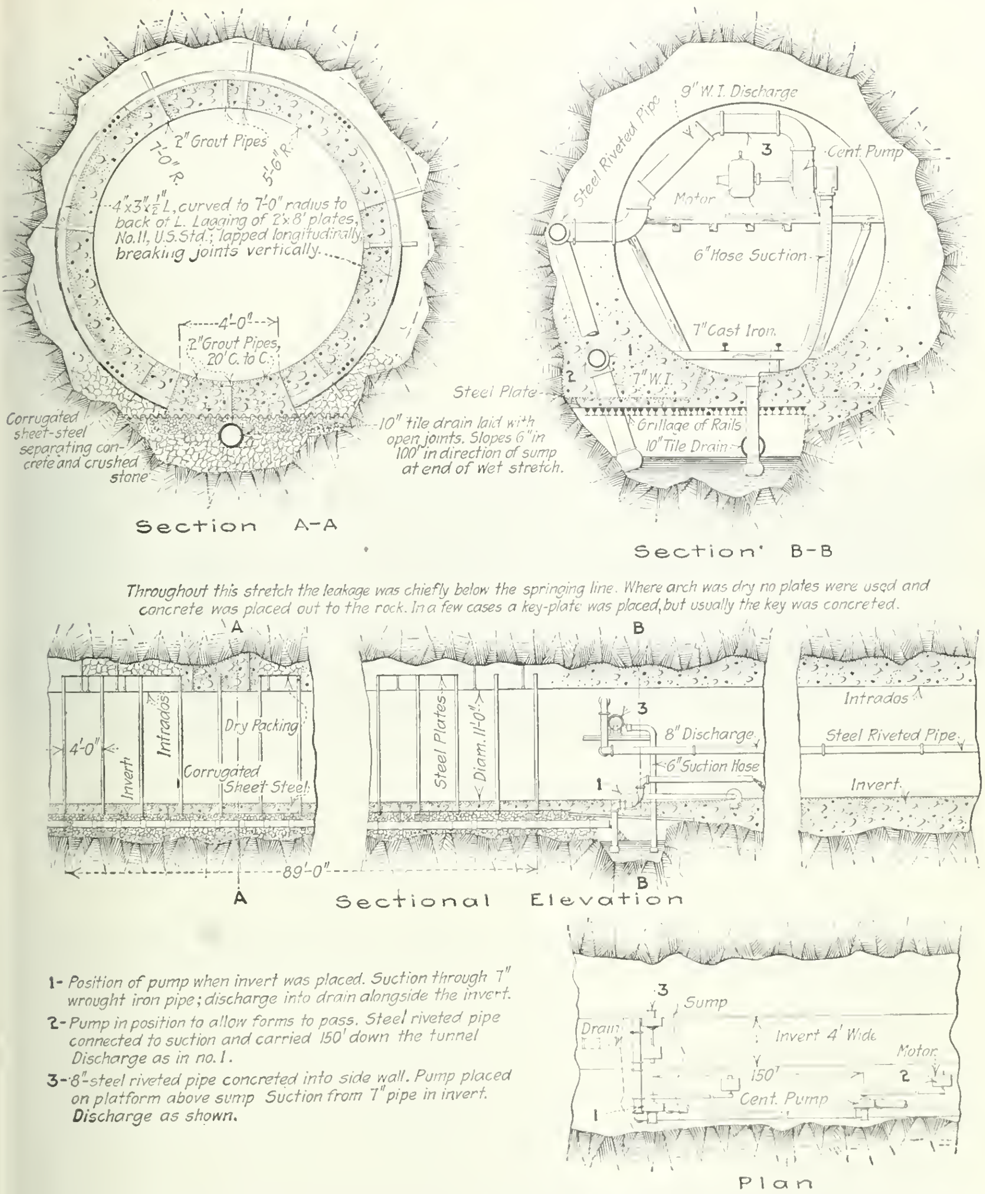
*Assistant Engineer, Board of Water-Supply, New York City.



Throughout this stretch the leakage was chiefly below the springing line. Where arch was dry no plates were used and concrete was placed out to the rock. In a few cases a key-plate was placed, but usually the key was concreted.

1- Position of pump when invert was placed. Suction through 7" wrought iron pipe; discharge into drain alongside the invert.

2- Pump in position to allow forms to pass. Steel riveted pipe connected to suction and carried 150' down the tunnel. Discharge as in no. 1.

3- 8" steel riveted pipe concreted into side wall. Pump placed on platform above sump. Suction from 7" pipe in invert. Discharge as shown.

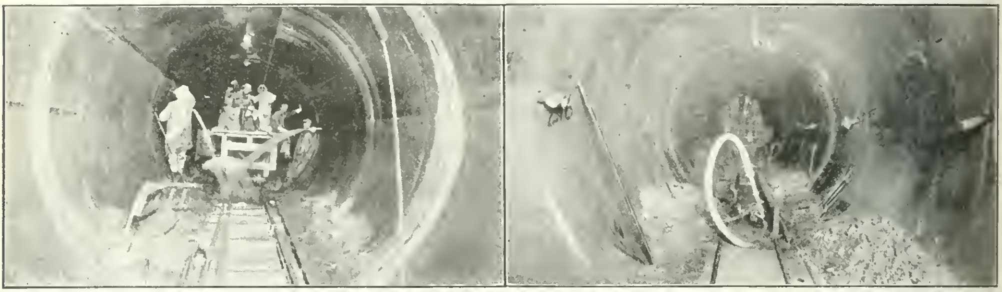
FIG. 3. CORRUGATED STEEL LINING AND ARRANGEMENT OF PLANT TO CONTROL WATER NEAR SHAFT 23

stretches not exceeding 100 ft. During the sinking numerous small seams were encountered which flowed water, but became dry as seams below were reached by the excavation, until at El. —221 a seam which evidently fed those above was encountered. The water from this seam flooded the shaft, requiring the installation of a large pumping plant to reclaim it. This water had been reached by a drill hole passing through about 5 ft. of sound rock. When the shaft had been emptied, this hole was fitted with a pipe and valve, and a series of holes encircling the shaft was drilled through to the water. Through pipes fitted in these holes 55 cu.yd. of liquid grout was forced. The grouting of this seam caused the water to rise in the rock and flow from smaller seams above, so while waiting for this grout to harden an effort was made to close the seams above. This was done by drilling holes in the seams, into which grout under low pressure was forced, wedges of soft wood being driven into the seams where necessary to prevent the grout from escaping into the shaft. Two cubic yards of grout was used, reducing the leakage from 50 to 15 g.p.m.

Upon resuming excavation it was found that the seam which gave the large flow had been successfully grouted and gave no trouble; but after the seams above were closed, the rock sealed so badly that it was necessary to suspend sinking and place the lining. The water remaining was handled through the concrete and later grouted by the same methods as described for the tunnel.

In handling the water in the tunnel, wherever possible any flow of 2 or 3 g.p.m. or more was collected into a deep-seated pipe and led through an opening in the form. Where smaller flows or general seepage was encountered and in connection with the deep-seated pipes, drip pans were used to collect the water, which was led from the pans through the forms by pipes (Fig. 2).

The pans consisted of sheets of No. 24-gage black iron cut to the desired size. The area to be panned was outlined, and 1-in. holes were drilled about 15 in. apart into the rock, the holes being 2 in. deep. Wooden plugs were driven into these flush with the rock face. The sheet iron was nailed to the plugs, the edges calked with oakum and plastered with cement or plaster of paris. The precautions of calking and plastering were taken to prevent the mortar from the concrete from getting behind the pan. The pans varied in size from one of 4 or 5 sq.ft. to a maximum of 150 sq.ft. Where possible, several small pans rather than one large one were used, thereby lessening the liability of damaging the concrete when placing the high-pressure grout. The pans were generally fitted with two pipes—one at the bottom to handle the water and later to take the grout, the other near the top as a vent to aid the circulation of the grout in the pan. A few small pans were connected to only one pipe, and in one instance a long narrow pan, following a seam, had 10 pipes. The pans were generally made to conform with the rock surface; but in some instances, in order to protect the metal from sharp edges of rock, or when a large amount of water was to be handled, they were partly filled with crushed stone. Much attention was given to the pans, and this care was justified when it is considered that the plugging of a pipe may mean the escape of the water into the green concrete and the possible removal and replacing of several cubic yards of porous concrete.



FIGS. 4 AND 5. GROUTING CARRIAGE AS SEEN FROM STATION 5761 + 50, NEAR SHAFT 23, BROOKLYN SECTION OF CITY TUNNEL, CATSKILL AQUEDUCT

Fig. 4—Looking north. Near view of carriage and water flowing from deep-seated grout pipes. Low-pressure grouting completed. Note water discharging from pipes. Fig. 5—Looking south. Front of car in distance and connection to invert pipe in foreground, showing method of cleaning high-pressure connections. High-pressure grouting completed

In the roof, to take care of the shrinkage of the concrete, key pipes were placed, generally about 10 ft. from each end of the 60-ft. section, the location selected being alternate places of low and high breakage. An unusual roof breakage was taken care of with a separate pipe.

All pipes were 2 in. in diameter and, when possible, straight, this being desirable as it is frequently necessary to clean out a pipe while grouting. In the 3,600 ft. of tunnel there were placed 215 pans and 781 pipes.

One section of the tunnel near shaft 23 (Sta. 5,761 + 00 to Sta. 5,761 + 89) flowed a large amount of water, 600 g.p.m., when first encountered. It was therefore decided to use a special construction rather than take the risk of damaging the green concrete, should drip pans be relied upon. This construction is shown by Fig. 3.

In this case the steel lining may be considered as a large drip pan attached to the metal ribs instead of to the rock, the water being led down to the drain and the sump instead of being carried through the forms and the plates, and dry packing being placed only where there was leakage to be handled, over about 60% of the area. The steel shell lining was extremely light, being designed neither to carry any strains nor to act as reinforcement.

The plant used in grouting consisted of two Canniff machines connected in series and two air compressors capable of raising the pressure from 100 to 350 lb. per square inch, placed on a small flat-car with a trailer, upon which the material was stored and the machines charged. Air was furnished through a 4-in. pipe line at 90-lb. pressure. A 2-in. line connected to the discharge pipe of the tunnel pumps furnished the water. Fig. 4 shows the grouting carriage near-by, and Fig. 5 farther removed, at two different stages of the work.

Beginning in the tunnel at the foot of shaft 24, grout consisting of one bag of cement and an equal volume of beach sand with 8 gal. of water (this being equal to 2½ cu.ft. of liquid grout or 1.66 cu.ft. of solid) was forced into the key pipes under pressure not exceeding 90 lb. until the pipe refused to take more or until the grout had moved along the tunnel for 250 or 300 ft., all of the valves on the key pipes and a number of the pan pipes above the springing line having beeen closed as grout began to flow from them.

This step, called the low-pressure grouting, was intended to fill the void between the concrete and the rock surface of the roof caused by the shrinkage and settlement of the concrete, as well as to confine the grout placed later under high pressure. As the tendency of the grout is to settle in the low places, leaving voids where the roof is high, the long pipes were cleaned out, after the grout had begun to stiffen and before it had set, for future connections.

Sixteen hours after the low-pressure grout had been placed, all valves were opened and any pipes showing leakage or any deep-seated pipes not previously opened were drilled out for high-pressure connection. The low-pressure grouting was a continuous operation, a three-shift organization being used, and was completed before any high-pressure work was started. The grout circulated along the roof so freely that connections to the key pipes, for the low-pressure work, were necessary only at intervals of from 150 to 200 ft. There were placed in this step 4,878 batches, which represents 2.193 cu.ft. of solid grout per linear foot of tunnel.

In the high-pressure work a neat cement grout consisting of one bag of cement to 6 gal. of water, making 1.4 cu.ft. of liquid grout, was used and was forced in under a pressure of 300 lb. per square inch, the pressure being maintained for about 6 min. after the grout had ceased to flow, this being the time found necessary to plug or dry out the grout in the pipe. By using a blowoff near the valve the liability of plugging the hose was removed. Connections were made to the lower pan pipes, all upper pipes being closed upon their venting grout. Later, before the grout in the upper pipes had set, connections were made to them, as it was found in most instances that those pipes would not be entirely filled, due to the presence of the water contained in the grout, the air being unable to drive it away.

The deep-seated pipes (in the seams which had been making water during the low-pressure work) were connected to and were grouted after the local pan pipes had been plugged. Generally only enough grout to fill the void formed by the pan could be forced into the pipes, except the deep-seated pipes and some of those near the roof where the grout had chance to escape to the roof.

In a few instances, due to the tightness of the rock and consequent retention of air and water in the pipes or to small leaks in the valves the pipes were not successfully closed, but upon being cleaned out and a connection maintained from 10 to 15 min. they would be found to be closed upon the removal of the valves.

The greatest difficulty encountered was in closing off the water coming through the contraction cracks above the springing line. These cracks generally flowed grout freely during the low-pressure grouting, but would close, partly opening again, after the grout hardened. As these cracks were not necessarily convenient to the pipe placed for other conditions, there were a few cases where the high-pressure grouting could not reach them and they continued to leak; but when near a key or pan pipe, the leakage was cut off without trouble. A few of the worst of these leaks were selected for experiment. The cracks were drilled into, pipes placed and grouted, the result in each instance being satisfactory. The remaining leaks were so small that the conditions would not justify the time or expense to close them. The leakage from these seams is decreasing through siltage, it is supposed.

The grouting in the stretch in which the special construction was used was not begun until all other grouting had been completed. After a careful study of the special conditions existing, the following operations were carried out: Three key pipes at each end beyond the stretch were left open as vent pipes during the last step of the low-pressure grouting; all pipes below the springing line except the deep-seated pipes were closed; the pipes at and above the springing line were left open; the first connection was made to the pipe at the upper end of the drain, and when this refused grout under 150-lb. pressure the next pipe in the drain was grouted and so on until all drain pipes were filled; then returned to the upper end of the drain, connecting to the pipes leading to the dry packing in the bottom; again returning, connecting to the springing-line pipes; the last step was to connect the key and deep-seated pipes, working in the opposite direction, using high pressure.

In order to keep down the pressure from the outside, all pipes except the invert pipes were left open or opened after the grout had settled. In this way most of the grout was placed against a pressure of 50 lb. or less, the final reading of the gage being 90 lb. when the grouting plugged the gage.

The method outlined gave results far better than had been hoped for. The grout forced into the drain pipe rose above the springing-line pipes without traveling any great distance ahead, a similar action being noticed from the other pipes, the retained water probably acting as a cushion, making it as easy for the grout to rise through the clean dry packing as to flow along the bottom through the packing filled with the solid grout.

The deep-seated pipes and the roof pipes flowed grout and had to be closed when grouting was being done in a near-by pipe, but could be opened later. This was a great aid, as it permitted most of the grout to be placed under low pressures, thus saving time and insuring a better circulation of the grout.

Assuming that the dry packing contained 45% voids, it was estimated that 1,350 batches would be placed under low pressure. There were actually placed 1,420. As expected, the low-pressure grouting did not to any extent reduce the flow of water, but filled the voids, forcing the water to the deep-seated pipes.

It was found upon opening the valves that but few of the pipes below the key had been plugged by the low-pressure work; consequently all pipes were opened and connected to under high pressure, several of the invert pipes requiring a second connection. Altogether, 217 batches were used in the high-pressure work on this section.

This section is now very dry, and that it was ever otherwise would not be noticed except for the number and the regularity in the placing of the pipes. The leakage for the 3,600 ft. of tunnel has been reduced to 6 g.p.m. and probably could be reduced still further, should it be considered necessary to resort to calking; but as it is expected that silting will reduce this leakage, no attempt will be made at present to reduce it by calking.

To complete all of the grouting, 96 shifts of 8 hr. were required. The gangs were green to this class of work and had to be trained. Each gang consisted of one foreman and seven men.

A total of 76 low pressure and 521 high-pressure connections was made, taking 578 cu.yd. of low-pressure and 121 cu.yd. of high-pressure grout. The record for 8 hr. was 122 batches under low pressure.

The cost of the work is detailed in the accompanying table, shown on the next page.

GROUTING COSTS IN TUNNELS 23-N AND 24-N FROM CONTRACT 67 ESTIMATES

Description	Quantity	Unit Cost	Amount	Total	Cost per Ft.
1,611-Ft. Tunnel 23-N Excepting Wet Stretch					
Drilling 1½ - in. holes or smaller	86 ft.	$1.00	$86.00	......	...
Drilling 1¾ - in. holes or larger.	38 ft.	2.50	95.00	......	....
Steel pipe for grouting	2,186 ft.	.50	1,093.00	......	....
Connecting machines to grout pipes	468 con.	1.50	702.00	.....	.
Sand for grout...	119 tons	2.00	239.00	......	..
Mixing and placing grout	309 cu.yd.	6.00	1,854.00	. . .	
Portland cement..	976 bbl.	1.50	1,464.00	......	..
				$5,532.00	$3.43
89-Ft. Tunnel 23-N—Wet Stretch (Sta. 5,761 + 00 to 5,761 + 89)					
Drilling 1½ - in. holes or smaller	......	1.00	......	.....	....
Drilling 1¾ - in. holes or larger.	6 ft.	2.50	15.00	......	....
Steel pipe for grouting	183 ft.	.50	91.50	. .....	....
Connecting machines to grout pipes	71 con.	1.50	106.50	.....	...
Sand for grout....	80 tons	2.00	160.00	......	....
Mixing and placing grout	142 cu.yd.	6.00	852.00	.... .	...
Portland cement..	407 bbl.	1.50	610.50	......	....
				1,835.50	20.62
1,700-Ft. Tunnel 24-N					
Drilling 1½ - in. holes or smaller	22 ft.	1.00	22.00	......	...
Drilling 1¾ - in. holes or larger.	9 ft.	2.50	22.50	......	....
Steel pipe for grouting	1,445 ft.	.50	722.50	......	...
Connecting machines to grout pipes	327 con.	1.50	490.50	......	....
Sand for grout....	103 tons	2.00	206.00	......	....
Mixing and placing grout	246 cu.yd.	6.00	1,476.00	......	....
Portland cement..	767 bbl.	1.50	1,150.50	......	....
				4,090.00	2.41
Total for 3,400 ft......................				$11,457.50	$3.37

The work described is being carried out by the Board of Water-Supply of New York City, of which J. Waldo Smith is chief engineer. W. E. Spear is department engineer, City Aqueduct Tunnel, and James F. Sanborn was division engineer at the close of the work.

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Water-Evaporation Studies by Weather Bureau

By Benjamin C. Kadel and Cleveland Abbe, Jr.*

Discussions of a paper recently published in an engineering journal show that there is need of a statement by the Weather Bureau as to its present position relative to the evaporation work heretofore carried out under the supervision of the bureau and also as to the bureau's present plans for the conduct of work of this character.

The results of the extensive campaign, popularly known as the Salton Sea campaign, carried on by the Weather Bureau from 1907 to 1911, were presented in a preliminary way in various numbers of the *Monthly Weather Review* of the same period; but as some questions arose thereafter as to the basis of discussions used at that time, the publication of the full report was deferred until it might be possible to revise all the work thoroughly. The original records are intact and without doubt contain many data of value. In order that this fund of information might be made available the Chief of the Weather Bureau, in February, 1915, appointed Benjamin C. Kadel and Dr. Cleveland Abbe, Jr., a committee to select the most valuable of these data and transcribe them for publication. This work has gone forward as rapidly as possible, and the data, in the form of a transcript of the original observations, will be published in the near future, probably in the form of a supplement to the *Monthly Weather Review*. In addition to this preparation for presenting to the public the information already in the possession of the Bureau a new series of evaporation stations is now being installed at various points throughout the United States. These stations[1] consist of an outfit selected with the object of so standardizing exposures and instruments that a comparison of values of evaporation in various portions of the country may be possible. It should be recognized that the demand for information concerning evaporation proceeds from widely different interests. The engineer wishes to determine evaporation losses from lakes, reservoirs and artificial supplies of water. The climatologist is interested in the relative evaporation in different regions. The botanist, the forester, the plant physiologist and the agriculturist each have still a different interest in the evaporation—as for example, from soil of whatever character and condition of cultivation, from transpiration, from vegetation in whatever form and stage of growth, etc. Thus far no standardized method has been evolved that permits determining exactly the data desired for any one of these requirements, much less a scheme for collecting data generally applicable to all. The plan contemplated by the Weather Bureau aims only to secure data of evaporation under conditions that are so nearly similar in different localities as to yield results having a comparable value. As the work progresses and as the data are examined and discussed in conjunction with observations with which the measurements of evaporation will be correlated, it is hoped to evolve relations that will be of value to the engineer, the forester, the plant physiologist, the botanist and the like.

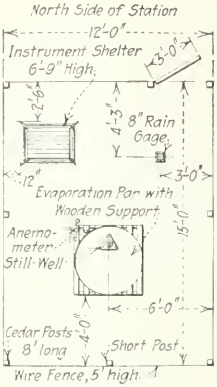

FIG. 1. PLAN OF STANDARD EVAPORATION STATION

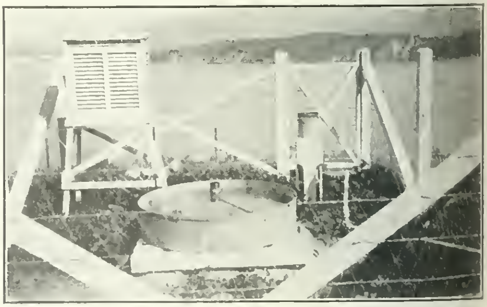

FIG. 2. EVAPORATION STATION AT ROOSEVELT DAM

Ordinarily the observations will be limited to measurements of evaporation, supplemented by such meteorological observations as will serve to identify the climate f the region—that is, the climatic records will be made harmonize with those made by the coöperative ob-ervers of the Weather Bureau. An anemometer will be dded to the outfit, because of the importance of the wind a factor in evaporation measurements.

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*United States Weather Bureau, Washington, D. C.

[1] Described and illustrated by one of us in "Instructions for the Installation and Operation of Class A Evaporation Stations," Circular L, Instrument Division (Benjamin C. Kadel, Chief), United States Weather Bureau, Washington, D. C.

Fig. 1 is a standard plan of a complete observation ation, Class A, and Fig. 2 is a view of a station.[2] The andard pan is a cylindrical galvanized-iron vessel 4 . in diameter and 10 in. deep, mounted on a skeleton amework just above the surface of the ground. This rm of evaporating vessel is undoubtedly subject to me criticism because it is exposed to radiation from n and sky, but it appears to be the most suitable form hen due consideration is given to the ease with which may be cleaned and cared for, its security against nwarranted change in water level due to deformation d its safety from insidious leaks. The pan is as large can be safely handled by one man.

A decided improvement in the methods of measuring ater heights consists of a heavy-based still well whose p forms a fixed point from which measurements are ade with a hook gage adjustable by means of a crometer screw (Fig. 3). Successive readings made by fferent observers agree within two or three thousandths an inch, even though observers have never used the ge before. This device, combining simplicity with ecision, makes possible satisfactory measurements by trained men.

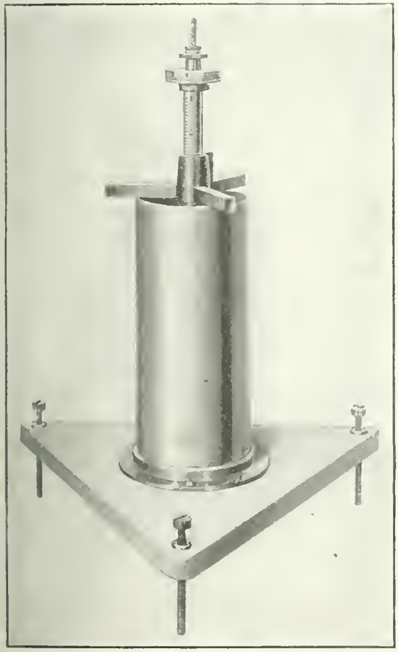

FIG. 3. EVAPORATING-PAN STILL WELL WITH HOOK GAGE

The hook gage is slightly below the top of the still well and is adjustable by a micrometer screw

This simple fundamental, known as Class A station, will be established side by side with floating pans or with the 8-ft. pan buried in the ground, which is the standard of the Bureau of Plant Industry, where opportunities occur. Some 25 stations are expected to begin records this year. These are located throughout the country.

Fair Competition Required in Kansas Bridge Contracts

In the letting of county bridge contracts in Kansas it has been common for the County Commissioners to adopt general plans giving merely the span and width with general specifications for the quality of materials, etc., and invite the bidders themselves to submit detail plans and specifications for the bridge which they propose to furnish.

Under this method of letting contracts the vendor of patent bridges who could make broad claims for the superiority of his designs has had every advantage. Few counties employ engineers competent to give advice on the comparative merits of different designs or even on the safety of a design. As a result of these conditions the chances of real competition in the lettings have been small.

The Supreme Court of Kansas by a recent decision has swept aside this corrupt system of bridge lettings and has ruled that the statute requiring all contracts to be awarded on a public letting to the lowest responsible bidder makes it necessary that the plans and specifications adopted and placed on file for the inspection of bidders must, so far as the nature and character of the proposed work will admit, be sufficiently definite and explicit to enable bidders to prepare their bids intelligently on a common basis. Further, the plans and specifications must be such that the amounts of material required to be used may be determined with reasonable accuracy by all the bidders, and this could not be the case if bids were accepted on designs prepared by one of the bidders.

In the case before the court which gave rise to this decision, the plans and specifications adopted by the Commission and on which it received bids did not give the thickness of the arch ring, the thickness of the piers, the dimensions of the abutments, or the thickness of the wing walls. The opposite side of the case was conducted by a company, which had submitted a bid for a patent bridge, and it contended that these dimensions were dependent on the method of reinforcing which the successful bidder might submit with his plan.

In passing upon this question the Court cited a large number of decisions and said:

> Authorities are practically unanimous in holding that there can be no active, intelligent competition among bidders unless plans and specifications are open to inspection which are sufficiently explicit as to afford to all bidders an equal opportunity to bid upon the same project or proposition.

The Court further ruled that after a contract for a bridge has been awarded, it cannot lawfully be changed by additional specifications furnished by the contractor in which substantial changes are made from the requirements on which the other bidders made their estimates.

The case in question was regarded as a test case and was brought by the Topeka Bridge and Iron Co. against the Board of County Commissioners of Labette County, Kan. The case for the county was conducted by the attorney general of the state and the principal witness was Prof. W. S. Gearhart, State Engineer.

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[2] For an unidentified view supplied by the authors there has en substituted a view from a photograph of the station at e Roosevelt dam, Arizona, taken recently by a member of editorial staff of "Engineering News."—Editor.

Slow Rate of Utilization of Irrigation Works

By R. P. Teele*

SYNOPSIS—An analysis of unpublished Census material to show the average rate at which irrigation works have been put in use. The slowness with which the land in the projects comes into use indicates that something must be done to hasten settlement and to aid settlers in getting their lands under cultivation.

It is well known that irrigation enterprises of any considerable size have been financial failures, almost without exception. A comparison of the values of unimproved arid land and the values of highly improved irrigated land shows a very wide margin which has appeared to be within the reach of builders of irrigation works, but which has so far always eluded their grasp.

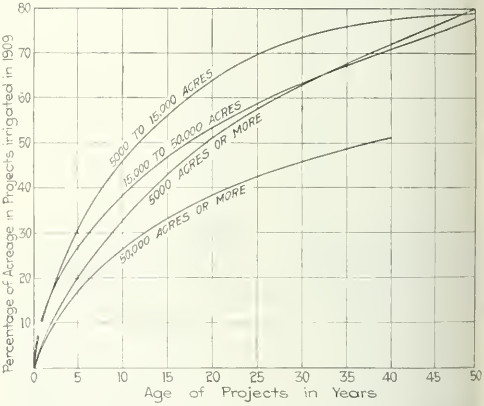
Much thought has been given to the search for the reason for the failure of promoters and builders of irrigation works to realize their dreams. The writer, with many others, has come to the conclusion that the immediate cause is the slowness with which the works built are utilized. This, of course, is not the fundamental cause, for there must be some underlying reason for the almost universal slowness in use. In this article the writer makes no attempt to get at the fundamental cause but he attempts to determine the average rate at which such projects have been utilized, in the hope that a knowledge of what may be expected in this regard may prove helpful in devising plans to overcome this weakness in our plans for reclaiming waste lands.

With the exception of the Government projects and perhaps a few others built within the last few years, no reliable records of the rate of extension of the acreage irrigated under individual projects are available. Very few of the projects for which records may be had have passed the construction stage and consequently their records are of little value for the purpose in hand. The unpublished records of the Thirteenth Census do, however, supply some information on this subject, and this article is based on an analysis of this Census material.

What the Census Figures Show

The schedules used in the special census of irrigation called, among other things, for the year in which each project was begun, the acreage included in each project, and the acreage which was irrigated in 1909 on each project. It is apparent that this will show for each project its age and the extent to which the acreage under it had been placed under irrigation in 1909. Not all of the schedules were completely filled out, but in the preparation of this paper all projects for which the necessary information was given have been tabulated in such a way as to show age and percentage of acreage in projects which were irrigated in 1909. All projects have then been segregated into age groups and the percentage of the total acreage in each age group which was irrigated in 1909 has been computed. The tabulations included all projects which contained 5,000 acres or more, and these have been divided into size groups. The results have been plotted with the age in years on the horizontal scale and the percentage irrigated on the vertical scale, and curves have been drawn to represent the rate at which the land in irrigation projects has been, and presumably will be, irrigated.

It is realized that the data upon which the curves are based are not above criticism, as in many cases th acreage included in projects undoubtedly represents the desires of promoters rather than careful surveys, an the acreage reported as irrigated represents a guess. However, it is believed that the acreages given as in projects are as accurate as the average estimates made b engineers in planning new projects today. One othe more or less serious objection presents itself. The method followed assumes that each project had, in the censu year, just arrived at the stage in which it is reported, while, as a matter of fact, it may have been as fully utilized for some years, or, in fact, may have gone back.



PERCENTAGES OF ACRES IRRIGATED BY AGE GROUPS OF PROJECTS

For the reasons given no attempt at mathematical refinement in locating the curves has been made. The points used for this purpose are based on percentages computed from the total acreages in projects and the total acreages irrigated for five-year groups running 1 to 5, 6 to 10, etc. In general the points representing the group 11 to 15 years old (1894 to 1898) have not been given as great weight in locating the curves as the other points, since few projects were begun during these years and consequently these points represent much smaller acreages than the other points. In fact, in some size groups there are no projects in this age group.

The total acreage in the projects begun each year since 1858 and the acreage irrigated in 1909 under these projects are given in Table 1 on the next page.

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*Chevy Chase, Md., formerly Special Agent in Charge of Irrigation, Bureau of the Census, Washington, D. C.

TABLE 1. UTILIZATION OF IRRIGATION WORKS

Year Begun	Age in Years	Acreage in Projects	Acreage Irrigated in 1909
08	1	572,410	61,192
07	2	910,895	100,271
06	3	575,518	53,190
05	4	527,754	80,450
04	5	974,400	119,740
03	6	960,236	206,380
02	7	197,000	78,250
01	8	257,479	131,785
00	9	241,087	74,058
99	10	64,607	23,400
98	11	29,525	16,550
97	12	13 169	7,200
96	13	88,200	53 660
95	14	151,963	62,710
94	15	209,356	102,942
93	16	77,700	54,915
92	17	183,607	98,350
91	18	449,799	152,751
90	19	496,513	206 933
89	20	310,816	178,157
88	21	368,362	176,458
87	22	279,920	125,004
86	23	242,718	184,513
85	24	306,492	148,999
84	25	152,899	100,515
83	26	180 243	126,912
82	27	139,180	93 851
81	28	414,078	188,422
80	29	142,229	89,521
79	30	102,505	42,770
78	31	131,880	88,746
77	32	245,290	112,239
76	33	25,350	18,500
75	34	199,280	100,621
74	35	86,200	63,000
73	36	186,815	128,130
72	37	157,948	59,953
71	38	221,142	102,632
70	39	357,549	301,528
69	40	100 296	70,986
68	41	6,400	2 560
67	42	8,000	3,500
66	43	25,730	19,520
65	44	34,223	28,552
64	45	68,270	63,270
63	46	28,000	14,997
62	47	21,055	19,055
61	48	19 570	12,530
60	49	67,854	59,860
59	50	10,000	10,000
Total	..	21,621,512	4,423,028

It will be noted that these projects include a total reage of 21,621,512 acres, or about two-thirds of the tal acreage included in all projects reported by the nsus. The acreage irrigated in 1909 under these ojects, however, was but 4,423,028 acres, or about one-ird of the total acreage irrigated in that year, accord-g to the Census. This wide difference in proportion explained by the fact that the largest acreage is repre-nted by projects from one to six years old, which show w percentages irrigated.

Incidentally, Table 1 shows much of the history of igation development in the United States. While the ures in the table represent only a part of the projects is probable that they indicate correctly the periods activity in large-scale irrigation development and the riods of depression. It will be noted that the first g year was 1870, the year when several of the enter-ses in northern Colorado were begun. This activity ntinued for a few years, to be followed by a period of pression after the panic of 1873. Development on revived, however, and there was activity until the nic of 1893, when there was a serious setback which owed its greatest effect in the years 1896 to 1899, e year 1897 showing a smaller acreage in projects un-rtaken than any year since 1868, almost thirty years fore. A revival began in 1900, which was greatly ac-lerated by the passage of the Reclamation Act in 1902, e years 1903 and 1904 showing the largest areas in e entire period. This activity continued up to the census year (1909) but began slowing down at just about that time. As is well known, there has been an almost complete cessation in the beginning of new projects since that time.

The accompanying curves show the rate of utilization of all projects embracing (1) 5,000 acres or more, (2) from 5,000 to 15,000 acres, (3) 15,000 to 50,000 acres and (4) 50,000 acres or more.

As is to be expected, the smaller projects show the most rapid rate of utilization and the larger projects the least rapid rate with the intermediate group and the average for all projects lying about midway between the two. Table 2 shows in percentages, on the basis of the charts, the extent to which the projects of the different size groups may be expected to be utilized at the five-year intervals after their beginning.

TABLE 2. PERCENTAGE OF ACREAGE IN PROJECTS IRRIGATED AT FIVE-YEAR INTERVALS FROM DATE OF BEGINNING

Years after beginning	5	10	15	20	25	30	35	40	45	50
	Percentage Irrigated									
All projects	20	33	43	51	58	63	68	72	76	80
5,000 to 15,000 acres	31	46	56	64	70	74	76	78	79	80
15,000 to 50,000 acres	29	40	47	54	59	63	67	71	75	78
50,000 acres or more	18	27	34	39	43	46	49	51	..	..

In the light of these figures it is not at all difficult to see why irrigation projects have been financial failures. It is customary to make rather liberal estimates of the acreage which can be irrigated by a proposed project and rather close estimates of the cost, then spread the cost over the entire acreage, and base the selling price of rights per acre on the ratio between this underestimated cost and the overestimated acreage, with, of course, a suitable margin for profit. The curves indicate that even 50 years after the beginning of the average project only 80% of the land is irrigated and contributing to repaying the cost, while the percentage for the larger projects is much lower. At the end of 20 years only 50% of the land in the average project and 40% for the large project is producing. In the mean time interest and operation and maintenance charges for the balance of the land must be carried by the constructing agency or by the land which is producing. In the one case it will break the company, and in the other it will break the farmers—and that will break the company.

Obviously, it will be necessary to increase greatly the selling price of water rights or take steps to accelerate the rate of utilization; and if settlement is slow with a low price for water it will presumably be slower with a higher price. It seems apparent, therefore, that the road to successful irrigation development lies along the line of giving greater attention to the settlement of the lands included in irrigation projects and to aiding settlers in bringing their lands into cultivation. It is not the intention to discuss these subjects in this article.

*

Water Consumption Has Been Reduced at Northampton, Mass., by the combined use of the pitometer and service inspections, according to the 1915 report of the Water Commissioners (Luther C Wright, Supt.). The use of the pitometer in November, 1914, showed an average daily consumption of 2,851,000 gal. and a minimum night rate of 1,889,000 gal., or a night rate 66% of the day rate. A house-to-house inspection to detect leaking fixtures was made. In April, 1915, after only some 50% of the services had been inspected, the daily consumption was 2,663,000 gal., the minimum night rate 1,560,000 gal., thus giving a night rate which was 58% of the day rate and an actual reduction in night consumption of 329,000 gal

Kansas Road Maintenance by Contract System

By E. V. Moone*

Finding it difficult to get satisfactory dirt-road maintenance done by farmers living along the roads, Sedgwick County, Kansas, has been trying out a new plan of road maintenance on the four main roads out of Wichita. Each one of these radiating roads has been placed under the charge of a competent man, who, under contract, devotes his entire time to maintenance and patrol, hires additional help when needed, and who holds his job only so long as results obtained justify the money expended—in the judgment of the county commissioners and the county engineer.

These men are under contract to keep the road in repair in every way, dragging, grading, resurfacing, filling around bridges and culverts, cutting weeds and trimming hedges, etc. While the amount of money expended is larger than the usual Kansas county dragging allowance, the results have been enough better to seem to warrant the additional expenditure. The better maintenance has concentrated so much travel on these main roads that the additional expense seems fully warranted. Travel on these roads frequently averages a motor car a minute during the day and early evening.

On the road east of Wichita, a farmer who has several boys and plenty of teams, as well as an automobile, is the contractor. This road leads to the newly opened Augusta oil fields and recently has been much traveled. Although of heavy soil, with no surfacing, this road has been in excellent condition almost every day, despite heavy rains and resulting floods.

The road north of Wichita has 13 mi. covered with Little Arkansas River gravel, and the cost of maintenance here has been kept down materially. The contractor on this section finds time to use some of his four teams on farm work and occasional hauling. South of the city is 9 mi. of sand-clay road and about 4 mi. with gravel surfacing. Two men and four teams work overtime on this road as it requires much hauling of clay for patching, as well as a great deal of "dressing up" with a grader.

West of Wichita one man is trying to maintain 21 mi. of road with a Nielson tractor. Although he can pull two drags and frequently makes the 48-mi. round trip in a day, he has not had entire success with the work. The difficulty of getting teams to do the necessary work that cannot be done with a tractor has been one of the main objections, and the county authorities are seriously considering dividing the road into two sections under two patrolmen.

The contractors are furnished with steel road drags, small graders, slip scrapers, shovels, axes and other necessary small tools. They contract to work under the direction of the county engineer, and to devote all the time necessary for proper road patrol and maintenance, and to keep themselves informed by actual inspection of the road as to its condition at all times. They are paid a stipulated flat rate per hour, which is a little less than average wages for men and teams and for single hands in this locality. Patrolmen sign receipts for county machinery in their charge and report all work done to the county engineer on post cards within 24 hr. of the time it is finished.

This system of maintenance gives the county authorities a chance to hold some one man responsible for the road condition on the section under his charge and eliminates the endless struggle to get the farmers to neglect their own work for the sake of the road, when both farm and road demand attention simultaneously. Results are generally approved by the people of the county, and no objections have been raised on account of the additional expense.

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*County Engineer, Sedgwick County, Wichita, Kan.

Pumping 7,500,000 Gallons Daily by Air Lift

The entire water supply (7,500,000 gal. per day) of El Paso, Tex., a city of 100,000 population, is raised from 32 deep wells by an air-lift system, making this probably the largest and most notable installation of its kind in the country. The water-works were taken over by the city from the International Water Co. in 1910 and since then improvements have been made under the supervision of Frank H. Todd, Consulting Engineer for the city.

The wells are 8 to 14 in. in diameter and 500 to 600 ft. deep. They are sunk in a high mesa north of the city, near Fort Bliss. The mesa is a part of the noted Tularosa Valley (the underground water-supply of which is the subject of a recent United States Geological Survey paper). These wells pass through irregular beds of clean but very fine sand with interbedded layers of clay. The latest wells have been driven by the clay-puddling method, in which no drill casing is used. The well casing is standard wrought-iron or steel pipe, with vertical rectangular slots $\frac{3}{8}$x10 in., cut out of the sections of pipe that pass through the water-bearing strata. These cuts are made by the water-works employees on the job. The method of placing the air line, shown in the accompanying sketch, is new and was devised by Mr. Todd. The air line is 2 in. and the water line 6 in. in the new 12-in. wells. The air inlets are about 214 ft. below the ground surface. The level of the water in the wells has gone down from about 177 ft. in 1905, when the first wells were sunk, to about 200 ft. at the present time. Each (12-in.) well yields about 450 gal. per min.

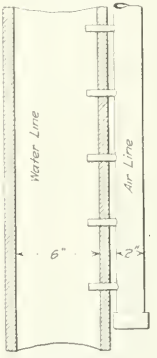

DIAGRAM OF AIR-LIFT SYSTEM

The air-compressor plant consists of two old steam-driven compressors, one a 750-cu.ft. Ingersoll-Rand and a 2,600-cu.ft. Ingersoll-Sergeant. The new equipment added since the city took over the works includes a 3,600-cu.ft. Allis-Chalmers steam-driven unit and two 2,000-cu.ft. Diesel-engine Nordberg compressor units. The Diesel engines are each 500-hp., Fulton Toisi engines, built by the Fulton Iron Works, St. Louis, Mo. Each is direct-connected to a 2,000,000-gal. triplex pump on one side and a 2,000-cu.ft. air compressor on the other. The compressors are driven at 155 r.p.m.

Water lifted by the air is delivered by concrete conduits to a centrally located basin where it flows to the pump intakes over a measuring weir. The water supply is then delivered into the city mains by high-pressure pumps

Bituminous Materials Tests for Sheet Asphalt

By Francis P. Smith*

SYNOPSIS—What tests for bituminous materials should be included in sheet-asphalt specifications? A discussion of points raised in an alleged attack on the specifications adopted in 1915 by the American Society of Municipal Improvements.

A lecture was delivered before the graduate students in ighway engineering at Columbia University, on Jan. 13, 916, by Charles N. Forrest, Chief Chemist of the Barer Asphalt Paving Co. This lecture has been printed n full or in abstract in various places since that date. t describes and compares most of the tests that are pplied at the present day for the examination and idenification of bituminous materials.

In so far as the paper relates to methods and results, t contains much of value. It also contains what the riter considers an unwarranted attack upon the speifications adopted by the American Society of Municipal mprovements in 1915. As the writer has been chairman f the Committee on Sheet-Asphalt Specifications of hat society for a number of years, he feels called upon) reply thereto. The following are quotations from Ir. Forrest's paper:

> The variety of bituminous materials available for roaduilding purposes is now very much greater than it was a ecade ago. The manner of their application has also enged and the suggestion of new methods for testing them as added a number of additional features to the earlier hemes, but even so, there are few tests employed in the eneral examination of bitumens which can be said to dictly indicate quality for any specific purpose. Some of them e very properly referred to as indirect indications of qualy, but after all, as the subject now stands, the only real test quality still remains a service test over a period of years.
>
> Following the introduction of the many new products or -called paving bitumens, during the past ten years, each e of which has generally appeared with many claims of periority, there has been a marked tendency to contract e general scheme of testing which was in vogue prior to eir introduction, in order that those characteristics which ch schemes indicated were essential, but did not happen to some specific new product, could be ruled out.
>
> The deliberations of associations of learned societies hich have had such matters as the drawing of specifications d schemes for testing materials under consideration, and e necessarily obliged to assume a neutral position, have sulted in, first, the elimination of all features which are t common to all substances of a certain class which have t been an absolute failure in service and, second, the exnsion of the limits of specifications to include everything hich has any sort of a favorable indorsement.
>
> The recommendations of such bodies are always a comomise and generally reflect average, rather than the most lvanced thought or practice.
>
> As an illustration of the considerable abbreviation of prest-day specifications, the recommendations of the American ociety of Municipal Improvements for suitable asphalt for eet-asphalt pavements may be quoted. It is as follows:

ECIFICATIONS OF AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS, 1915

Refined Asphalt	Asphaltic Cement	Flux
repared from natural mineral bitumen	Refined asphalt and flux	Residue of petroleum
enetration, 77° F. olubility CCl_4	Penetration, 77° F. Flash Volatilization Hardness after volatilization Ductility	Penetration, 77° F. Specific gravity Volatilization Flash Solubility CCl_4

> This is a typical example of a compromise specification and one which is popularly described as open, because a great variety of substances fall within the scope of its limitations, both in regard to common characteristics and the wide latitude of the few of them which have been mentioned.
>
> A more elaborate specification or scheme of examination is illustrated in the form of report of the Office of Public Roads for bituminous materials for different purposes.

This quotation is preceded by a scheme of tests which were stated to have been adopted by Mr. Richardson for the *identification* of asphalts. In order to avoid reproducing all three of these schemes, herewith is given an enumeration of all the tests in Mr. Richardson's schedule and also in the two schemes of the Office of Public Roads:

> Physical Properties—(1) Specific gravity, (a) original substance dry, (b) pure bitumen; (2) color of powder or streak; (3) luster; (4) structure; (5) fracture; (6) hardness original substance; (7) odor; (8) softening point; (9) flows; (10) penetration at 78° F.; (11) general character; (12) melting point; (13) flash point; (14) burning point; (15) viscosity; (16) float test; (17) ductility.
>
> Chemical Characteristics—(18) Loss on heating, (a) original substance, (b) dry substance; (19) character of residue; (20) penetration of residue; (21) bitumen soluble in carbon disulphide; (22) organic matter insoluble; (23) mineral matter; (24) bitumen soluble in 62° Bé. naphtha; (25) bitumen soluble in 88° Bé. naphtha; (26) per cent. of bitumen removed by H_2SO_4; (27) bitumen soluble in carbon tetrachloride; (28) fixed carbon; (29) sulphur; (30) distillation test; (31) ultimate composition.
>
> Additional tests which have been used to some extent and which, though mentioned in the article, are not included in the schemes referred to are as follows: (32) Paraffine; (33) brittleness.

It is evident that these schemes of analysis are meant to be broad enough to embrace the examination of all classes of bituminous materials, both in their raw state and in their manufactured state. It therefore follows that many of these tests do not apply to the examination of refined asphalts or asphalt cements for use in sheet-asphal. pavements and should not be included in sheet-asphalt specifications. Among the tests enumerated there would appear to be no question that the following are for identification purposes only:

> (1-b) Specific gravity, pure bitumen; (2) color of powder or streak; (3) luster; (4) structure; (5) fracture; (6) hardness original substance; (7) odor; (11) general character; (18-a) loss on heating, original substance (as differentiated from dry substance); (22) organic matter insoluble; (23) mineral matter; (26) per cent. of naphtha-soluble bitumen removed by H_2SO_4.

Certain other of these tests have never been seriously advocated for use in sheet-asphalt specifications, as follows:

> (8) Softening point; (9) flows; (14) burning point; (15) viscosity; (30) distillation test; (31) ultimate composition.

Softening point and flow point, if of any value from the sheet-asphalt paving standpoint, are covered by melting point, which latter test is hereinafter discussed. Burning point is obviously valueless. Viscosity is of certain value in connection with road oils, but is dependent upon so many conditions as to be chiefly of use as an identification test.

As far as the writer's view of the distillation test is concerned, it entirely coincides with the following sentences contained in Mr. Forrest's paper:

> As a research matter, distillation in the laboratory of all kinds of bituminous materials has been a source of considerable information, but as a routine test is impractical in the examination of road-building materials except under certain tar and cut-back oil products.
>
> The same is true with regard to ultimate composition
>
> The ultimate analysis of bitumens and other road-building materials has never been of interest to practical road builders

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*Of Dow & Smith, 131 East 23d St., New York City.

Included among the remaining tests are certain others that may be regarded as controversial. These are as follows:

> (1-a) Specific gravity, original substance dry; (12) melting point; (16) float test; (24) bitumen soluble in 62° Bé. naphtha; (25) bitumen soluble in 88° Bé. naphtha; (28) fixed carbon; (29) sulphur; (32) paraffin; (33) brittleness.

With regard to the specific-gravity test, Mr. Forrest appears to agree with Professor Blanchard that it is of value mainly as a means of identification.

While in a few instances melting-point and viscosity requirements have been incorporated in sheet-asphalt specifications, the use of these tests and the advocacy of them have been so limited that the writer believes he is justified in dismissing them from further consideration.

The float test is in a sense a measure of consistency, giving information which occasionally is useful in connection with viscosity, melting-point and penetration tests. It can hardly be deemed essential in sheet-asphalt specifications, however, and its inclusion in them has never been seriously advocated.

While certain authorities have urged the use of the naphtha-solubility test as indicating the amount of body-forming hydrocarbons, its inclusion in specifications has been largely for purposes of identification. The test itself appears to have been originated in the early days of the industry, chiefly as a means for distinguishing between so-called Trinidad Lake and Land asphalts. The limits of solubility in naphtha between which asphalts could be considered as suitable for paving purposes and outside of which they should be condemned for paving purposes have never been established.

The writer believes that the test for fixed carbon is valueless as indicating the suitability of an asphalt for paving purposes.[1]

Sulphur has been recognized as playing a very important part in the formation of bitumens in nature.[2] In the early days of the industry no specifications made any reference whatever to sulphur contents. Trinidad and Bermudez asphalts contain approximately 5.5% and 4% of sulphur respectively. About the time that California asphalt was put upon the market and became a serious factor in the paving industry certain specifications were promulgated containing clauses to the effect that the asphalt must contain at least 2% of sulphur not artificially incorporated. As California asphalt contained only traces of sulphur, this was evidently an attempt to bar out California asphalt.

The history of the paraffin test is somewhat similar. Many of the Mexican asphalts are higher in paraffin than those obtained from California, Trinidad or Venezuela; and regardless of the fact that asphalt cements for many years had contained large proportions of paraffin flux, an attempt was made to bar out Mexican asphalts by inserting a clause in the specifications to the effect that the asphalt should contain not more than 1% of paraffin. This clause, if adopted, would permit the use of California, Trinidad and Bermudez asphalts, but would bar out many Mexican asphalts. The subject of the paraffin contents of an asphalt was treated exhaustively by A. W. Dow and the writer in an article that appeared in *Engineering News* of June 8, 1911, pages 680 to 683.

As far as the brittleness test is concerned, Mr. Forrest states in the article under discussion, as follows:

> A test for brittleness is not usually mentioned in connection with bituminous road-building materials, but is in use by some investigators for special purposes.

It would appear from this that Mr. Forrest did not have any intention of urging the inclusion of this test in sheet-asphalt specifications.

Based on the foregoing, it is the writer's opinion that the tests just discussed as identification tests, as tests not suitable for the examination of asphalt cements for paving purposes and as controversial should not be included in sheet-asphalt specifications. This leaves the following tests available for the examination of paving asphalts, *all of which are included in the American Society of Municipal Improvements specifications:*

> (10) Penetration; (13) flash point; (17) ductility; (18) loss on heating; (19) character of residue; (20) penetration of residue; (21) bitumen soluble in carbon disulphide; (27) bitumen soluble in carbon tetrachloride.

The writer believes that he is entirely justified in stating that the only inference possible for the uninformed hearer or reader to draw from Mr. Forrest's paper is that the American Society of Municipal Improvements specifications have had so many important tests omitted from them that they are valueless and that Mr. Forrest has attempted to support this view by marshaling an imposing array of tests, regardless of whether or not all of them are really applicable to refined asphalts or asphalt cements for use in sheet-asphalt pavements. In his attempt to belittle the American Society of Municipal Improvements specifications he has misquoted them and omitted tests that they contain, as is shown by the following quotation.

Under the head of "Refined Asphalt" the A. S. M. I. specifications contain:

> a. Clauses governing the methods of refining and providing for supervision of them and inspection at the refinery.
>
> b. Every refined asphalt admitted under these specifications, if required by the engineer, shall be equal in quality to the recognized standard for its particular kind or type of asphalt.
>
> c. Asphalts obtained by the refining of natural liquid bitumens shall not be reduced in the refining process to a penetration at 77° F. of less than 30.
>
> d. All shipments of refined asphalt of any one kind shall have the batch number plainly marked on each package or container and shall be uniform in consistency and composition and shall not vary from maximum to minimum more than 15 points in penetration at 77° F.
>
> e. A clause for solubility in carbon disulphide and carbon tetrachloride (and not only carbon tetrachloride, as stated).

The requirements for asphalt cement are correctly stated, although no mention is made of the clauses safeguarding its preparation and handling. The clause limiting the materials from which fluxes may be made is omitted, as well as the following clause:

> They shall be of such character that they will combine with the asphalt to be used to form an acceptable and approved asphalt cement complying with the requirements of these specifications.

As further justification for the writer's criticism of Mr. Forrest's paper the following is a complete list of the tests contained in sheet-asphalt specifications drawn up, distributed and advocated by the company of which Mr. Forrest is chief chemist. For convenience of comparison a parallel column shows the list included in the A. S. M. I. sheet-asphalt specifications:

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[1] Those interested in an exhaustive discussion of this test should refer to "Municipal Engineering," September, 1913, and "Canadian Engineering," Nov. 13 and 20, Dec. 4 and 18, 1913; Jan. 1 and 15 and Feb. 5, 1914.

[2] Those who are interested in this matter may refer to Mr. Richardson's article on the subject appearing in the "Journal" of the Society of Chemical Industry, January, 1898.

Barber Asphalt Paving Co.	American Society of Municipal Improvements
Flux:	Flux:
Vater	....
pecific gravity	Specific gravity
'enetration	Penetration
olubility in carbon disulphide	Solubility in CCl_4
'lash test	Flash test
....	Loss on heating
....	Character of residue
Refined Asphalt:	Refined Asphalt:
Vater	....
'enetration	Penetration
olubility in CS_2	Solubility in carbon disulphide
'ixed carbon	....
'araffin scale	....
ulphur	....
....	Solubility in carbon tetrachloride
....	Uniformity of penetration and composition of different shipments
Asphalt Cement:	Asphalt Cement:
pecific gravity	....
enetration	Penetration
oss on heating (penetration and ductility of residue)	Loss on heating (penetration of residue)
olubility in CCl_4	Solubility in carbon tetrachloride
rganic insoluble (nonbituminous material)	....
lash test	Flash test
loat test	....
raffin scale	....
uctility	Ductility
ixed carbon	....
niformity of penetration and ductility of different shipments	Uniformity of penetration and composition of different shipments
....	Solubility in carbon disulphide

From the foregoing we see that the A. S. M. I. specifications are more exacting on the subject of flux than are e B. A. P. Co. specifications. While the water test is t specifically mentioned in the A. S. M. I. specifica- ns, as it has but little bearing on the quality of the aterial, it is implied owing to the fact that a flux ntaining any considerable proportion of water could t be used in the kettles without causing foaming.

Taking up the subject of refined asphalt, the same marks apply to the water test mentioned thereunder. e A. S. M. I. specifications include a test for solu- ity in carbon tetrachloride and a provision for in- ring the uniformity in penetration and composition different shipments. These tests are not included the B. A. P. Co. specifications. The tests for fixed rbon, paraffin scale and sulphur included in the B. A. P. . specifications and not in the A. S. M. I. specifications either controversial or purely identification tests and ve been dealt with at length in a previous portion of communication.

As far as the tests required for asphalt cement are cerned, we find that the B. A. P. Co. specifications ntain the following tests which are not present in the S. M. I. specifications: Specific gravity, nonbitunous matter, float test, paraffin scale, fixed carbon.

These again are chiefly identification tests. As pre- usly explained, they are in no sense indicative of the ving value of the asphalt. As a matter of fact, the onbituminous-matter" test is so drawn as to exclude thing but Trinidad and Bermudez asphalts. The raffin-scale test is so drawn as to exclude a large pro- rtion of the Mexican asphalts. The fixed-carbon test o drawn as to exclude practically all of the California, xas and Mexican asphalts. There can be no question, refore, that these tests are inserted purely for pur- es of identification and limitation. This is also true the fixed-carbon, paraffin-scale and sulphur tests under ined asphalt. The value of the float test is very blematical.

In considering the foregoing it must be borne in mind t the Barber Asphalt Paving Co. was under no obligations to assume a neutral position, and the fact that it deliberately included tests which barred out asphalts other than Trinidad Lake and Bermudez asphalts clearly showed that it was not its intention to assume a neutral position. It therefore was free from any of the limitations which Mr. Forrest insists necessarily attend the deliberations of learned societies. In spite of this fact the only tests present in its specifications which are not included in the A. S. M. I. specifications are such tests as would identify certain asphalts and admit them to the exclusion of others. Further comment along these lines would appear to be unnecessary.

After discussing the various tests in detail, Mr. Forrest further states:

> Prof. A. H. Blanchard in his very excellent book, "Elements of Highway Engineering," has quoted Mr. Prevost Hubbard upon the subject, "Interpretation of Results of Tests," and the following remarks from that source upon the significance of a number of tests which are now under discussion are of interest:
>
> Specific gravity is of value mainly as a means of identification. . . .
>
> Flash point is of little value, other than a quick means of differentiating between heavy crude oils and cut-back products and fluid residuums . . . .
>
> Melting point of solid bitumen is mainly of value as a means of identification, and for control work on the part of manufacturers.
>
> Maximum and minimum limits covering consistency are essential. (Consistency as here referred to embraces penetration or viscosity.)
>
> The distillation test as applied to tars is a very valuable one both for the purpose of ascertaining their road-building properties and method of preparation if they are refined products.
>
> Solubility Carbon Disulphide—The solubility of bitumen itself is entirely independent of its character and consistency.
>
> Solubility 88° Bé. Naphtha—As applied to oils and oil products, this determination is of value as indicating the amount of body-forming hydrocarbons which give mechanical stability to the material.
>
> Evaporation test is a purely arbitrary one, but when applied to road oils will often prove of considerable value.
>
> Fixed carbon shows much the same thing as naphtha-insoluble bitumen . . . .
>
> Supplementing the above estimate of the value of certain tests by Mr. Hubbard, a quotation from Messrs. Dow and Smith[3] upon the subject of paraffin is given by Professor Blanchard as follows:
>
> Paraffin—We are decidedly of the opinion that the scale paraffin test per se should not be regarded as a measure of value of bituminous compounds for road-making or paving purposes.
>
> Upon inspection of the specifications of the American Society of Municipal Improvements for asphalt cement for sheet-asphalt pavements it will be observed that but few of the tests which have just been discussed are mentioned. Those which are mentioned, or which affect the asphalt cement through being mentioned under the requirements for refined asphalt or flux, which combine to produce the asphalt cement, are penetration, evaporation and ductility. These are characteristics which are common to all bituminous materials and, in the light of the available information upon this general subject, cannot be regarded as furnishing conclusive evidence of suitable quality of any or all materials for such a purpose.

It is entirely true that the characteristics shown by the penetration, evaporation and ductility tests are common to all bituminous materials; but if they were not common to such bituminous materials as are used in the paving industry, it would of course be obvious that they could not be included in the specifications. The fact that they are common to bituminous materials which are not used in the paving industry has no bearing whatever upon the subject, provided the limits prescribed in the specifications bar out such materials as are not suitable for sheet-asphalt paving, and this the writer contends is the case.

Mr. Forrest also states:

> The drift of this subject during the past few years, during which time one after another of the tests which did not happen to suit some new material, as it had theretofore been interpreted, has been thrown into the discard, rather brings us

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[3] By Prevost Hubbard—"Proceedings," American Road Builders Association, pp. 213 to 216; see also "Engineering News," June 8, 1911, pp. 680 to 683

abreast with the fact that a great deal of attention is being paid to the testing of an element which forms but a small part of an article of manufacture—namely, the pavement in place and ready for work—which might perhaps be devoted with the hope, at least, of more positive results upon the finished article as a whole.

The writer contends that a review of the history of the asphalt-paving industry and the specifications which have been adopted from time to time shows that the first portion of Mr. Forrest's statement as just quoted is not in accord with the facts and that, if anything, the reverse is true. Practically the earliest specifications that were adopted called for Trinidad asphalt or its equal. A little later on, a competing asphalt entered the market obtained from the Island of Trinidad, but not from the so-called Pitch Lake. The specifications then underwent an amendment to the effect that the asphalt must be equal in quality to that obtained from the Pitch Lake in Trinidad, and the naphtha-solubility test was advocated as practically the only means of differentiating between these two kinds of Trinidad asphalt. A little later, Bermudez asphalt appeared upon the market, and an active campaign was started to show that it was distinctly inferior to Trinidad Lake asphalt. In fact, Mr. Richardson in a lawsuit in Lincoln, Neb., went so far as to declare on the witness stand under oath that Bermudez asphalt was a most inferior paving asphalt.

When the Bermudez and Trinidad Lake asphalts were gathered under one control, the merged interests waged a joint warfare against the California asphalt and clauses were introduced in specifications to the effect that all asphalts must be made from hard natural asphalts such as were found in the Trinidad and Bermudez deposits. Although the test had never been used in asphalt specifications it was then discovered that the fixed carbon in Trinidad and Bermudez asphalts ran below 15%, while that in the California asphalts ran above 15%; 15% was therefore advocated as the limit of demarcation between good and bad asphalts. The sulphur test previously alluded to was also introduced. Later on, when the Mexican asphalt appeared in the market, the paraffin test was advocated as a very valuable one, as the writer has already described, although it, too, had previously never appeared in any asphalt specifications.

It is quite true that a great deal of attention is being paid to the testing of the asphalt itself and that the asphalt constitutes only approximately 10% of the finished pavement. So far as the A. S. M. I. specifications are concerned, however, an examination of them reveals that a great deal of attention is also paid to the testing and selection of the materials forming the balance of the pavement. It is therefore not correct to draw the conclusion that in the A. S. M. I. specifications only the asphalt is tested and that the tests prescribed are so limited in number and so inconclusive in character that both good and bad asphalts are admitted indiscriminately under them. Broadly speaking, asphalt for paving purposes must meet three essential requirements:

1. It must be of the proper consistency for use.

2. It must be sufficiently cementitious to firmly bind the particles of mineral aggregate together.

3. It must be sufficiently permanent in character to withstand the test of time, traffic and climatic conditions.

The writer contends that the fact that an asphalt is found in a so-called lake has nothing whatever to do with these qualities. Many asphalts are found in deposits of this character which are totally unfitted for paving purposes, and much of the asphalt found in the Bermudez Lake is unfit for paving purposes.

So far as consistency is concerned, that is ordinarily determined with sufficient accuracy by the penetration test. So far as cementitiousness is concerned, the ductility test up to the present has given us more information in this respect than any other test that has been devised and Mr. Forrest is on record as stating that "the ductility test as performed according to the general way of doing it, as we know it, is a measure of the cementitious value."

As an accelerated exposure test, we undoubtedly gain very valuable information by subjecting the asphalt to heating for a stated period of time under stated conditions and noting the hardening due to this heating and the character of the residue left after heating.

In other words, these three tests form the skeleton on which we rely to determine the suitability of an asphalt for paving purposes. Supplementary tests are of value in helping us form an opinion; but where the limits given for these supplementary tests are such as to bar out certain brands of asphalt regardless of their worth as established by service tests and experience throughout the country, their introduction into a specification is indefensible from the public standpoint.

From this brief review of the subject we see that in direct opposition to Mr. Forrest's statement there has been a constant tendency in the asphalt-paving business whenever a new asphalt came up to decry its value and to attempt to devise tests that would show a difference between the new asphalt and those previously used and then advocate this test as a very valuable one and set such permissible limits under it as would bar out the new asphalt.

Quoting again from Mr. Forrest's lecture:

> Bituminous pavements which are prepared locally and put down in sheet form—that is, as a unit—do not lend themselves readily to testing as a whole or as a complete mixture; but it is obvious that a series of tests which can be applied to the finished article of manufacture—namely, the whole mixture or the pavement in place—would be much more conclusive and satisfying from the point of view of the engineer who is responsible for the work than the type of tests now in vogue, confined as they are to the raw materials as separate units, and give no direct information as to how congenial such raw materials will be after they are combined.

There is no doubt that a series of tests on the asphalt pavement itself would be valuable, if they could be devised and standardized. Although many efforts have been made in this direction, up to the present they have not met with success, which accounts for their not being incorporated in specifications. The specifications, however, do recognize the variations rendered necessary by differences in the character of the raw materials used and such modifications are placed under the control of the engineer.

The National Road Board of Great Britain has devised a very elaborate machine for testing asphalt pavements, but the results obtained have not yet been reduced to a practical basis and such a machine would be too expensive to install in a city or private testing laboratory.

Finally, it may be said that, recognizing the difficulty of obtaining concordant results in different laboratories and the necessity for employing uniform methods for conducting the various tests, the A. S. M. I. specifications describe each test in detail, state the limit of accuracy of the test itself and what conclusions may be drawn in each case from the results obtained. They also specify the size of the samples to be examined and the methods to be employed in obtaining them.

[Proof of the foregoing article was submitted to C. N. Forrest, Chief Chemist of The Barber Asphalt Paving Co. Mr. Forrest's comments on Mr. Smith's statements follow.—Editor.]

Sir—I have read Mr. Smith's discussion of my recent ddress to the graduate students in highway engineering t Columbia University. I fail to find, however, any nisstatements on my part in my references to the speifications of the A.S.M.I. It appears that the tests ontained in these specifications that I am said to have mitted are really not tests at all, but certain clauses hat simply refer to the tests that I did mention. Mr. Smith states in his "e" that "under the head of Refined Asphalt the A.S.M.I. specifications contain a clause for olubility in carbon disulphide and carbon tetrachloride" and not only carbon tetrachloride, as stated).

Again consulting my copy of the proceedings of the A.S.M.I., 1914, p. 588, par. 4, and succeeding clauses n Refined Asphalt, I fail to find any reference to soluility in carbon disulphide, or any mention of specific sts that I did not quote. I have no criticism to make f this omission in the specifications, but merely make statement of fact.

It may be of interest to mention in connection with is subject that despite the specifications which Mr. mith supports so feelingly, a committee on Standard 'ests for Bituminous Materials was appointed at the st convention of the A.S.M.I. under the chairmanip of Professor Blanchard "to invite and direct the öperation of all chemists dealing with bituminous marials for the purpose of further standardizing present ethods of testing and for the purpose of encouraging d developing additional methods and appliances for luating paving bitumens." C. N. Forrest.

Maurer, N. J., June 28, 1916.

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Catchbasins and Culverts on County Roads

The extensive system of bond-issue roads now under nstruction in Vermilion County, Illinois, includes a eat number and variety of minor structures in the way culverts, farm-drain entrances and catchbasins. This ork is under the direction of P. C. McArdle, Chief ngineer for the Vermilion County Roads.

The standard catchbasin, Fig. 1, consists of a 24-in. trified-tile pipe set on end, with a circular slab of ncrete around the bell and a concrete filling at the ttom. A cast-iron grating is set in the bell. The pipe s an outlet of the same diameter as the drain with hich it connects. The concrete is 1 : 3 : 5.

For farm-drain entrances an 8-ft. length is lined with le, embedded in concrete and having a concrete cutoff ll, as shown in Fig. 2. The concrete is a 1 : 3 : 5 mix, d the quantity ranges from 1½ cu.yd. with 10-in. tile 3½ yd. with 24-in. tile.

The standard culverts are of reinforced concrete of tangular box section, with end walls of plain concrete, shown in Fig. 2. The normal sizes range from 1x1 ft. to 10 ft. span and 8 ft. high. Special sections are sometimes required, having great width in proportion to height in order to give the necessary area of waterway and to keep within restrictions of headway and grade.

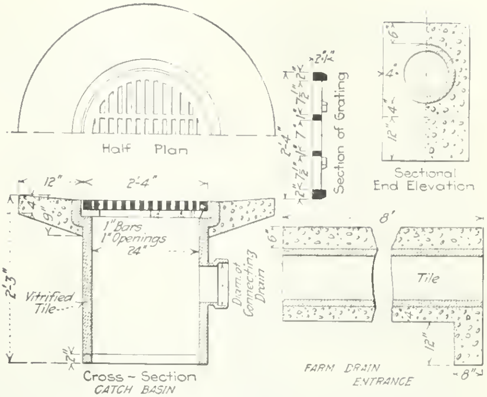

FIG. 1. CATCHBASIN AND FARM-DRAIN ENTRANCE FOR VERMILION COUNTY ROADS, ILLINOIS

The concrete in top and bottom is 1 : 2½ : 4, while that for the side walls and head walls is 1 : 3 : 5. All exposed edges are beveled by means of ¾-in. triangular molding set in the forms. The reinforcing bars, which are in the top and bottom only, are of mild or medium steel rolled from billets, no rerolled material or high-carbon steel being permitted. The standard drawings contain lists of quantities, with lengths and sizes of bars, for the various sections of culverts. Tile drains 3 in. in diameter are placed in the abutment walls, 12 in. above the ground line at abutments.

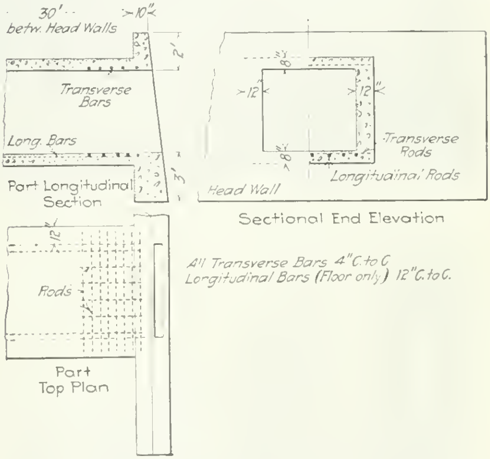

FIG. 2 TYPE OF REINFORCED-CONCRETE CULVERT FOR VERMILION COUNTY ROADS, ILLINOIS

For a culvert 3x2 ft. there are 1.82 yd. of reinforced concrete, 8.75 yd. of plain concrete and 532 lb. of steel; for a culvert 6x5 ft. the quantities are 11.9 yd., 35.9 yd. and 1,385 lb.; for a culvert 10x6½ ft. they are 17.8 yd., 576 yd. and 3,160 lb.

Cargo-Handling Equipment on Italian Freight Steamer

A remarkable equipment for cargo handling has been installed on a large freight steamship, the "Milazzo," recently put in service by the Italian General Navigation Line, operating between New York City and Italian ports. As may be seen in the accompanying views of the vessel, a row of ten elevator shafts extends along each side of the hull, reaching down to the bottom of the hold, while the elevator guides extend a considerable distance above the deck. There is a tunnel fore and aft on each side of the ship in line with the elevator shafts and double tracks for narrow-gage cars are laid in thes tunnels.

The primary purpose of this equipment is for handlin coal, grain or similar bulk cargo. Through chutes i the roofs of the tunnels, grain or other bulk freigh may be spouted direct into the cars, which are run t the elevators, hoisted, and dumped into the incline chutes, shown in Fig. 2. The elevators may also be use for handling freight in and out of the hold when th vessel carries general cargo. It is claimed that with thi system of cargo handling it is possible to load and unload the ship in a very much shorter time than with th ordinary ship hoisting tackle and thus reduce the delay in port.

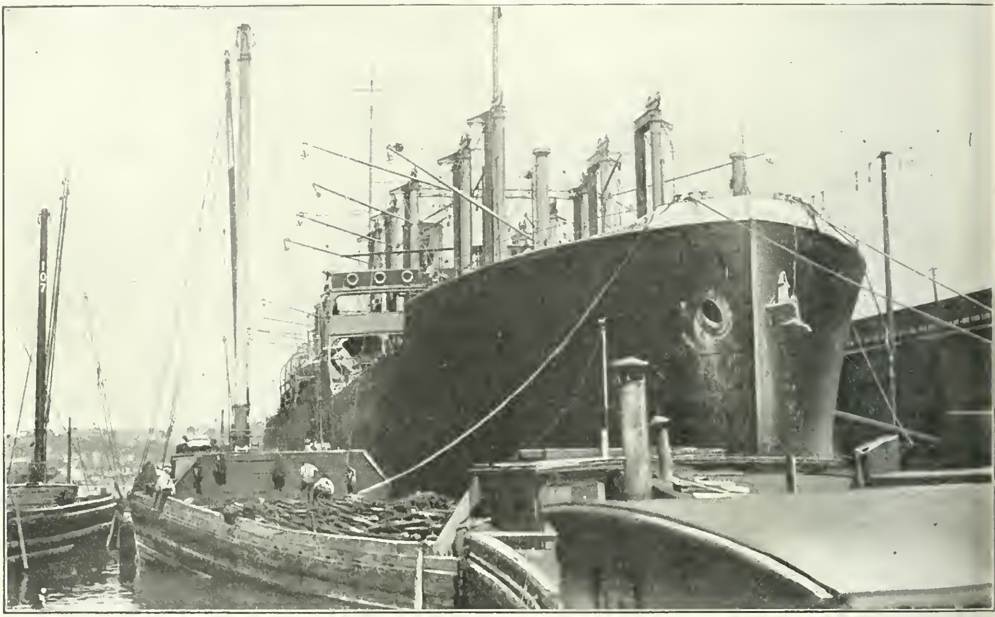

FIG. 1. AN ITALIAN FREIGHT STEAMER, THE "MILAZZO," FITTED WITH CARGO ELEVATORS

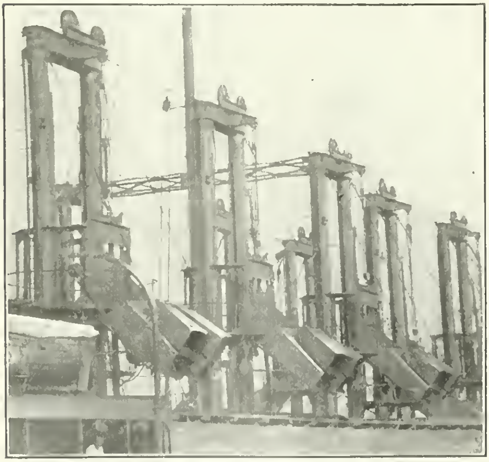

FIG. 2. VIEW OF UPPER WORKS, SHOWING FOLDED CHUTES FOR DISCHARGING BULK FREIGHT

The new vessel was launched in Spezzia, Italy, i May last and is just completing its first round trip acros the Atlantic. The vessel is 512 ft. in length, 33.8 ft in depth and 65.8 ft. beam. She has a displacement o 20,010 tons and is driven by quadruple-expansion engine of 4,000 hp., giving her a speed of 11 knots. A siste ship, the "Volturno," building in the same yards, wil be put in service in the fall.

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Litigation Over Paving Contracts at Nashville, Tenn., between the city authorities and the Southern Bitulithic Co was terminated by a compromise agreement on July 8, under which the city pays the company for the work it had completed up to the time construction was stopped by court injunctions a year ago, and the company is to proceed with the completion of the contracts now in force. While this terminates the litigation between the city and the company taxpayers' suits against the city to prevent it from carrying out the contracts for paving on the ground of their invalidity are still pending. An unusual feature of this complicated litigation at Nashville was the issuance of a court order placing the city's affairs in the hands of a receiver. Before the order was put into effect, however, it was appealed to a higher court, which immediately annulled the order.

Testing Various Soils for Drainage Properties

By John R. Haswell*

SYNOPSIS—The success of a land-drainage enterprise will be greatly influenced by the character of the soil not only as regards its fertility, but as regards its ability to yield up its moisture. The characteristics of different soils which make them readily drained, on the one hand, and difficult of draining, on the other, are here explained, together with experiments to determine the relation between soil textures and freedom of drainage.

There are numerous cases where engineers in general ractice can take up drainage work as a side line. A nowledge of soil conditions is absolutely essential, however, to successful designing. An examination of the soil aps published by the United States Department of griculture will be found very helpful in this work. oils are classified according to the diameter of the grains omposing them. The standard classification is as follows:

	Millimeters
ne gravel	2 to 1.0
oarse sand	1 to 0.5
edium sand	0.5 to 0.25
ne sand	0.25 to 0.10
ry fine sand	0.10 to 0.05
lt	0.05 to 0.005
ay	0.005 to 0

Loams contain various proportions of the basic con- ituents and have none of the characteristics of any class. should also be understood that the name silt merely notes soil whose particles range in size between a sand id clay and does not allude to the popular idea that it is dely water-borne soil. It is true, however, that alluvial posits are usually made up of a large proportion of this nstituent, because the heavier particles of sand settle in near the river channel and the clay continues to muddy e water after the silt has been deposited.

It is impracticable to get an analysis of all the soils countered, but the texture can be determined by placing small piece of average soil between the teeth. In some ils this makes the sand more perceptible, while the clay ntent is known by the smooth feeling when the teeth netrate it. After experience on soils of known classifi- tion it is comparatively an easy matter to determine the atus of a new soil.

Soils that are formed in the same general way are aced in a soil series. The soils in a series may exhibit the differences in texture from gravel to clay; and ien such is the case, the series is said to be complete. the United States a series is named from a town or ysical feature near where it was first encountered. ake, for instance, two soils in the same class—Sassafras t loam and Elkton silt loam. The mechanical analysis r texture shows similar classification, but they differ aterially in plant production. The Sassafras contains ganic matter and drains more readily than the Elkton t loam, which has been developed under poor drainage nditions and thus has a different structure from the other. It is therefore advisable to know the series to which a soil belongs as well as the class or type, and the color of the soil is of great assistance in this determination.

Soil Aëration

Practically all the benefits from land drainage are dependent on air entering the soil as the gravitational water passes out, the capillary water being held for the use of the plants. The gravitational water is the surplus water that runs into the drains.

This percolation generally takes place readily in a sandy soil, but in the heavy, tight soils usually classed as clay or as silt loams the circulation of soil water and air is not between the particles, but through the pore spaces separating the granules of soil, the granules being composed of a number of soil grains or particles stuck together. The ideal condition of granulation is intermediate between a compact puddled mass of tightly drawn soil grains and the rough clods that the surface of such a soil breaks into when plowed. The first will not support plant growth, and the latter is hard to cultivate, so besides constituting the ideal from a drainage standpoint, this granular or crumb structure, as it is sometimes called, is the desire of the farmer. The granule best adapted to plant growth varies in size from about 0.5 to 0.01 in. in diameter. Farm crops demand soil air for their growth, and this is present between the granules.

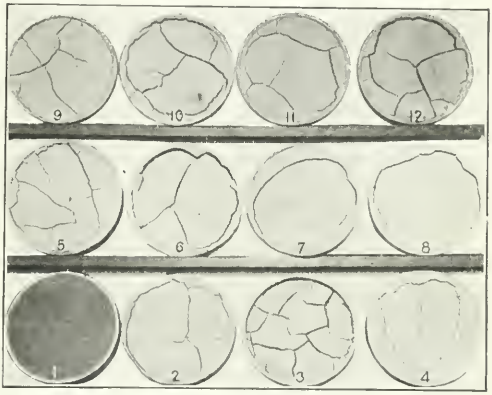

FIG. 1. VIEW OF PUDDLE-TEST SOIL SAMPLES AFTER DRYING

In the experiments outlined the soils used were not absolute separates, but natural soil materials in which predominated those properties of a pure soil separate whose name they bear. Table 1 gives the general proportions of the different classes composing the soils used.

TABLE 1 PERCENTAGES OF SOIL SEPARATES IN SOILS TESTED

Conventional Name	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Very Fine Sand	Silt	Clay
Clay	0	2	3	6	9	38	42
Clay loam	2	4	4	12	10	32	36
Silt loam	1	2	3	6	11	56	21
Sandy loam	4	10	12	26	12	22	14
Sand	4	14	20	33	13	9	7

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*Drainage Engineer, Office of Public Roads and Rural ngineering, U. S. Department of Agriculture, Washington, C.

Enough clay to fill three ordinary pie tins was mixed with water until thoroughly puddled. One pan was kept moist throughout the whole experiment, and the other two were allowed to dry. These two were then thoroughly moistened by gentle sprinkling and the process repeated until they had been dried five times, the first pan being allowed to finish with the last two.

The pans that had been repeatedly dried and wet showed the smaller granules and a more even granulation.

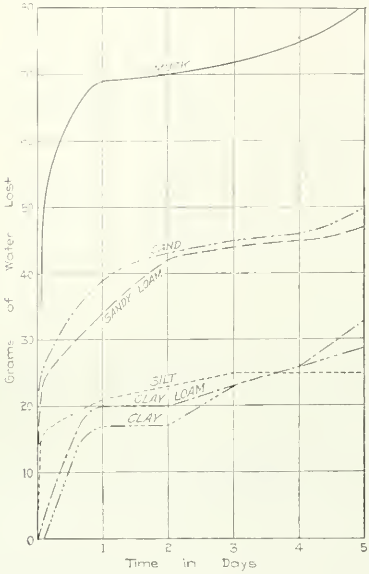

FIG. 2. CURVES SHOWING RELATION OF TEXTURE TO WATER-HOLDING CAPACITY IN VARIOUS SOILS

This is easily explained, since water tends to float the soil grains and thus deflocculate the mass. While in this loose, muddy condition, with no particle of soil attached to another except by being in the same mass, the soil was placed in the pans. During the evaporation of the water the moisture film around the particles had to contract, which produced considerable pressure due to surface tension. The particles were drawn together in small masses or crumbs by repeated drying. Thus the large mass was broken up into crumbs, when fissures or lines of weakness developed. It should be mentioned that the contrary is true in a soil that is too wet, for when a granular soil is kept saturated a long time the granules break up and the soil "runs together," assuming the single-grain structure, where each soil particle or grain is independent of the others and not grouped in a crumb.

To demonstrate the effect of organic matter and sand on the granulation of clay an experiment similar to the foregoing was conducted using straight clay, and clay mixed with half its volume of sand in one pan, and muck, in the same proportion, in another. These pans were wet and dried five times, as previously described. The tin with muck and clay in it showed the finest and most complete granulation, due to the large expansion and contraction of the muck upon wetting and drying. The clay sample ranked next in the uniformity and extent of granulation and also shrinkage of the mass, while the sand mixture showed the least change. The sand particle is inert, and such a soil readily assumes the single-grain structure.

The water in the soil is contained in films around the soil particles and in the capillary spaces of contact between the soil grains. The finer the soil the greater will be the amount of water held, as brought out in a later experiment. In a coarse soil the film around the grain is important, but in the finer soils the water held by capillarity between the grains has by far the larger volume.

PUDDLE TEST

Batches of soil were mixed as given in Table 2, the figures being percentage of total weight of dry soil mixture. After thoroughly mixing, the 12 batches were puddled into tin plates, as in the first experiment, and allowed to dry. Photographs (Fig. 1) were taken to show the extent of the checking, and a relative determination of hardness was made by observing the penetration of a knife-edge.

As would naturally be supposed, there was no checking in the pure sand, sample No. 1 (Fig. 1). Of the others, samples Nos. 7 and 8 showed the least cracking, while No. 3 broke up the most. The first two were the mixtures containing the least clay, while the latter was pure clay.

Arranged in order of hardness, the test showed the following: Nos. 4, 9, 6, 7, 5, 11, 3, 10, 12, 8, 2 and 1. As shown by the table, the mixtures containing the largest percentage of sand were the hardest, while of course the pure sand with no cementing material to hold the grains together was the softest. The tests were not fine enough to draw close distinctions between the samples in the middle of the series. Half of the mixtures between the two extremes were about of the same hardness.

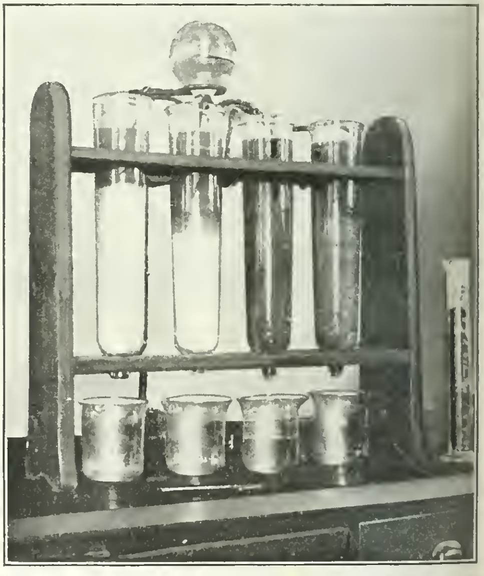

FIG. 3. VIEW OF APPARATUS USED IN TESTS OF RATE OF PERCOLATION IN VARIOUS SOILS

The puddle experiment opens up a wide field for thought. The principal idea, from a drainage standpoint, is an indication of how porous a puddled soil will become after it is drained and allowed to dry. In producing a sand-clay road a hard, nonshrinking surface is desired, and similar experiments should aid in determining proper proportions. Of course, the impact of traffic and washing of rains would qualify the laboratory findings. Better results would be obtained from a series of wettings and dryings such as would occur in nature.

TABLE 2. SOIL MIXTURE IN PUDDLE TESTS

No. of Sample	Percentages of Soil Sand	 Silt	 Clay
1	100	0	0
2	0	100	0
3	0	0	100
4	50	25	25
5	25	50	25
6	25	25	50
7	50	40	10
8	40	50	10
9	50	10	40
10	10	40	50
11	40	35	25
12	10	20	70

Influence of Texture Upon Water-Holding Capacity

"The term 'texture' is used to refer to the size of the individual particles of which a soil is composed. . . . The relative proportions of these various-sized particles influence greatly the physical properties of the soil."[1] The amount of water which a soil can absorb and retain against the action of gravity is dependent on its texture, structure and the amount of organic matter contained in it. The first mentioned was the basis of this experiment.

Brass cylinders 1⅞ in. in diameter and 9½ in. long were used in this work. A perforated bottom, covered by a cloth dam, prevented any fine material from seeping hrough from the tube after being filled with soil and stood in water. A cylinder was used for each of the fol-owing soils: Muck, clay, clay loam, silt, sandy loam and and. The filled tubes were compacted until there was no settlement when the cylinder was dropped 4 in., the final evel in all being 1 in. below the top.

The weights of the cylinders having been read before and after filling, the cylinders were stood in water the urface of which was kept at the same elevation as the oil in the tubes. The columns of soil were so short that here was practically no settlement. The time required or free moisture to appear on the surface of the soil was ecorded as far as possible.

The cylinders and saturated soils were next weighed, no water being allowed to escape from the scale pan. They were then covered with water glasses and weighed at the end of one hour and each day for five days. The percentages by weight of water taken up, water held and water lost, at the end of the fifth day, are given in Table 3.

It will be noticed that the water appeared at the top of he tubes in the following order: Muck, sand, sandy loam, lay loam, with clay and silt over night and therefore ndeterminate.

TABLE 3. TEXTURE AND WATER-HOLDING CAPACITY

Soil	Time Required for Water To Appear Hr.	 Min.	% of Water by Weight Taken Up	 Lost	 Retained	 Lost First Day
			(At End of Fifth Day)			
lay	Over night		39.5	5.7	33.8	3.3
lay loam	7	40	40.7	6.8	33.9	4.1
lt	Over night		37.3	4.6	32.7	2.9
andy loam	1	30	31.2	8.0	23.2	5.8
and	0	10	27.0	7.8	19.2	6.1
Muck	0	25	55.9	28.1	26.8	22.9

The curves in Fig. 2 were plotted from the daily record. A number of runs would have established smoother curves, but the results obtained show up natural soil conditions very well. In general, clay parts with its moisture very slowly and the other soils in approximately the following order: Clay loam, silt, sandy loam, sand and muck. It will be noticed that the silt curve is the flattest. This soil lost all the drainage water in the first three days, after which it held the remainder while the clay continued to lose.

Without the last column in Table 3 this experiment would result in confusion. We often hear that sand "holds more water than clay" and that the "runoff from sandy lands is greater than clays." The table shows that for the same condition of dryness clay will take up more water than sand, but will not part with as much, and that the rate of drainage from the sand is almost two times as fast as from the clay for the first 24 hr. Silt is shown to be the slowest to drain, while the loams come next to the pure sand.

Percolation Experiment

Percolation jars 20 in. long and 4½ in. in diameter were arranged as shown in Fig. 3. A constant head of 1¼ in. was maintained by means of an inverted flask whose neck just touched the water surface in a beaker used as a distributing reservoir. The beaker cannot be seen in the figure, but the distributing siphons leading from it are shown. The water of percolation was received in a beaker placed under each jar.

The soils used were clay, silt, sandy loam and sand, which were tested loose, compacted and with the addition of 1% of lime by weight with the soil compacted. The percolation through silt and clay was so slow that long runs had to be made in order to get fair averages, the results being reduced to grams of water per hour. Reading from left to right in Fig. 3, the soils in the jars are clay, silt, sand and sandy loam from a subsoil.

Tables 4 and 5 show that coarse-textured soils permit the most rapid percolation both in quantity of water passing and in the time required for the water to appear.

TABLE 4 PERCOLATION OF WATER THROUGH COLUMNS OF SOIL

Soil	Grams of Water per Hour — Treatment Loose	 Compact	 1% Lime, Compact
Clay	13	0.6	1.1
Silt	5	1.2	2.7
Sandy loam	139	9.0	15.0
Sand	269	58.0	25.0

TABLE 5. TIME REQUIRED FOR WATER TO DRIP

Soil	Hours and Minutes — Treatment Loose	 Compact	 1% Lime, Compact
Clay	Over night	93 00	26 00
Silt	Over night	41 00	13 00
Sandy loam	1 15	5 45	3 30
Sand	0 30	0.35	1 05

The larger the total pore space in the soil the greater the percolation and the less time required for the water to pass. A comparison of the loose and compact columns in the table shows that soil cultivation can be made to assist drainage.

The effect of lime corresponds with actual results obtained on farms. Lime will open up a tight soil by flocculating the soil grains and will make a sandy soil denser for the same reason. The lower percolation in sand after the addition of lime shows this very clearly. The lime shortened the time required for the water to appear in all the soils except sand, which was made to have less pore space due to the action of the lime and hence retarded the passage of the water. This shows that leaching from sandy soils can be lessened by the use of lime.

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[1] Lyon and Fippin, "Soils," p. 70.

In considering the drainage possibilities of a tract the following outline of procedure is recommended in reference to the soil:

1. Obtain a soil map of the area, if available, and locate the spot.

2. Determine the uniformity of the soil and see if there are any areas too small to be shown on the map.

3. Observe the series to which the soil belongs and see by reference to the text accompanying the soil map if the members of the series are usually well drained.

4. Determine the classification and examine the subsoil for pervious or impervious strata, joint clay formation, etc.

5. Note any color changes in the soil.

6. Compare, if possible, this soil with some similar soil which has already been drained.

It must be remembered that the change in structure mentioned under "Granulation Experiment" and "Puddle Test" would not occur immediately after draining, but would require several years in a fine soil. This accounts for the increasing yields for the first three years, so often seen in drainage records. After the soil becomes well granulated, the production fails to increase further from drainage.

When a drain is first opened, it is interesting to watch the water-bearing strata discharge into the ditch. After a short time, usually within a week or two, the flow falls off and sometimes ceases until after a rain. Then as time goes on, the discharge from the drain increases in amount and duration after storms, showing the effect of better soil conditions. This is the explanation for the statement that extensive tile drainage will reduce flood flows by changing a saturated, unabsorbing soil into one which will absorb rainfall and liberate it gradually instead of letting it run over the ground surface.

The practical uses to be made of the foregoing data have been set forth by the writer in a published bulletin.[2] A few extracts sum up the conditions governing depth and spacing of underdrains:

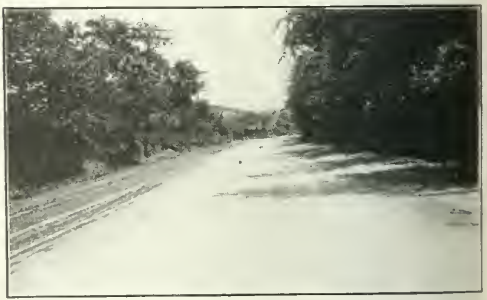
> Three feet is the common depth for tile in average soils growing the ordinary crops. The depth should be greater for alfalfa and less for strawberries because of the difference in the root systems. . . .
>
> In a tight "post oak" (silty) soil the percolation of water is very slow and of small extent, so that drains but 2 ft. deep are possible, while in open loams drains as deep as 5 ft. have proved the most satisfactory. According to Fippin,[3] up to a depth of 4 ft. an increase in the depth of the drain will permit an increase in the interval between drains of about two rods for each foot in depth. For example, a drain 4 ft. deep will drain a strip two rods wider than will a drain 3 ft. in depth, provided, however, that the line be laid in an open soil. The only extra expense is that of an extra foot of digging, which is more than offset by the smaller number of laterals required. Where the subsoil is a heavy clay overlain by an open topsoil, it is good practice to lay the tile at least as deep as the line of division. Under these conditions the soil water generally spreads over the subsoil and can be reached only by tile laid as suggested.
>
> In the so-called uniform system of drainage the number of laterals can be greatly reduced if the depth is a maximum for the soil in question; for the laterals must be so closely spaced that no unaffected land will lie between them, and the greater the depth of drain the wider the strip of land affected. In tight, close soils the drains may have to be but 2 ft. deep and 40 ft. apart for efficient drainage, while a depth of 4 ft. and a spacing of 200 ft. may produce equally good results in a loose open soil. . . .
>
> The presence of a "joint clay" formation in the subsoil is a great help to under-drainage, as the water will follow the joints. The presence of this type can be detected by digging a test pit; if the subsoil breaks up into small cubes, it is said to be of a "joint" formation.
>
> Some retentive subsoils must be broken by deep plowing before they will permit tile drains to operate freely. A subsoil plow run in the bottom of an ordinary furrow will generally give a total depth of plowing of 18 in. In some sections, after years of cultivation to the same depth, a "plow pan" or "plow sole" of firmly compacted earth has been formed by the tramping of the horses and the downward pressure of the common moldboard plow. This bed of tightly packed soil must be broken before thorough drainage can be accomplished; and even when underdrains are not installed, the good effect of such subsoiling will often be appreciable. Retentive soils are frequently rendered susceptible to drainage by heavy liming. . . .

⁂

Dished Surface for Concrete on Hilly Country Roads

Sioux City, Iowa, which has gained fame on account of the excellence of its concrete pavements, is extending paved streets so far out of the business and residence section of the city that in much work now under way the conditions are those of typical country roads. These pavements are built under the supervision of T. H. Johnson, City Engineer.

On level stretches or moderate grades pavements are of the ordinary crowned cross-section, 16 ft. wide, 6 in. thick at the sides and 8 in. at the center. But on grades of 4% or more the crown is replaced by a concave, or dished, cross-section. The surface of the pavement is made 3 in. lower on the center line than at the edges, but of uniform thickness (7 in.). The 8-ft. earth shoulders are crowned so that the drainage of half of them goes to the center of the pavement and the other half to the usual side ditches.



DISHED CONCRETE PAVEMENT, SIOUX CITY, IOWA

The object is twofold. The pavement takes a large part of the runoff during rains and saves washouts which almost invariably occur on unpaved hill streets with every severe shower. The character of the soil in the hills is very peculiar. It will stand for years in cuts with a perpendicular face, but erodes under running water with astonishing rapidity. The other object is to preserve the shoulders of the pavement. The tendency with a crowned concrete pavement is for the water and traffic to form a gulley along the edge of the pavement slab. With the dished cross-section there is no such tendency. The soil on the shoulders tends to work in and form a cushion to protect the edge of the slab.

The water that runs down the center of the pavement is diverted at the foot of the slope by means of dished concrete aprons across the shoulders to the side ditches.

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[2] "Land Drainage in Maryland," Bulletin 186, Maryland Agricultural Experiment Station.

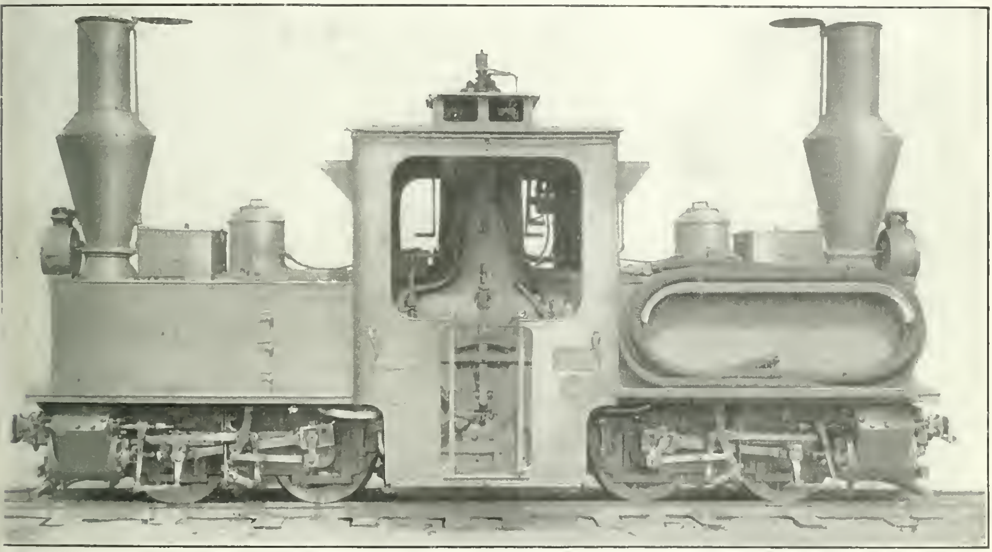
[3] "Land Drainage in New York," by E. O. Fippin; Circular 70, New York Department of Agriculture.

Beyond the aprons the crowned pavement begins again, the transition being so gradual as to make easy riding, and the change is not conspicuous. The dished pavement of the hill, however, is rather noticeable, and the appearance is not so pleasing as that of a crowned roadway.

* * *

French Military Locomotives Built in America

The curious locomotive shown in the accompanying view is one of 280 engines built for the French Government by the Baldwin Locomotive Works, of Philadelphia, and intended for use on military railways of 24-in. gage. They are of what is known as the Pechot type, being named after their inventor. They are flexible-wheelbase noncompound engines of the 0-4-4-0 class. Their general design is similar to that of the earlier Fairlie type, having a double tandem boiler (with two barrels and fireboxes) and being mounted on two steam trucks, so hat the engine is powerful for its size and exceedingly lexible. In the Mallet type of engine there is only one team truck, the second group of driving wheels being arried in fixed frames.



AMERICAN-BUILT FLEXIBLE LOCOMOTIVE OF 24-IN GAGE FOR THE FRENCH GOVERNMENT
Baldwin Locomotive Works, builder

In these new Pechot locomotives the boilers have 25-in. teel barrels and a steel shell inclosing the inside fireoxes, which are of copper, $16\frac{1}{2}$x$23\frac{1}{2}$ in. The tubes re of brass, $1\frac{5}{8}$ in. in diameter and 5 ft. 8 in. long. ach boiler barrel contains a separate set of tubes. and here is a smokebox and stack at each end of the locomoive. The dome is placed above the fireboxes. It conains two throttle valves, one serving each truck. Steam s normally admitted to all four cylinders; but if deired. the locomotive can be operated by one steam truck nly. The boiler barrels are supported by saddles placed irectly over the center pins of the trucks, while the fireox shell is supported by two plate frames that are riveted to the saddles. The boiler simply rests on the saddles, without being attached to them, thus allowing for expansion and contraction.

The four cylinders are all 7x9.6 in. The live-steam pipes leave the boiler through openings in the bottom and pass down through the center pins of the trucks, so that the ball joint in each pipe can be arranged to coincide with the center on which the truck swivels. The steam distribution is controlled by balanced slide valves, driven by Walschaerts valve gear. Reversing is effected by means of a hand lever. The engine has 26-in. wheels, with 3-ft. rigid wheelbase for each truck and a total wheelbase of 12 ft. 6 in. The weight is about 14 tons.

The cab is located at the center, the engineman being on one side and the fireman on the opposite side. The water-supply, 400 gal., is carried in four tanks placed beside the boiler barrels. The two tanks on the fireman's side are shorter than the others, so as to provide space (adjacent to the cab) for coal bunkers of 880 lb. capacity. Each firebox has a side door and is fired independently of the other. The American-made equipment includes injectors, whistle, safety valves, lubricator, steam gage, headlights and cab and signal lamps. The locomotives are fitted with hand screw-brakes and with drawbars of the radial type.

These locomotives were erected at the Eddystone plant of the builders, and were subjected to severe tests, each being run under steam for approximately half a day on a special track built for testing purposes. Each locomotive was shipped complete in one case. The smokestacks and a few small fittings were removed, but were boxed with the locomotive, so that very little erecting work was necessary on arrival at destination. Considering the facts that the locomotives were built throughout to metric measurements and were of most unusual design, quick records for delivery have been made.

River Terminals Projected for St. Louis

The commercial interests in the cities of the Mississippi Valley which have for years been urging Government appropriations for waterway improvement have come to understand that even more important to the revival of waterway traffic than improved channels are improved terminal facilities at the principal cities. The most important port on an inland river in the United States is St. Louis. The tonnage of water-borne traffic at Pittsburgh, it is true, is much larger, but the Pittsburgh water traffic is almost wholly of coal, while the St. Louis water traffic is general merchandise of much higher value per ton.

As is well known, there has been a great falling off in the traffic on the Mississippi River. In 1887, the freight shipments by river to and from St. Louis amounted to 1,290,000 tons. In 1914 the river traffic had dwindled to 151,000 tons. In contrast with this, the total rail shipments at St. Louis in 1914 amounted to over 52,000,000 tons and the freight taken by rail lines approximately parallel to the rivers was about 28,000,000 tons. Notwithstanding these impressive figures, there is a large public sentiment in the Mississippi Valley which favors the creation of facilities that will make the revival of river traffic possible, and this sentiment is as strong in St. Louis as anywhere.

A report on a proposed terminal system for river traffic in St. Louis was recently made by S. W. Bowen, Chief Engineer of the City Department of Public Utilities. The report is a voluminous document, containing with its appendices a great amount of statistical matter, and extensive maps and drawings illustrating the structures it is proposed to build.

Mr. Bowen first investigated the question, What amount of river traffic should the proposed terminals be planned for? A canvass was made of the principal manufacturing and shipping concerns of the city, which resulted in tentative promises of about 250,000 tons of freight annually for shipment by river. While this would be a material increase over the present river traffic it is noteworthy that out of 350 letters sent out only 114 replies were received. Mr. Bowen thinks it probable that if the proper terminal facilities were once furnished, a considerably larger tonnage of river traffic than that stated above might be reached, probably as much as 500,000 tons. Even this traffic would not be sufficient to warrant the city in making a very large outlay on river terminals. Mr. Bowen believes, however, that there is opportunity for considerable traffic to develop between the Pacific Coast ports and Mississippi Valley points by way of the Panama Canal and New Orleans. There will also be a further increase in the territory opened to river traffic from St. Louis if the proposed Intercoastal Canal along the Gulf is completed.

The class of freight most likely to be handled on the Mississippi River in the future appears to be general merchandise, except that some grain may possibly be handled by river, if the business were of sufficient volume to justify the building of grain elevators at river terminals for delivering material to boats. Mr. Bowen outlines the requirements for an efficient terminal system for inland river traffic as follows:

> An efficient river terminal system should consist of a series of docks conveniently located with respect to the manufacturing and distributing centers, and a complete railway system connecting the docks with all of the railways entering the city. The docks should be fully equipped with the most modern freight-handling machinery. There should be warehouses on the docks for the protection of transient freight and storehouses lying back of the warehouses for freight to be held some time. The railway system should include a belt line with receiving and storing yards and small sorting yards at each dock.

St. Louis is better able than most river cities to construct a river terminal system since 50% of the total river frontage is owned by the city. The city also owns a single-track railway line about 7 mi. long extending along the river front in the northern part of the city. In addition, part of the St. Louis Transfer Ry. system came into the city's possession on Dec. 15, 1915. It is proposed to extend these railway lines so as to form a belt line entirely around the city, with connections for the transfer of cars at each railway intersected.

There are a number of suitable locations for municipal docks along the river front, and local conditions will determine which of these sites are preferable for first development. In the design of the docks, the Government requirements are that the river bed in front of the docks shall be dredged to a depth of at least 8 ft. below low-water mark and shall be maintained at that depth. Fills must be made above and below the dock to form easy approaches and prevent the formation of eddies.

The elevation of the roadway paving on the dock site is fixed at the same elevation as the high-water mark of the record-breaking flood of 1903. The floors of wharves and warehouses would be placed 3.7 ft. above this level. Mr. Bowen thinks it likely that if another flood equal to that of 1903 should come, after the levees on the east side of the river are built, the high-water mark at St. Louis would be raised 2 to 3 ft. above that of 1903. The floors of warehouses and wharves would still be above a flood of such a height, and the small depth of flood water would do no damage to the paving for the short time it might flow over it.

After an extensive study of freight-handling machinery suitable for use at docks, the decision was in favor of locomotive cranes in connection with motor trucks, with the possible later addition of gantry jib cranes. With such equipment, it is estimated that miscellaneous package freight can be handled for about 20c. per ton. The present river traffic at St. Louis is handled by four packet lines and three tow-boat lines. It is estimated that to provide for present requirements, with a reasonable provision for future growth, four 300-ft. docks would be required on Valentine St. and the same number at North Market St.

The estimated cost of these docks and warehouses, with their mechanical equipment, is $1,230,000. For extensions of the municipal railway system, about $554,000 would be required. Adding a reasonable percentage for contingencies, the total estimated cost of the whole municipal system would be $2,000,000 in round numbers. At North Market St., the dock construction on the lines proposed would reclaim about 17 acres of land. It is estimated that this could be sold for enough to reduce the net cost of the project to $1,500,000.

In estimating the capacity of these docks to handle traffic, Mr. Bowen assumes an annual freight transfer amounting to 550 tons per lin.ft. of dock, which corresponds with European experience in mechanical cargo handling. At this rate, the 2,400 lin.ft. of docks provided would be capable of handling 1,320,000 tons of river traffic. The annual expense to the city of this proposed dock and railway system, including interest at 4%, sinking fund at 2.06%, and maintenance, is estimated at about $208,000. To provide a revenue to meet this expense, Mr. Bowen recommends that a rate of 10c. per ton be charged for freight handled over the docks, and for the use of the municipal belt line that a rate per car be fixed or else that the line be leased at an annual rental.

⁂

Causes of Rail Corrugation

The corrugation of rails on street railways, with its ·auses and the means to prevent and remove it, has been the subject of extended discussion. The following ·tatement as to the causes, which are listed in the ·rder of their importance, has been prepared by Mason D. Pratt, Chief Engineer of the United Railways and Electric Co., of Baltimore, Md. It is based on twenty-five years of experience in the manufacture of rails and the construction and maintenance of track. He states hat this was submitted to the chief engineers of all he larger street-railway systems in the country, and that vhile their individual experience varied somewhat, the ·onclusions were substantially agreed to by those who ıad given the matter careful consideration. The causes re as follows:

1. Self-propelled cars. Practically all corrugation ·ccurs on electric railways where all or a large majority ·f the cars are self-propelled.

2. Girder or other rails having considerable vertical tiffness.

3. Soft steel for rails. The extent and depth of ·orrugation is in inverse ratio to the content of carbon nd other hardening elements.

4. Single type of cars in operation; particularly ouble-truck, four-motor equipment. On tracks over hich there is regularly operated a service of mixed ·pes of cars, corrugation may appear from time to time, ıt unless some other feature (as for instance No. 3) · the cause, the corrugation will usually "iron out."

5. Contour of rail head. Flat-headed rails, or those n which the wheels have only a narrow or partial earing, will develop corrugations earlier than those on hich the wheels have a full bearing (as on convex-head ıils).

6. Heavy mill scale on the rails. On rails that have een rolled under conditions producing heavy mill scale ıat is allowed to go through the finishing pass, the ırface of the rails has been so heavily marked as to start ·rrugation immediately after the rails have been put in ·rvice. Mr. Pratt has inserted the following clauses ı his specifications for rails for the last two years, and ıis has had a beneficial effect.

> In the rolling process such precaution shall be taken as ay be necessary to entirely remove mill scale just prior to ıils entering last two finishing passes and otherwise to pro-ıce a finished bar having smooth, regular and true surface ı head and in finishing contact areas.
>
> Any rails showing by the closest possible inspection the ıghtest indication of corrugation will be rejected.

Other causes are: (7) Rapid acceleration and de-·leration. (8) Unequal diameter of wheels on same xle. (9) Long radius curves. (10) Intensity of wheel ·ads. (11) Track foundation. (12) Segregation of eel. (13) Track sanding. (11) Grades.

Austin Dam Section Criticized

That the novel and radical section of the new part of the Austin, Tex., dam has less stability than the originally planned hollow section, is the statement of Bartlett & Ranney, Consulting Engineers of San Antonio, who were recently employed by the city to report on the dam. As noted in the article in *Engineering News*, June 3, 1915, p. 1089, the width of the base of the hollow reinforced-concrete dam built across the Colorado River to fill in the spaces left when the masonry dam there was washed out in 1900 was reduced materially by carrying the downstream deck about 20 ft. upstream of the top of the upstream slanting deck, in distinction to the usual hollow-dam section in which the two decks meet at a peak. The original hollow section designed for the site had a base of 125 ft. 9 in. The modified section has a base of 93 ft. The change was made by the contractor with the approval of the engineer under a clause in the specifications which provided that the contractor might make any change that, in the opinion of the engineer in charge for the promoting company, would be desirable, provided such changes did not decrease the amount of equipment in the power house, the height of the dam or its stability, the size of the reservoir, or in any way decrease the capacity or completeness of the installation or in any way lower the standard of the grade of construction.

The consulting engineers' report regarding this section is as follows:

> Considering the structure as a whole in relation to its stability on the foundation—a matter of fundamental importance and especially so in view of the notoriously faulty character of the foundation—we find that the change in design did decrease the stability. But we find that as respects the rigidity of the structure itself and the strength of the slabs which support the water, the adopted design is superior to the original design. The character of the foundation at the site of this dam, the failure of the old dam, the many investigations and studies which have been made in connection with the failure and proposed rebuilding, the certainty of a considerable silt pressure in time, as well as the unusual height of the structure for an overflow dam, all indicate the emphatic need for extreme conservatism in reconstruction.
>
> The sliding tendency of 0.51 for the contract dam is increased to 0.58 in the dam as constructed. Under the conditions, we do not think that any increase in the sliding tendency is justifiable.
>
> In general, we are forced to state that as respects its fundamental stability on its foundation, the dam as rebuilt is a radical design while the dam as designed was of conservative type.

The consulting engineers also reported that while not embraced under the scope of the report as pertaining to the changes in the original contract and specification, they considered that the old masonry portion of the dam, which is now the middle stretch of the present dam, has an insufficient factor of safety against sliding.

⁂

Workmen's Compensation to be paid the dependents of 290 workers killed in industrial accidents in Pennsylvania during the first five months of 1916 aggregate $742,962.75, according to a compilation made by the State Bureau of Workmen's Compensation for Labor Commissioner John Price Jackson. During this period 862 workers were killed, and it is estimated that when all the compensation agreements are perfected, the total amount for fatalities will approximate $1,500,000. The average total payment in each of the 290 cases is $2,560.90, and the average weekly wage of the 862 killed was $11.86, or a total annual payroll of $666,084.64. The majority of the fatalities occurred in mines. The division by occupations is: Miners, 375, laborers, 187; iron and steel workers, 157 railroad employees, 119, clerks, 7 firemen, 9, salesmen, 5, civil engineers, 1; policemen, 1; motormen, 1, teachers, 1; carpenters, 1

Field and Office

Drafting-Room Practice in a Departmentalized Shop

Five distinctive features individualize the drafting room of the Wellman-Seaver-Morgan Co., Cleveland, Ohio. They prove that success in the drafting department is by no means incompatible with free departure from conventional methods to fit special needs of the business or personalities.

Leading features are: (1) Departmentalization of the drafting room to match the departments of the engineering organization; (2) functionalized control, in which the engineering direction and administration are separated; (3) cost recording applied to the single drawing, with a card file for all drawings; (4) a system for limiting house-account jobs; (5) use of cut sheets.

The company builds a large range of structures and machines, and its engineering work covers at least two broad classes of structural steel and three classes of mechanical-engineering construction. This condition is met by a complete departmentalization of the engineering branch, in fact of the whole company except the shop. In many concerns where this is the case, the drafting room is a single unit, technically and administratively, but here the drafting room also is departmentalized. Long use of this plan of operation proves its success.

The six departments, each headed by an engineer, are: Coal and Ore Handling, Hydraulic Turbine, Mine Hoist, Crane (charging machines and coke-oven equipment), Furnace and Estimating. The drafting force is divided into corresponding groups, and each group is headed by a foreman. Including an extra group, for billing and orders (3 stenographers and 3 clerks), the whole force comprises normally 90 men. The 44-hr. week is used.

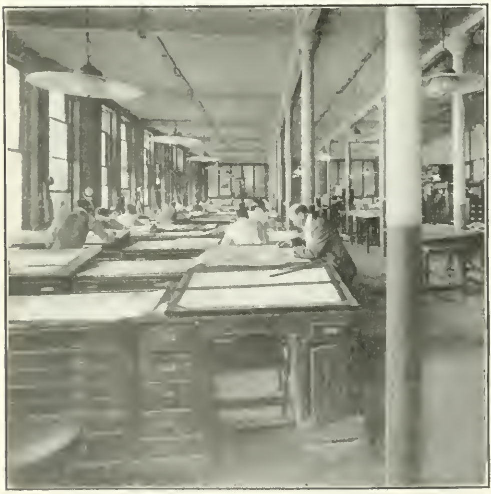


FIG. 1. CORNER OF DRAFTING ROOM

Administrative control of the drafting force is in the hands of the Engineer of Construction, who employs, disciplines and manages. For technical instructions, however, the group foremen are directly under orders of the department engineers. There is no one corresponding to the Chief Draftsman of the usual type of organization. Finished drawings are checked by the group foreman and are countersigned by the department engineer.

This division of functions is not merely formal but is applied consistently. Thus, space limitations made it necessary to locate two groups of the drafting force away from the main drafting room—in fact directly under the eye of the respective department heads. These groups nevertheless are under the same administrative control as the force in the main room.

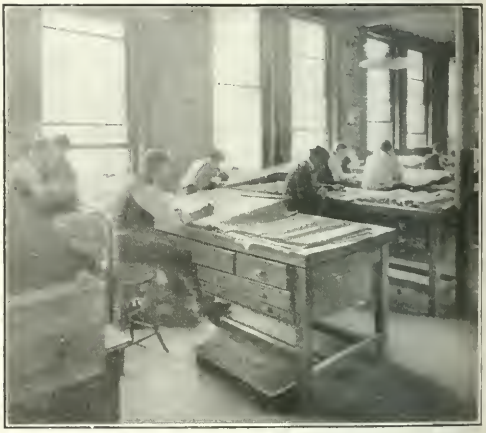


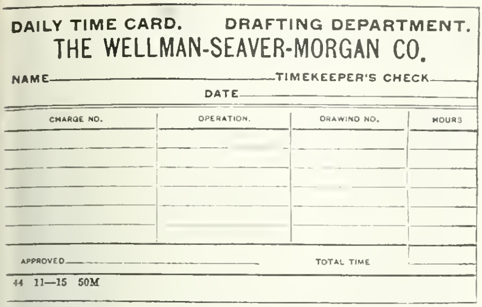
FIG. 2. DRAFTING TABLE OF OWN DESIGN

In this organization good disciplinary control is secured without a time clock. The group foremen are responsible for their men to the Engineer of Construction. They are accountable for both regularity and order, in addition to efficiency.

Record Forms and File Cards

To obtain a permanent record of drawings and a reliable basis for estimates of drafting costs an unusually careful system of recording the drafting-room operations was devised. It is based on the draftsman's time card (Fig. 3), which states not merely the job number but also the operation (designing, detailing, tracing) and the drawing number. The group foreman countersigns and turns in the time cards of all his men. The original goes to the paymaster; a duplicate is filed in the drafting room.

On completion of a drawing, it is turned in to the Engineer of Construction, accompanied by a report card (Fig. 5) giving all pertinent data that describe the sheet.

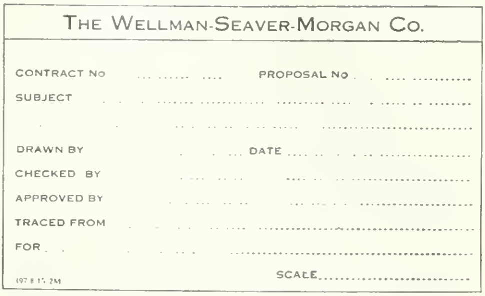


DAILY TIME CARD. DRAFTING DEPARTMENT.
THE WELLMAN-SEAVER-MORGAN CO.
NAME——————————TIMEKEEPER'S CHECK——————
DATE——————

CHARGE NO.	OPERATION.	DRAWING NO.	HOURS

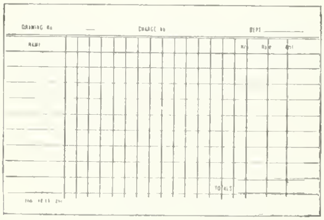
APPROVED—————— TOTAL TIME ——————
44 11—15 50M

FIG. 3. TIME SLIP GIVES OPERATION AND SHEET NUMBER



THE WELLMAN-SEAVER-MORGAN CO.
CONTRACT No .... PROPOSAL No ....
SUBJECT ....
....
DRAWN BY .... DATE ....
CHECKED BY ....
APPROVED BY ....
TRACED FROM ....
FOR ....
197 8 15 2M SCALE..........

FIG. 5. REPORT CARD FOR INDIVIDUAL DRAWING



DRAWING No —— CHARGE No DEPT ——
NAME
TOTALS

FIG. 6. COST RECORD CARD IS FILED FOR EACH SHEET

xcept the time spent on it. This report card is filed a permanent record of new drawings made on a given rder.

A cost card for the drawing is made up from the me slips, posted up each day, and totaled when the port card announces its completion. This card (Fig. 6) ives the total time and cost, and an analysis of this me by men and by dates. An analysis by operations in be deduced, when needed, from the rates of pay iown on the card.

Regular (contract) jobs are started by a group foreman on receiving from the Engineer of Construction a iplicate of the order made out by the contracting agent engineer. This order is returned after completion all the drawings of the job.

House-account jobs, or what might be called nonproicing work in the drafting room, are initiated by a special order made out on a numbered-series card issued by the Engineer of Construction. This card, besides tending to limit the amount of such work, helps to ensure proper locating of the charge in the accounting department. The latter result is secured by sending a duplicate of the card to the accounting department when the job is initiated, and giving on this card a sufficient description of the proposed work that the latter department is enabled to place the charge against the proper one of several standing accounts authorized by the management of the company. Fig. 7 shows the card and its duplicate. The back of the duplicate is ruled for the daily time and cost figures from the time slips, the time-slip entries being identified by the number taken from the special-order card.

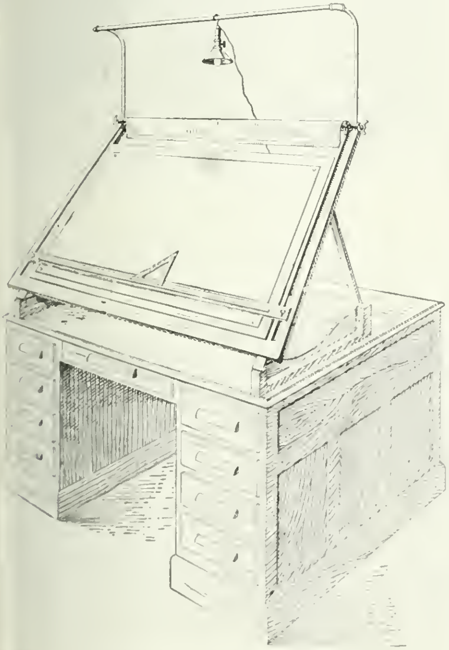


FIG. 4. SKETCH OF UPRIGHT BOARD AND LAMP MOUNTING AS FORMERLY USED

Now abandoned for horizontal tables and ceiling drops

EQUIPMENT OF THE DRAFTING ROOM

The arrangement of the room is determined partly by the space layout and the window lighting. The room is about 40x100 ft., and 15 ft. high; about three-fourths of the wall space has windows. With narrow piers, and windows extending to the ceiling, the side light easily allows of placing two tables in line from the wall. As the column arrangement makes an 8-ft. aisle down the middle of the room, the row of two tables on either side just fills the available space. In the other direction the tables are spaced about 4 ft. 8 in., or three per 14-ft. bay.

Present practice as to equipment is of relatively recent date. Up to eight years ago the room was fitted with upright drawing boards mounted on easel brackets set on top of office-type desks. Fig. 4 sketches roughly the desk and board, and its lamp fitting. The brackets could be adjusted to different angles, the board (about 32x40 in.) could be shifted up and down on the brackets and could even be slid down to rest on the draftsman's knees, and a parallel-ruler working in slots of the rails served in place of the T-square. The lower stile had a projecting tray to hold pencils and tools. A pipe support over the top carried a baby Nernst lamp whose hook could be slid along the pipe rail to any position.

The horizontal-board plan is now used exclusively. Many of the old desks were adapted for this by putting 6-in. legs under them; two desks with a filing case between give enough table length for two draftsmen. The rest of the room is equipped with large tables designed and built by the company. Fig. 2 shows one of these quite clearly. There are two drawers for tools and books, and two large ones for drawings. The top is 34x84 in.; it has an oak border and a soft-pine filling. This is rarely or never used for pinning down drawings, but a drawing-board on taper rails is placed on it.

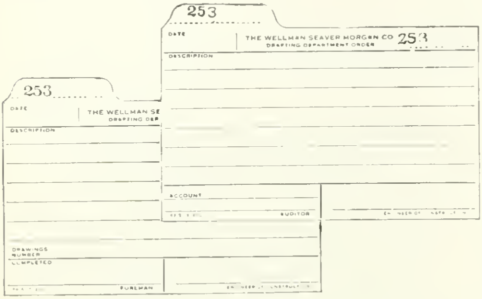

253
DATE
THE WELLMAN SEAVER MORGAN CO 253
DRAFTING DEPARTMENT ORDER
DESCRIPTION
ACCOUNT
AUDITOR
253
DATE
THE WELLMAN SE
DRAFTING DEP
DESCRIPTION
DRAWINGS NUMBER
COMPLETED
FOREMAN

FIG. 7. DRAFTING-ROOM ORDER CARDS FOR HOUSE-ACCOUNT JOBS

Cards 3x5. Lower, white, goes to drafting-squad foreman as his order. Upper, buff, goes to auditor, and is ruled on back for time and amount

Several large boards are used in the Hydraulic Department. These range from 4x6 to 5x10 ft.. and have a steel edge for the T-square. For other departments the regular table serves satisfactorily.

There are a few drafting machines, but most of the tables are equipped with T-squares. Triangles and other tools are furnished by the men. Special tools such as pantograph, beam compasses and special-curve and radius templets are furnished by the company.

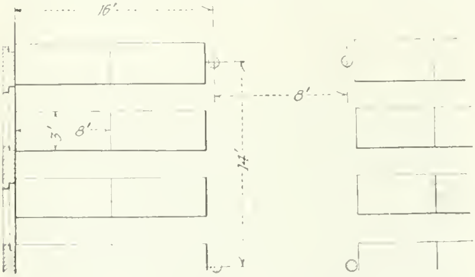


FIG. 8. PART PLAN SHOWING TABLE ARRANGEMENT

The present lighting system has one 360-watt drop fixture in each bay (11x16 and 8x11 ft.). The fixture has six 60-watt tungsten lamps placed under a 39-in. General Electric "diffuser," and inclosed below by a pearl-glass shade, all hung about 6 ft. from the ceiling (9 ft. from the floor). The illumination is said to be entirely adequate. Ceiling and walls, painted buff in oil, are important factors in the lighting.

Most of the work is done on cut sheets. Buff drawing paper is used for pencil layout and detailing, and this as well as the tracing cloth and blueprint paper is bought in sheets. The tracing cloth is bought with border and company stamp (lower right corner) printed on.

The reason for using blueprint sheets is that the two machines—imported vertical machines, among the first made—take sheets only.

There are four standard sizes of drawing sheet: only in turbine work and other special cases is it necessary to depart from these. They are:

Over All	Inside Inner Border Line
26 x36 in.	23¾x33¼ in.
18 x26 in.	16 x23½ in.
13 x16 in.	10¼x14 in.
9½x12 in.	7¼x10⅝ in.

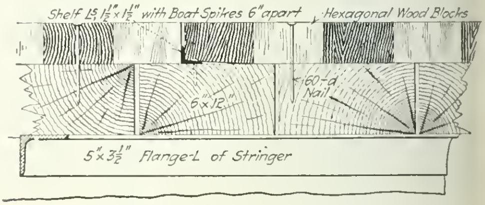
The sheet sizes are selected by the group foreman in planning out the work on a particular job. The smallest size is used for drawings that are likely to be wanted in letter size for filing with correspondence and notes.

⁂

New Wood Floor Construction for Bascule Bridges

For the roadway paving of bascule bridges at Chicago, the Department of Public Works is now using hexagonal wood blocks 3½ in. thick, instead of 4-in. rectangular blocks. One of the main reasons for the use of the hexagonal blocks is that being all heartwood the expansion is radial instead of longitudinal, so that there is less trouble from expansion and contraction movements.

The floor construction used with these blocks makes a very substantial deck, and is shown in the accompanying drawing as applied to the new Belmont Ave. bridge. There is a course of transverse timbers 6x12 in., laid close together (with 1¼-in. spaces) upon the steel stringers. On this planking are placed the 3½-in. hexagonal paving blocks, which are cut from 6- or 7-in. tamarack posts. These blocks are of what is known as the Hex type, manufactured by the Jennison-Wright Co., of Toledo, Ohio. They are treated with 12 lb. of creosot oil per cubic foot of timber. For use on bridges they vary in thickness from 2½ in. to 3½ in. according to the traffic conditions.


Shelf L 1½"x1½" with Boat Spikes 6" apart
Hexagonal Wood Blocks
60-d Nail
6x12
5"x3½" Flange-L of Stringer

WOOD PAVING WITH 3½-IN. HEXAGONAL BLOCKS FOR BASCULE BRIDGES AT CHICAGO

On the bascule bridges, each third row of blocks has every block fastened by a single 60-penny nail driven through its center and into the subplanking. To prevent slipping of the blocks due to the raising of the bridge, galvanized-steel shelf angles 1½x1½ in. are laid across the planking at intervals of 6 ft. and spiked in place. The blocks of the adjacent row are cut to an incline on the bottom so as to fit over the leg of the angle.

The paving originally designed for the Belmont Ave. bridge consisted of transverse 1x6-in. planks, 6 in. apart, laid on the stringers and covered with 2x8-in. longitudinal planks laid close together. On these was to be layer of tarred paper upon which 4-in. rectangular locks were to be placed. The blocks were to be fastened y toe-nailing with a 10-penny nail in every block of ach third row.

The new floor construction is slightly heavier and more xpensive. But it will require much less maintenance wing to its greater rigidity under the heavy motor-truck oading carried by the Chicago city bridges, and to the limination of troubles from expansion and contraction f the paving. This construction is to be used on all the ew bridges, and is being applied rapidly to existing ridges to replace the old plank and Shuman paving. his latter consists of built-up sections formed of planks n edge, bolted together.

The new type of paving has been designed under the irection of John Ericson, City Engineer, and Thomas . Pihlfeldt, Engineer of Bridges.

⁂

Raising Settled Bent of Heavy Concrete Viaduct

Soon after the construction of the western section of e Colfax-Larimer viaduct in Denver, Colo., described *Engineering News,* Jan. 27, 1916, p. 168, water from leaking hydrant seeped under the foundations of the edestals of one bent and caused a settlement of about in. No cracking of the concrete girders occurred and while the settlement was not serious it was decided to bring the bent back into place. The accompanying views show how this was done.

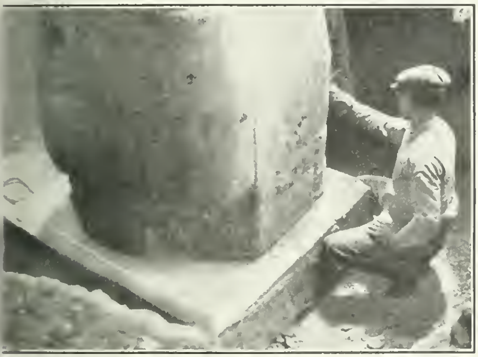


FIG. 1. CLIPPING AWAY CORNERS TO RELEASE BONDING RODS

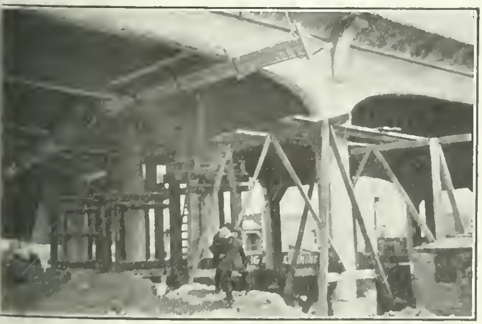


FIG. 2. SETTLED BENT, COLFAX-LARIMER VIADUCT, DENVER, COLO.

The posts were lifted off the pedestal blocks and a layer of grout placed under them. The posts had been bonded to the pedestals by four twisted bars, one at each corner, so that it was first necessary to cut away the concrete and expose these bars, as is being done in Fig. 1. (In the later constructed bents these dowels were omitted.) On the concrete footing a grillage of 12x12-in. timbers was built, held together by steel rods as shown in the detail in Fig. 3. To avoid the possibility of splitting off the 12-in. ledge on the concrete footing the rods were taken up so tightly that the friction between the concrete posts and the timbers sustained a large part of the load.

On top of the 12x12's a 12x16 was placed, which carries the jacks. The jacks bear against two 12x12's which carry four 12x12 posts held in place by four yokes of 12x12's and $\frac{3}{4}$-in. rods, as shown in Fig. 3. The load is transferred to the structure by two struts of 12x16 hard wood resting against the haunches of the arched-end girders. These struts are prevented from slipping by four $2\frac{1}{8}$-in. rods.

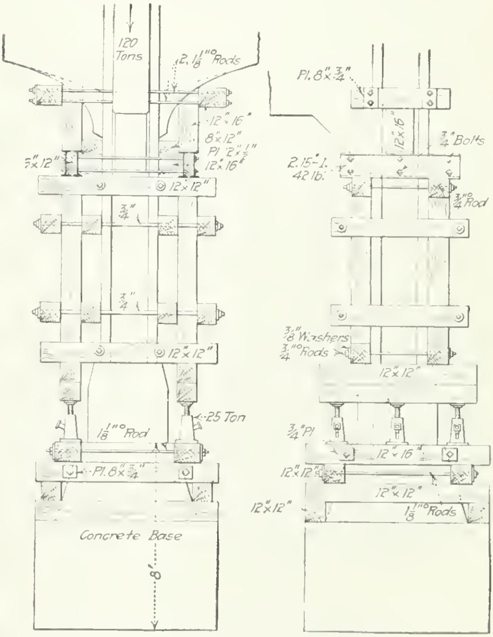


FIG 3. DETAIL OF GRILLAGE, INCLUDING TWO 70-TO AND FOUR 25-TON JACKS

When the accompanying views were taken only one post had been lifted from the pedestal. Six jacks totaling 240 tons were required; two 70-ton jacks in the middle, as shown in Fig. 3, and four 25-ton jacks on the ends. The post finally separated from the pedestal with a very perceptible snap. The work of raising the other posts was suspended until enough jacks could be secured to lift all four posts simultaneously.

High Steel Prices Increase Use of Concrete Bridges

The Minnesota State Highway Department has found that with present high prices of steel reinforced-concrete bridges can compete quite successfully with steel bridges, especially where short spans are required. In a recent issue of the *Minnesota Highway Journal* the following analysis of the situation is given:

During the present year two plans are being furnished for nearly all bridges under 30 ft. in length. In each case one plan is for the beam span on reinforced-concrete substructure, while the other plan is for the reinforced-concrete bridge throughout, the substructure in both plans being practically alike.

The results of the bids so far indicate that 60% of these bridges will be built according to beam-span plans, while 40% will be reinforced concrete throughout. In comparison with last year the reinforced-concrete bridges have made a big gain over the beam span.

In one case early in the year, when the office was not crowded with work, three different plans were prepared for a bridge 250 ft. long. The location of the bridge was such that any one of the three schemes submitted could be built for about the same cost. It was thought that by having three different plans on file more bidders would be attracted. The plans prepared were as follows: (1) A series of six reinforced-concrete jack-girder spans on reinforced-concrete piers. (2) Two 75-ft. truss spans and two beam spans on reinforced-concrete piers. (3) Eight beam spans on reinforced-concrete piers.

On the three schemes ten contractors submitted 19 bids, and the lowest responsible bid was on scheme 1, which was accepted. It was quite surprising to learn that the accepted bid was below the estimated cost, and that the reinforced-concrete design won out over the two steel designs, one of which it was generally conceded would be the winner.

⁂

New Standard Irrigation Weir

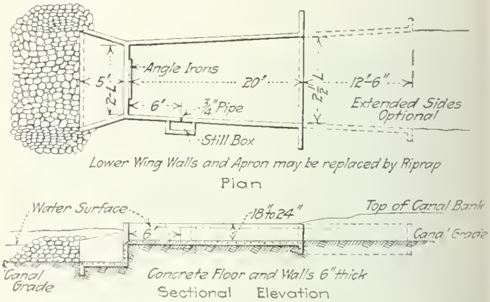
Experiments have been conducted by the United States Department of Agriculture in the Fort Collins hydraulic laboratory (run in coöperation with the Colorado Agricultural Experiment Station) to develop a standard weir that would be self-cleaning, require a minimum amount of labor and material for construction, measure discharges with an accuracy commensurate with irrigation-service needs, and be easily operated by an ordinary person.

Such a weir has been designed and is shown in the accompanying sketch. The following specifications covering it are reprinted from the *Journal of Agricultural Research*, Mar. 13, 1916 (an article by V. M. Cone, Irrigation Engineer, Office of Public Roads and Rural Engineering).

The weir notch is rectangular in form, with sharp crest and sides. The floor of the weir box must be level with the crest, and it is therefore convenient to use an angle iron for the crest, embedding one face of the angle until flush with the surface of the floor, the other face of the angle extending downward. The sides of the weir notch may also be made of angle iron placed in a vertical position, with one end extending below the crest and one face of the angle against the angle-iron crest. The angle can then be attached to the weir bulkhead through holes placed in the other face. This arrangement is durable and inexpensive and will meet the requirement of sharp crest and full lateral expansion for the escaping stream of water. The grade of the canal downstream from the weir must be low enough to give free fall and complete aëration to the nappe.

The floor of the weir box must be level throughout, and there must be no sudden or decided differences in elevation between the floor and the grade of the channel of approach. The weir box must be placed in the center of the ditch, so the axial line of the box corresponds with the axial line of the canal, in order that the water may enter the weir box in straight lines. The width of the weir box must be twice the length of the weir crest (2 L) at the plane of the weir, and two and a half times the length of the weir crest (2½ L) at a distance of 20 ft. upstream from the plane of the weir. The standard tests were made with a weir box 32.5 ft. long, except for the 4-ft. weir, and the sides were extended at the angle indicated. However, for the 1-ft. weir at least, the discharge through a box 32.5 ft. long with sides set to the standard dimensions is within 1% of the discharge obtained by placing 90° wings at the end of a similar box 20 ft. long. The use of 45° wings will cause an error of about 2½%. Therefore the weir box for the new irrigation weir should be made with sides spaced 2 L at the plane of the weir and 2½ L at 20 ft. upstream from the weir, with the sides continuing at this angle until they meet the banks of the ditch or canal; or the box should be only 20 ft. long with wings to connect the sides of the box with the canal banks, and these wings should form an angle of 90° with the axis of the weir box. The 90° wings give a discharge about 1% greater than with the extended sides for a head of 0.2 ft. and about 1% less for a head of 1 ft.

Extending the sides of the weir box until they are the full size of the canal will give more accurate results, but this accuracy may not be required, and the saving in cost of construction due to the shorter length of the weir box with wings may be more desirable than the 1% of accuracy in measuring the water. Unless the canal bottom is easily eroded or scoured, it would not be necessary to extend the floor of the weir box beyond 20 ft., even if the sides of the box are extended.



NEW STANDARD IRRIGATION WEIR

The comparatively high velocity of the water flowing through the weir box causes a wave action and generally disturbed condition of the water surface, which makes it quite impossible to determine the head h in the open weir box. Any stilling device placed in the weir would interfere with the action of the weir, and it is therefore necessary that a still box be placed outside the weir box and connected through the side of the weir box with one or more 1-in. pipes located 6 ft. from the plane of the weir. The pipe should be placed near the floor of the weir box to insure its being submerged for low heads, and care must be used to place the pipe normal to the side of the weir box, and not normal to the axis of the box. If the pipe is pointed downstream the velocity of the water in the weir box will cause a suction action which will make the water surface in the still box lower than that in the weir box. If the pipe is pointed upstream, there will be a velocity head added to the actual water level in the weir box, and the water in the still box will be higher than that in the weir box. Although no sand or silt will accumulate in the weir box, regardless of the amount carried by the stream, silt may be deposited in the still box and clog the connection pipe unless it is cleaned regularly. By making a deep still box, space will be provided for such silt accumulation and therefore less frequent cleaning will be required. The still box should have inside dimensions of at least 1x1½ or 2 ft., with such depth as is necessary. The head in the still box may be determined by means of a scale, a hook gage, or an automatic registering gage.

The new irrigation weir may be constructed of lumber, but the design is such that it may be easily constructed of concrete. There would be no difficult form work required for the concrete, and it would make an inexpensive, durable and satisfactory measuring device, especially if the angle-iron sides and crest of notch were used in connection with the concrete box.

The formula for discharge past this weir is:

$$Q = (3.83 - 0.07L)\ Lh$$

Discharge tables for weirs of 1 to 4 ft. length and for heads of 0.2 to 1.25 ft., by ⅛ in. steps, have been computed and published (in a bulletin reprint of the article already noted). In addition to the requisites already mentioned as kept in mind during the development of this weir, the following advantages are reported:

No lowering of canal grade or building-up of banks is required in construction. The device is not patented. It cannot easily be tampered with or injured so as to alter its discharge.

⁂

Stump Pullers Operated by Hand and Horse Power

The hand-power stump puller shown in Fig. 1 is of the clutch type, and is manufactured by the A. J. Kirstin Co., of Escanaba, Mich. The pulling cable passes through a pair of clutch boxes operated by the movement of a long lever. As the lever is swung to and fro the clutches are gripped, moved and released alternately, so that the cable is held firmly by one clutch while the other is released and moved back for another grip and pull. The operation of the pulling setup shown is as follows:

The puller *A* has one end attached to the cable *B* by means of a trip hook *C*. The cable is passed around an anchor stump, then to the block *D* and returns to pass through the clutches on the puller. A second cable *E*, has a ring socket at one end which is hooked to the block *D;* it passes through a second block *F* and is then led to the anchor stump, to which it is secured by looping under a hook *G* on the end of the cable. A third cable *H* with a hook at one end and ring socket at the other is looped around the stump which is to be removed and secured by its hook, in the same way as at *G*. Its free end is passed around a take-up or cable-shortening device *J*, which is hooked to the second block *F*, and provides for taking up all slack between the block and the stump.

For heavier pulls, a third cable and block, similar to *EF*, may be used, with the take-up hooked to this block, as shown in the top diagram of Fig. 2. For comparatively light pulls, only the first block and the two cables *B* and *H* are used, the latter being connected to the block *D* either directly or through the take-up.

Other hand-operated stump pullers are of the drum type. One of these is the "K" device manufactured by Walter J. Fitzpatrick, 182 Fifth St., San Francisco, Calif. In this the cable is wound upon a small drum mounted in a frame and driven by pawl and ratchet gear by means of a long lever handle. From the drum the cable is led through a block and then returns, passing around the anchor stump and having its end attached to the frame carrying the drum. This arrangement is shown in the second diagram in Fig. 2.

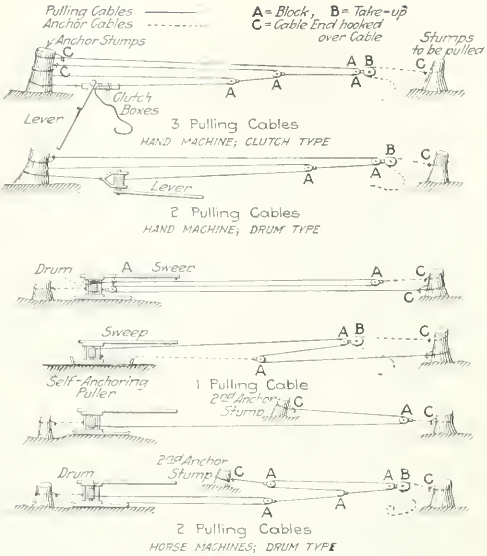


FIG. 2. ARRANGEMENT OF OUTFITS AND RIGGING FOR PULLING STUMPS

Horse-operated stump pullers are drum machines, having the drum mounted upon skids or a truck and driven by means of one or two sweeps to which horses or teams are hitched. The frame carrying the drum may be hitched to an anchor stump, or secured by embedding its sills in the ground and driving heavy stakes at the ends. Fig. 3 shows an outfit by the Faultless Stump Puller Co., of Cresco, Iowa. Similar machines are made by numerous makers, each having its own special features.

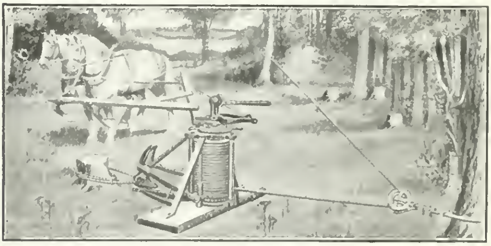


FIG. 3. LETTING HORSES DO THE WORK

The arrangement of the cable rigging is adapted to the power required, and some typical arrangements are shown in Fig. 2. Power is multiplied by attaching additional lines and blocks as indicated. When not required for this purpose, these extra parts may be used as snatchblocks to guide the main cable clear of obstructions

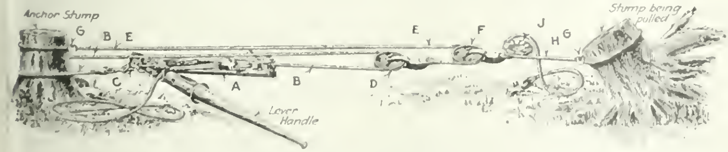


FIG. 1. HAND STUMP PULLER OPERATED BY CLUTCHES

or to keep it down near the ground so that the horses can step over it.

Various special devices are used in stump-pulling work. When stumps are small or too short and rotten to hold the cable loop or snare, a steel stump hook or root plow is used. This is of V-shape, with one leg horizontal and hitched to the cable; the other leg is inclined and ends either in a heavy point or in a broad-forked end to engage the stump or root. Handles on the back enable a man to guide the plow into position as it engages the stump. There are also root hooks (like ice tongs) for pulling short and rotten stumps.

For clearing brush, there is a device having three or four short ropes or chains attached to an iron head which is hooked to the pulling cable. These ropes are looped around the stumps or trunks, and enable a large amount of the brush to be removed at each pull. Where the stumps are to be piled for burning, a "skidder" or light portable derrick on skids is used.

NOTES

Traffic Signal Lamp Posts have been made to answer the purpose of traffic policemen in St. Louis and some other cities. In St. Louis traffic lights have been placed in the middle of several of the busiest streets and boulevards for the purpose of separating the two streams of traffic, indicating a street-car crossing and providing an "island of safety" for pedestrians. The light shown in the accompanying view at 12th and Locust St. is typical of the style of light generally used. At this particular intersection there are two lights, but the one shown is placed just a short distance south of Locust St. about one-third width of the roadway from the east curb. This is for the purpose of separating northbound vehicular traffic into two parts, that going to turn west on Locust St. passing to the west of the light, and that going to continue north on 12th St. or turning east on Locust St. passing to the east of the light. An explanatory sign indicating this is mounted on the lamp post. Just north of Locust St. and about one-third width of roadway from west curb is located the other light to separate the southbound traffic in a similar manner. Generally the traffic red lights do not require any signs.—William Holden, Engineer, Department of Streets and Sewers, St. Louis, Mo.

TYPICAL TRAFFIC SIGNAL LAMP POST, ST. LOUIS, MO.

Cleaning Up a Wide Ditch with a trenching machine is shown in the accompanying view of a Minneapolis waterworks pipe-laying gang. The trenching machine cuts the initial trench, which is widened by five men with long bars, working alongside the machine. Three men with shovels in the bottom of the trench shovel the loose material into the buckets and leave the trench leveled to grade for pipe laying. The trenching machine is owned by the municipal waterworks department. The work shown is in 20th Ave., Minneapolis, in connection with the installation of a new 46-in. lock-joint steel main.

TRENCHING MACHINE RAISING LOOSE MATERIAL

Blasting in Clay—Blasting down the face of clay pits which have been worked by pick and shovel is reported by L. C. Longstreet, a North Carolina operator. A line of holes 3 ft. deep was put down 6 ft. back from the face and each loaded with 1½ sticks of 40% dynamite. In some brickyard pits a large amount is blasted out in the fall and allowed to freeze and thaw through the winter.

Steel Steps for Manholes and Catchbasins at Pueblo, Colo., have been reduced in cost from 35 to 20c. by changing the stock and the method of manufacture. Formerly the steps were forged from ½-in. rods. They are now made from ⅜x1-in. flat bars, cut, bent and twisted cold. The steps measure 9 in. wide by 4 in. broad, and the ends for insertion in the brick are 9 in. long, not including a turned-up portion 1 in. high. D. P. Gaymon is city engineer of Pueblo.

To Sterilize Camp or Household Water—Following is a satisfactory method of sterilizing small quantities of water for use in camps and summer cottages, that is recommended by public-health authorities. Take a level teaspoonful of chloride of lime and rub it up in a teacup with a little water to a thin paste free from lumps. This should then be made up to a cupful and diluted with three more cupfuls of water and poured into a bottle and tightly corked. This is a stock solution and will keep for a week if tightly corked. A teaspoonful of this stock solution should be added to each 2-gal. pail of drinking water, thoroughly mixed, and allowed to stand for a few minutes. This will give about one-half part of free chlorine to a million parts of water, which will destroy all typhoid and dysentery-producing germs in 10 min.

Editorials

New York Leads United States in City Zoning Progress

In breadth of scope, recognition of fundamental principles, and attention to detail, the zoning or districting egulations governing the height and use of buildings and he percentage of lot area built upon, adopted on July '5 by New York, places that city far in the lead of the ities of the United States, if not of the world. Boston nd some other American cities, including New York tself, have limited the height of buildings over either a mall part of their area or as regards some classes of uildings; various American cities, again including New York, have prohibited covering more than stipulated per-entages of lots with certain classes of buildings; Los ngeles divided its area into residence and industrial dis-ricts in 1909 and has been followed in this by a number f other American cities; in Germany and some other uropean countries all these matters have been regulated or decades and some of them for a century or more; ut of American cities, New York has now placed itself ar in the lead in all the particulars named.

The adoption of these restrictions by a 15 to 1 vote of e Board of Estimate and Apportionment on July 25 as the culmination of two years' work by a Commission Building Districts and Restrictions, authorized by a gislative amendment to the city charter in 1914, pre-ded by a year of study by a Heights of Building Com-ittee, aided by the experts of the City Plan Committee f the Board of Estimate. Before the restrictions were ut in final form a preliminary report was published nd public hearings by geographical districts were held. ractically no opposition to the general principles were iced and comparatively few to the details of the plan.

Broadly, the scheme establishes *Use*, *Height* and *Area* stricts. *Use* districts are divided into Residence, Busi-ess, Unrestricted and Undetermined (see *Engineering ews*, April 13, 1916, p. 700). *Height* districts are of ve classes, with building heights limited to 1, 1¼, 1½, 2 nd 2½ times the width of the streets, measured at the uilding line, but with possible greater heights back of at line by the use of setbacks or by mansards. *Area* stricts are of four classes, permitting built-over areas the first story ranging from 100% in business to 50% parts of residence districts having detached or semi tached houses.

Obviously, the area and height limitations are in the terest of light, air, and health. The use limitations rve the same purposes in varying degree. All the re- tions will play a vital part in the harmonious deve ment of the city plan and will contribute to the sta lity of real estate values, including the prevention of ighted districts where property values fall because of regulated development. (See editorial note, "Mer-ants Turn City Planners," *Engineering News*, March 6, 1916, p. 523.)

Judiciously administered, this districting plan substi tes public control of city growth under a systematic plan designed to promote the interests of the whole city for haphazard, piecemeal private control aimed solely to benefit individual property owners, often to the ultimate damage of other owners of private property.

The change is bound to be salutary. Under the leadership of New York and with stimulating examples in other parts of the United States, as well as in Canada, the zoning movement and more intelligent city planning generally is bound to make great progress in America within the next decade.

* * *

Dr. Travis and the Septic Tank

The intermediate step between the one-story septic tank as Cameron left it and the two-story septic tank of Imhoff is little known and soon forgotten in this country. The interesting recent example of a hydrolytic or Travis two-story septic tank at Luton, England, described by Borough Surveyor Tomlinson in the first pages of this issue, affords a fitting opportunity to call attention to the notable part played by Dr. W. Owen Travis in the evolution of the septic tank.

The main and probably the most useful conception of Travis, or rather his working out of the principle first tested under H. W. Clark at the Lawrence Experiment Station of the Massachusetts State Board of Health, was to separate the settling and the digesting or liquefying functions of the septic tank. Dr. Travis carried on sedimentation in an upper and digestion in a lower compartment, to prevent gas rising and carrying sludge up into the settling sewage. His lower compartment, however, extended upward in a central longitudinal space between the two settling chambers, and, at the original working installation at Hampton, 12½% of the total tank influent was carried through the settling compartment, which had cross walls provided with ports to lessen the carrying forward of gas-buoyed sludge.

The second and apparently more original if less valuable feature of the Travis tank was embodied in his colloidors, or multiple surfaces for depositing sludge and adherent matter in addition to the deposits on the sides and sloping bottoms of his settling compartments. The hint for this also came from Lawrence.

When Dr. Imhoff took the Travis tank in hand for the Emscher District in Germany he adopted the two-story idea, but made an absolute separation of the settling and digesting function by carrying his influent through the upper compartment only. Dr. Imhoff did not adopt the colloidors. He made various other changes in design and operation. His tanks in the Emscher District impressed Rudolph Hering and other American engineers as superior to those of Dr. Travis. Thus it was that the Imhoff rather than the Travis tank was brought to America and its use has since spread through the country, much as did the Cameron tank some years earlier.

Notwithstanding the vogue of the Imhoff tank in Germany, the United States, Canada, and elsewhere, it ap pears to have got no footing in England for some years and very little at all. Nor has the Travis tank been as widely used in England as would naturally be expected—at least the one built some years ago at Norwich and the initial working-scale tank at Hampton-on-Thames have been the only examples commonly mentioned here.

In view of the foregoing facts and opinions it seems probable that Mr. Tomlinson's article on the Luton hydrolytic tank will be welcomed by sewage engineers generally, both in and of itself and because it brings to the front the name of a man who does not always get credit alongside of Cameron and Imhoff for playing an important part in the evolution of the septic tank.

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Wanted: A State Road Policy

The State of New Jersey has been building good roads through state aid longer than any other state in the Union. The state and its counties, cities and towns have all been spending money liberally for a quarter of a century past on good road construction and maintenance. Yet the condition of New Jersey roads is now so bad that the recent legislature voted to borrow $7,000,000 on state bonds for road reconstruction, provided this bond issue receives approval by popular vote at the November election. In addition to this, the legislature created a commission with broad powers to investigate the entire road question and formulate if possible a better policy for the state to follow in highway construction and maintenance.

This commission has begun its work by sending out a circular letter of inquiry, which was reprinted on page 187 of *Engineering News* of July 27. It outlines in brief terms the difficult features of the road problem that faces not only New Jersey, but many other states.

In all the good-roads literature that has been poured out in such profusion for more than a score of years the chief appeal has been for more money to build good roads. Volumes of figures have been published to prove that the community which spends money liberally to build good roads has done all that is necessary to place it on the highway to wealth. New Jersey and its communities have done all this. The state expended last year for road construction and maintenance $1,263,000.

This money has not been expended ignorantly. New Jersey roadwork has had as good engineering talent engaged on it, probably, as any state in the Union. A most fortunate feature of New Jersey's past road policy is that the state's expenditure on roads has been money raised by direct taxation and not money borrowed on bond issues. While New Jersey counties and towns have a considerable amount of road bonds outstanding, the state as a whole is not in the difficult position of some of its sister states which have borrowed money on long-term bond issues to spend on roads that are already worn out.

On the other hand New Jersey is unfortunate in this respect: Because of her early activity in road construction she has expended many millions of dollars in the construction of water-bound macadam roads, a type of construction admirably suited to the horse-drawn traffic which existed at the time the roads were built, but wholly unsuited to the motor traffic of the present day. The various makeshifts that have been tried during the past decade to enable a water-bound macadam road to stand motor traffic have involved large expense and have generally proved unsatisfactory in service. Fortunately, the last few years have seen the development of types of road surface which can withstand the stress of motor traffic and whose first cost and cost of maintenance are not prohibitive.

The first item in a road policy for New Jersey, therefore, should be the adoption of permanent types of roads in place of the types formerly used. In order to do this, however, and in order to insure the efficient and economical conduct of road construction and repair, New Jersey needs to reform its system for the conduct of its highway work. This reform need not be a very radical one, for New Jersey has had for years a state highway department. What is needed is to increase the authority and responsibility of this highway department so that it may have power to supervise the roadwork carried on by counties and by towns, as well as the work carried on by the state. In order to do this the department will need to be organized on a permanent basis, with a legal tenure of office for the engineers employed in the department and with rigid exclusion of politics from its organization. This reform may sound like a simple thing to effect, but it is far from simple in the majority of states, and it remains to be seen whether it will prove simple in New Jersey.

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A Revolutionary Improvement in Concrete Road Building

For a number of years engineers interested in road construction made pilgrimages from all parts of the country to Wayne County, Michigan, to see the famous concrete roads there and to learn how it was possible to use ordinary concrete as a paving material for country roads. An article printed in the last issue of *Engineering News*, describing the remarkable results attained in building concrete roads and streets at Sioux City, Iowa, wil doubtless be the means of setting in motion a steady stream of engineers from all parts of the country to visit Sioux City and see for themselves how these results are obtained.

It is no exaggeration to say that the concrete roads and streets of Sioux City represent an important advance over anything heretofore attained in concrete-road construction within our knowledge. The main reason for this improvement in the character of the concrete is found without doubt in the method adopted for finishing the roads. This method was described by the City Engineer of Sioux City, T. H. Johnson, in *Engineering News* a year ago and was more fully explained in last week's issue. Briefly stated, it consists in applying to the finishing of a concrete road the method long in use for giving a hard, wear-resisting surface to concrete sidewalks. A dry mix of cement and sand is applied to the surface of the concrete after it is spread on the subgrade and smoothed off. The quantity of this dry mix is small, just sufficient to absorb the surplus water; and this mixture is thoroughly incorporated with the upper layers of the concrete by rubbing with heavy floats.

Concrete experts all agree that to make the strongest concrete it should be mixed with the smallest amount of water to permit thorough mixing and that surplus water left at the surface of the concrete when it hardens forms laitance and leaves a weak, friable skin on the surface vhen the concrete sets. Under the present standard nethod of finishing concrete roads, however, in use everyvhere, save at Sioux City, it is impossible to have the oncrete as dry as it should be when the final set takes lace. Enough water must be put in the mixture to ermit the materials to be thoroughly incorporated; and vhen this mixed concrete is placed on the road, formed nto shape by the strike board and floated, more or less urplus water invariably comes to the surface. The concrete is so soft that in order to finish it the workmen ngaged in finishing have to lie flat on a portable bridge noved along over the surface of the road. The most they in do is to give the surface a light smoothing.

In contrast with this is the method used by Mr. John-on at Sioux City, where by applying the dry mix of ment and sand to the surface just as soon as the road is rought to shape, the surplus water is drawn out by apillary attraction and the concrete is at once so stiffened hat the workmen engaged in floating can walk upon it d make hardly an impression. The concrete then ceives a thorough compacting and kneading from the avy wooden floats, such as it is not at all possible to give a road finished from bridges in the usual manner.

It is not at all strange that the surface of a concrete ad finished in this manner should be far harder and ore durable than that of a road finished in the ordinary ay. Further than this, the remarkable freedom from acks of the Sioux City roads indicates that the beneficial tion of the heavy float is felt through the whole thickss of the concrete layer.

It is worth while remarking in this connection that the ality of the sand used in the concrete and in the finishg may very likely be another factor in the remarkable sistance to wear of the Sioux City roads. The need of ater attention to the sand for concrete ought to be tty well known by now to engineers everywhere; but it ms important to emphasize that for concrete-road conuction and especially for the wear-resisting surface of oncrete road it is essential that a *silica* sand be speci l. In certain sections of the country the sand in gen l use for mortar and concrete is composed chiefly of ticles of limestone instead of silica. Concrete made h such sand cannot be expected to show a great resist e to abrasion and is sure to be much more slippery n concrete made with a sharp silica sand.

Of course we do not attempt to say that the methods i use at Sioux City are above criticism or incapable further improvement. Many engineers for example l probably think that the use of the strike board to e the pavement its cross-section is a better plan than ving wholly on the skill of the workman. Many will tion also whether so much expense in floating the shed pavement is warranted. That the Sioux City tem of construction, as a whole, however, has proved lf thoroughly satisfactory, is proved by the fact that r successive incumbents of the City Engineer's office e continued its use.

inally, it is well worth pointing out that the high lity of concrete in the Sioux City pavements is being ained at a trifling expense. In fact, the contract price square yard prevailing there is little, if any, higher n that in many other cities where concrete roads are g built. There are many cases where improved hods and materials are advocated for engineering k, and the engineer-in-charge may legitimately reject them on the ground that the increased expense involved is not warranted by the improvement in results. To build concrete roads by the Sioux City plan, however, costs so little more than it does to build them in the ordinary way and the results obtained are so vastly better that no reason appears why the Sioux City method should not shortly become standard practice.

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Street Cleaning in New York

According to the recent report of Richard T. Fox on an examination of the New York Department of Street Cleaning, the status of the street sweeper has much improved in the last few years. The laborer who wields a broom in New York City today receives an annual salary of $840, has two weeks' annual vacation, sick leave and a life pension if he reaches a fixed age limit after 20 years' service. There are not a few college graduates who can do no better.

Mr. Fox truly says that such favorable working conditions "have no parallel in the history of the business world for laborers of this class." Yet instead of the body of alert, active, interested workers one would expect to find, the investigator was surprised to find a large number of old men, and aside from these many more who were physically below the standard such excellent rewards should command. A general inefficiency and want of discipline were evident, with a corresponding lack of thoroughness of the work.

For street-cleaning service the three more important boroughs of New York City—Manhattan, Brooklyn and The Bronx—pay the sum of $8,000,000 yearly, exclusive of snow removal. The number of permanent employees is approximately 7,000. Snow removal costs add from $2,000,000 to $3,000,000 more a year. The administration of this work obviously requires an expert, and consequently Mr. Fox's first recommendation is that the offices of Commissioner and Deputy Commissioner be freed from politics.

Other recommendations for the administration of the department are that the Commissioner be given greater latitude in making expenditures and that there be greater coöperation between this and the various other city departments, particularly on the part of the courts and police department in enforcing the ordinances against littering the streets with paper and other refuse. The equipment of the department and the cost-keeping system are held to be inadequate and not up to date.

The foregoing recommendations apply to the department as a whole, but some of those which apply only to the installation of a model district are of almost equal interest. Among these are that hand sweeping only be employed, supplemented by flushing or washing with water under pressure; that the sweepers wear leggings; that they polish their shoes daily; that sweeping the sidewalk be included in their work and that permanent stations or boxes be provided at convenient intervals for storing the sweepings between collections.

With polished shoes, leggings and a brown khaki uniform the street sweeper's dignity ought to be raised at least to that of the average citizen; and with the strong arm of the law to protect him from the unnecessary labor entailed by careless people who throw refuse in the street, the work ought to be attractive; the commissioner should be given sufficient latitude to make it efficient.

Letters to the Editor

Supporting the Mississippi Levee System

Sir—The editorial in your issue of June 29, "The Mississippi Levee System Sustained by the Courts," shows a clear conception of the problem and a correct understanding of public sentiment in this section. The suit that you refer to was never taken very seriously by the levee district officials. It was brought by owners of lands along the narrow margin between the levees and the river banks. These lands have always been overflowed at high water (except small areas where hillside slopes approach the river), and were purchased by their present owners with a full knowledge of this fact. It is true that confinement of the flood water between levees causes deeper inundation of these lands than formerly; but they are worth more now than they were before levees were built. This increased value results from their proximity to the highly developed country immediately behind the levees, which only recently was largely a wilderness; and from the fact that when these places are submerged, their owners can now drive their livestock over the levee to safety, where formerly they built mounds or rafts for them, or boated them to another state.

You rightly say, "This minority finds representation in certain Southern newspapers." It would be well for this statement to be weighed in connection with several newspaper quotations appended to one of the Congressional speeches referred to below.

Recently the writer received a circular letter from Congressman James A. Frear, inclosing various extracts from the *Congressional Record*, and the Chicago *Tribune* article from which you quote, all in opposition to the Humphreys flood control bill. The same letter and inclosures will doubtless reach many other engineers and it is gratifying that your timely editorial will give them another view of the matter. It is evident that the two Congressmen and the Chicago *Tribune* have a misconception of the whole situation on the lower Mississippi River.

For the benefit of engineers who have not been in touch with the organization and work of the Mississippi River Commission, it should be stated that appointments to membership in that body are made by the President of the United States, and membership continues until death, resignation or removal for cause. No membership has yet been terminated except by the first two methods. In the personnel of this Commission are several United States Army engineers, several civil engineers and one lawyer. In the entire personnel of this Commission since its organization few of its members have been residents or property owners on the lower Mississippi.

The Mississippi River Commission has made surveys, soundings, discharge observations and studies for more than thirty years, and has pronounced that the only practicable way to control the floods on the lower Mississippi is to revet the caving banks and complete the levee system. For thirty years its members have been as competent and have had as good opportunities as any one possibly could have to study and compare various plans of flood protection and control, and it has been one of their duties to decide upon the best plan for the Mississippi River.

The completion of the levee system is not a land reclamation scheme. The reclamation of the lands on the lower Mississippi has already been effected. These lands are now protected, and have been for years, by almost continuous levee lines from Cairo to the Gulf, and behind these levees are large sections of highly developed country, with frequent towns and busy railroads. The existing levees were paid for in large part by the landowners. The United States Government has, for about thirty years, made some contribution toward this work; but it is believed by the writer that, up to this time, the total contributions by the Government do not much exceed the total cost of replacing levees that have caved into the river because the banks have not been revetted to prevent the channel from shifting. The lands protected by these levees are so far from being unreclaimed, that fully 90% of the area behind the levees was free from water during the flood of 1916, which made record stages on a large part of the river. Only a small percentage of these lands is owned by syndicates.

Occasionally the writer has thought proper to enter discussions of the levee question in civic clubs, in the hope of preventing the adoption of resolutions proposed by the "vociferous minority." It is remarkable that a man in almost any other walk of life can expect a hearing on an engineering subject and be accredited with disinterestedness; but that an engineer's arguments meet with the response, "of course you favor levees, because you are an engineer." The idea is prevalent in this section that in some way all engineers will profit directly if Congress makes large levee appropriations.

With an apology for mentioning personal affairs, but realizing that upon every engineer favoring Government appropriations for levees rests the burden of proof that he is disinterested, the writer will state here that he owns no property that would be benefited by levee construction, from Government appropriations, that he is not employed on levee work and never expects to be employed on that work again; that he has not been for fourteen years; and that if he were or expected to become a levee district engineer, he would be working against his own interest to favor levee building by the Government, because their expenditures are supervised by their own engineers. (Twenty years ago the writer left the Government service, having then about reached the limit of salaries for civil engineer assistants.) For the Government to finish the levee system will put a number of levee district engineers "out of a job."

The writer is convinced that no expenditure of like amount which this nation could make, except for military and industrial preparedness, will give larger returns in an increase of the nation's wealth and prosperity, than at necessary to make this valuable section of country solutely secure against Mississippi flood water. That vees and revetment will accomplish this has been consively demonstrated. A. L. DABNEY.

Porter Building, Memphis, Tenn., July 3, 1916.

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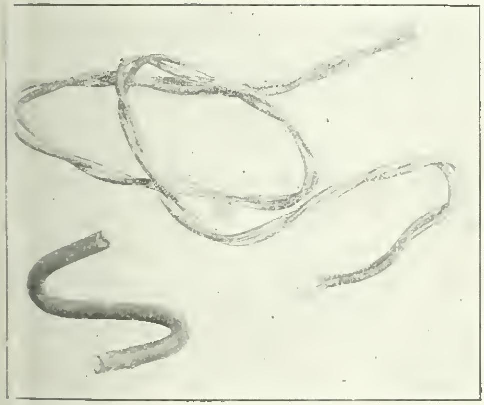
Gypsum and Its Effect on Embedded Steel

Sir—There seems to be a somewhat popular supposition at gypsum in contact with metal will cause progressive rrosion of the latter. Certain facts available show the ntrary to be the case, and in justice to the material I ink they should be put on record.

The most recently revised building codes, as well as the 15 edition of the National Board of Fire Underwriters ommended standard building regulations, include the e of gypsum for the fire-protection of steel supporting mbers. The advisability of admitting gypsum for this rpose was the outcome of investigations conducted durg 1911 by the "Joint Committee on City Departments" New York under the direction of Chairman Ira H. olson, Consulting Engineer for the National Board of re Underwriters.

A subcommittee conducting a special investigation of question of possible evil effect on the embedded metal sed the uncovering of the reinforcing steel used in the struction of the Metropolitan floor (gypsum floor) ich formed the roof garden of Hammerstein's Victoria eater in New York City. The part of the construcn cut into was under the stage and near a tank of ter which was used for diving and other purposes. This tion it was thought would disclose the worst possible itions, as corrosion of the embedded steel (if any) ld be aggravated by any possible and continued sture.



STEEL WIRE AND HOOKS NOT CORRODED AFTER EMBEDMENT IN GYPSUM FOR 15 YR.

S. G. Webb, Secretary of the Gypsum Industries Assotion was present during this investigation and states t the reinforcing consisted of S-hooks secured to the am flanges, to which were attached the twisted wires ing the reinforcement. The S-hooks were not galized or covered in any manner with a protective coatof any kind, though the twisted wires were galvanized. The steel-supporting I-beams, the S-hooks and the twisted wires were buried in the gypsum construction for a period of about 15 years and when taken out were all in excellent condition. The S-hook and twisted wires, shown in the accompanying view, were taken from the construction referred to.

During August, 1912, a fire test was made upon a Metropolitan floor (gypsum) at the testing station of Columbia University, for the City of Toronto, Can. This construction (a 4-in. thick poured reinforced-gypsum slab) successfully passed the 4-hr. load and fire test required by the New York Building Department. After this test the entire construction was torn out, and the wreckage thrown into a scrap yard where it remained exposed to the elements of the weather through the following winter, spring and summer.

An examination of this scrap made by Mr. Woolson, Prof. James McGregor, of Columbia University, H. B. McMaster, S. G. Webb and representatives from the New York Building Department, disclosed the fact that any metal which remained embedded in the gypsum mixture was not corroded, but all metal which had been exposed to the weather during the months of exposure of course showed signs of active and progressive corrosion.

The United States Bureau of Standards is conducting a test to determine the relative protective value of various coatings upon metal lath. This test was commenced upon full-size panels in 1911. A progress report by J. C. Pearson, of the Bureau, gives the following facts:

Assuming the numeral 10 as indicating perfect condition—no rust—the following was found with reference to the gypsum plasters:

Lath Galvanized Before Expansion—9.6 for gypsum plaster, 9.8 average of all plasters.

Painted "Special" Iron Lath—9.0 for gypsum plaster, 9.3 average of all plasters.

Painted Steel Lath—9.0 for gypsum plaster, 9.1 average of all plasters.

Sherardized Lath—7.5 for gypsum plaster, 8.3 average of all plasters.

Unpainted "Special" Iron Lath—7.25 for gypsum plaster, 7.0 average of all plasters.

Plain Steel Lath—7.5 for gypsum plaster, 7.6 average of all plasters.

Commenting on the showing of gypsum plasters, Mr. Pearson states:

> Examination of the table will show that the condition of the lath under the three representative brands of gypsum plasters is almost exactly a general average condition of all the interior panels; that is, the corrosive action of the straight gypsum plaster appears to be less vigorous than was anticipated.

These facts and experiences prove two things: (1) That gypsum is a fixed salt, and neutral in action; in other words, the SO_3 is completely combined with CaO in the anhydrous form of gypsum of $CaSO_4$. Dr. W. F. Hillebrand, United States Bureau of Standards, says: "It is incorrect to speak of a sulphuric acid content of gypsum. The properties of sulphuric acid are lost when the acid is fully neutralized as in gypsum." (2) That when gypsum is used upon metal lath, or is in contact with structural metal for the purpose of fire protection, and when air and moisture are prevented from coming in contact with such metal, no progressive corrosion can occur.

VIRGIL G. MARANI.

205 W. Monroe St., Chicago, Ill., July 13, 1916

Portland Cement Made from Oyster Shells

By H. Struckmann*

The extensive shell deposits found all along the coast of the Gulf of Mexico have for many years been the object of considerable research work by portland cement manufacturers, as the shells properly prepared represent the purest lime constituent possible for cement making. In the past the difficulty has been to find a process by which the shells could be pulverized preparatory to mixing them with the alumina and silica constituents as contained in certain clay deposits, but this problem has at last been solved by treating the shells under the wet process as developed by F. L. Smidth & Co., of New York City.

The new plant which the Texas Portland Cement Co. has completed at Manchester, near Harrisburg, Tex., is the result of the research work conducted in the company's laboratories at Dallas as well as the recheck in the laboratories of F. L. Smidth & Co. The location of the plant was selected at Houston, Tex., in preference to other shipping points along the Gulf coast on account of the railroad facilities available at Houston and particularly on account of the recently completed ship channel which will enable the Texas company to handle export shipments by loading the cement direct from the plant into the bottoms.

The actual construction work of the plant was started in the late fall of 1915 at which time the company's engineering force was moved from the main office at Dallas to Houston, while the plans and contracts were prepared in the office of the writer who is the company's Consulting Engineer.

The plant represents an investment of approximately $750,000 and as can be seen from the general view the various structures occupy considerable space. Described briefly, it consists of the following buildings and structures.

On the ship channel is a wharf of ample capacity to receive the shell barges, bulkheads having been provided along the shore to prevent any sliding or cave-ins of the bank which might gradually fill up the channel. From the wharf a 650-ft. structural-steel crane runway supports an electrically operated monorail crane which serves the double purpose of unloading the shells from the barges and delivering them to the mill, as well as delivering the shells from the barges to a 20,000 cu.yd. storage underneath the runway, this precaution being necessary to insure steady operation in the plant whenever weather conditions interfere with the dredging process in Galveston Bay.

Next adjoining the crane structure is the wet raw-grinding department used in treating the shells and clays which are ground preliminarily in a 0.85 wet Kominuter and finished in a 20 tube-mill, discharging the resulting finely pulverized slurry into two basins which are being agitated constantly. From these basins the chemist gets his first check on the analysis of the raw material before the pumps discharge the finished slurry into a series of storage basins, making it possible to secure a perfect and uniform mix of the raw material before delivering it to the kiln for burning.

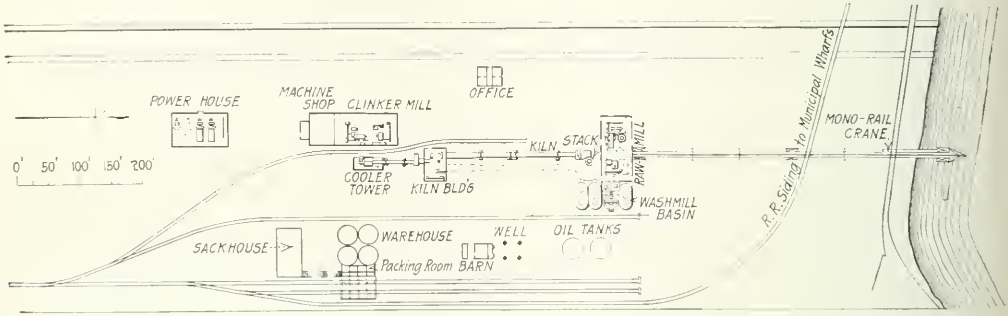


FIG. 1. PLAN OF THE NEW CEMENT MILL OF TEXAS PORTLAND CEMENT CO., NEAR HOUSTON, TEX.

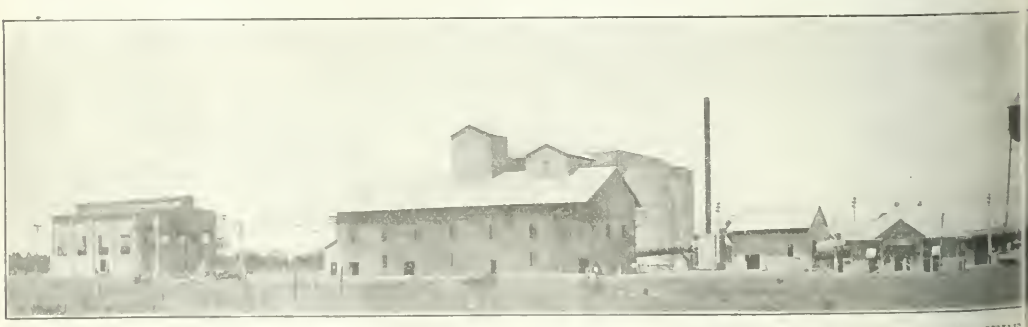


FIG. 2. PANORAMIC VIEW OF THE NEW CEMENT PLANT OF THE TEXAS PORTLAND CEME

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*Consulting Engineer, Kansas City, Mo.

This feature in the wet process as used at the Houston ant is one of the important points which has made practical to produce a high grade and uniform cement it of a material which in the past has had little or value.

After the finished slurry has been analyzed, corrected d checked, it is delivered to the kiln department ready r the burning process which takes place in a 9x8x220-ft. tary kiln operated by variable-speed motors so as to ve the chemist perfect control over the burning. siduum oil is used for fuel.

From the kiln, the clinkers are discharged into a 60-ft. rotary cooler where they are cooled preparatory adding the usual amount of sulphuric anhydride which mixed with the clinker in the form of gypsum.

The last stage in the manufacture of the cement, the nker grinding, is handled with one No. 85 Kominuter d one No. 20 special Danula tube-mill, which repre- nts the latest improvement in tube-mill grinding and ich has shown a very remarkable saving in horsepower compared with past known methods of tube-mill inding.

The product discharged from the clinker mill is ivered to a belt conveyor discharging into the ware- use, which consists of four 30-ft. diameter by 60-ft. gh circular concrete tanks nested together, using the ls and interspace for storage in addition to the main ıks.

The packing department, screen house and trainshed built monolithic with the circular silos, which are vated about 4 ft. above the outside ground level so as permit plenty of air and ventilation in the basement taining the conveying machinery.

The power plant consists of a monolithic concrete ucture large enough to accommodate four 450-kw. sel engine units, direct-connected to General Electric erators. Only two of the engines, which were fur- hed by the Fulton Iron Works, of St. Louis, have n installed for the present capacity, but all arrange- nts have been made to install two additional units.

n general, the plant has been equipped with the most dern and uptodate machinery on the market, and it ery gratifying that the wet process has made it possible treat the material available and produce a high grade tland cement, incidentally eliminating the usual dust sance surrounding a cement plant.

While the plant has now been in successful operation nearly two months, during which time it has turned close to 50,000 bbl. of cement, the company has just recently started shipments under the direct supervision and recheck of the engineers of the Pittsburgh Testing Laboratory, who certify to the quality of every barrel of cement leaving the plant.

In this connection one of the important features of the plant is that by using oil for fuel and shipping kaolin in from the numerous deposits in Texas, it will be possible to produce pure white cement out of the materials used at Houston.

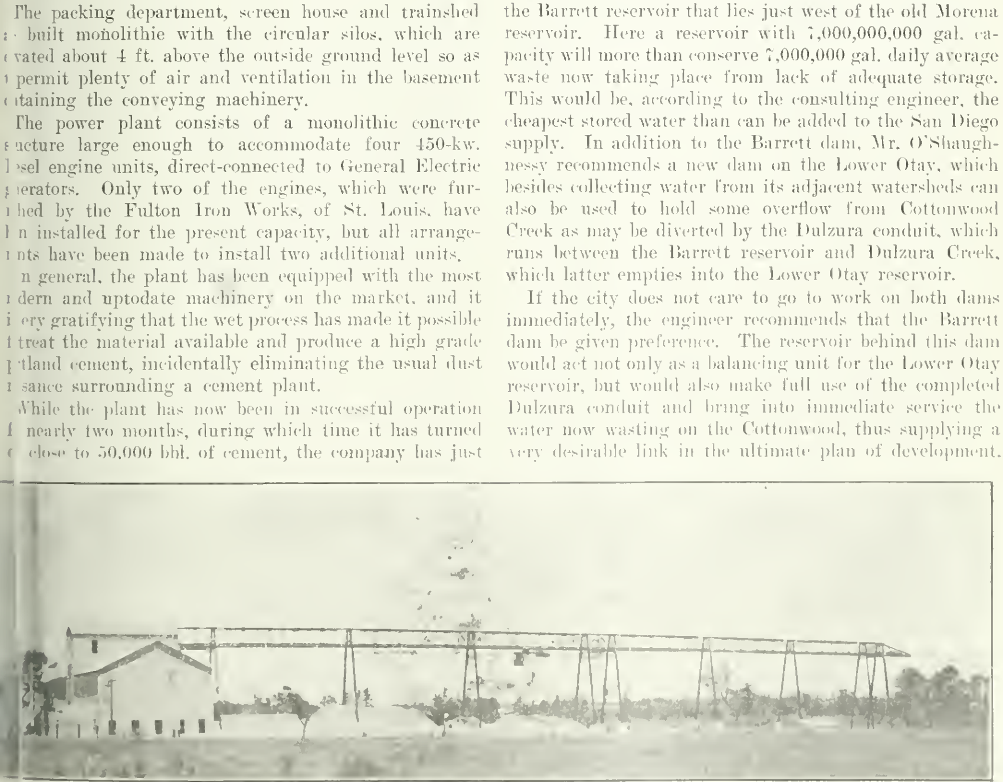
*

Two New Dams Proposed for San Diego Water-Supply

Following the destruction of the rock-fill dam at the Lower Otay reservoir of the San Diego, Calif., water-supply (noted in *Engineering News,* Feb. 3, 1916, p. 236) the city called in for consultation M. M. O'Shaughnessy, City Engineer of San Francisco, to make plans and specifications for dams to create additional reservoirs for the city water-supply. Mr. O'Shaughnessy has just reported to the Mayor and Common Council, recommending the construction of two new dams to provide reservoir capacity for future water-works needs in the city. The city at present owns sites for both dams and some preliminary work toward the utilization of the reservoirs in question has been done.

One of the two new dams proposed is at the mouth of the Barrett reservoir that lies just west of the old Morena reservoir. Here a reservoir with 7,000,000,000 gal. capacity will more than conserve 7,000,000 gal. daily average waste now taking place from lack of adequate storage. This would be, according to the consulting engineer, the cheapest stored water than can be added to the San Diego supply. In addition to the Barrett dam, Mr. O'Shaughnessy recommends a new dam on the Lower Otay, which besides collecting water from its adjacent watersheds can also be used to hold some overflow from Cottonwood Creek as may be diverted by the Dulzura conduit, which runs between the Barrett reservoir and Dulzura Creek, which latter empties into the Lower Otay reservoir.

If the city does not care to go to work on both dams immediately, the engineer recommends that the Barrett dam be given preference. The reservoir behind this dam would act not only as a balancing unit for the Lower Otay reservoir, but would also make full use of the completed Dulzura conduit and bring into immediate service the water now wasting on the Cottonwood, thus supplying a very desirable link in the ultimate plan of development.



HE HOUSTON SHIP CANAL. OYSTER SHELLS BROUGHT IN ON TRESTLE AT RIGHT

With these two dams built, a much more complete utilization of the two watersheds now in the city's ownership will be possible and the available city supply will be increased in average years by approximately 10,000,000 gal. per day.

The data on the two dams may be recorded as shown in the accompanying table. It will be noticed that both dams are to be of the gravity section in arch plan, and are to be built of cyclopean or rubble concrete. Mr. O'Shaughnessy says that the exploration work of the two water-sheds has proved that the foundations are amply able to withstand all pressures from floods which may develop. These pressures should not exceed 10 to 11 tons per square foot for either structure. For both dams there is a central part made lower than the remaining in order to pass flood waters. It is estimated that the probable time for constructing the dams will be from 15 to 18 months if they are carried on simultaneously; if built in sequence from 30 to 36 months.

TABLE GIVING DATA ON BARRETT AND LOWER OTAY PROPOSED DAMS AT SAN DIEGO, CALIF.

	Barrett	Lower Otay
Height of overflow section above stream bed (ft.)	140	137 5
Height of nonoverflow section above stream bed (ft.)	152	145
Available storage at overflow (billion gallons)	6 75*	15†
Length of crest (ft)	640	750
Length of available spillway crest (ft.)	242	212
Width of crest and roadway (ft.)	15	15
Depth of overflow (ft)	12	75
Capacity of spillway (cu.ft. per sec.)	30,000	13,000‡
Volume of dam (cu.yd.)	89,000	86,000
Cost (estimated) (dollars)	690,400	682,200

* Can be increased to 7 billion gals. by flashboards.

† Can be increased to 15.5 billion gals. by flashboards.

‡ Additional spillway provided which will bring capacity up to 26,000 cu.ft. per sec.

It is yet to be determined whether the people will be asked to vote for the construction of both dams at present, whether they will be allowed to choose between the two, or whether one of the two will be submitted to them for ballot. The city attorney has been instructed to outline preliminary steps for a bond issue.

⁂

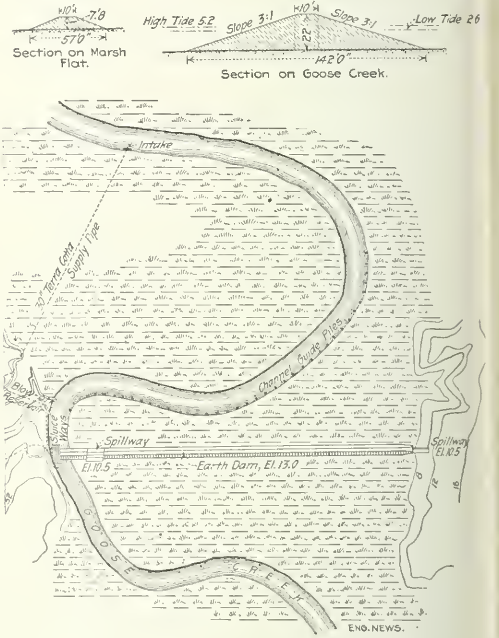
Overtopped Earth Dam Fails

The partial failure by overtopping of the low earth dam of the Charleston (S. C.) Light and Water Co. on July 14 possesses interest beyond that due to the resulting damage. More than 16 in. of rain fell during the 24 hr. ending about the time the dam failed. The embankment rested on a marsh and when constructed 13 years ago required three times the clay fill indicated by the theoretical cross-section—on account of the way the fill sunk into the mud. The dam served the double purpose of impounding fresh water and shutting out salt water due to the tidal flow. Last to be mentioned, but by no means least, the dam was overtopped nearly four years ago; and some two years ago John H. Gregory, consulting engineer, New York City, reported (according to an editorial in a Charleston newspaper) in connection with valuation proceedings that the "dam was not a safe structure either under normal or abnormal conditions." As stated farther on, "legal complications" had a part in the postponement of action to make the dam safe.

Before taking up the failure and the emergency repairs that were rushed through to save the city from salt water or no water at all, some facts regarding the dam may be presented.[1]

The dam was completed in 1903 by the American Pip Manufacturing Co., of Philadelphia, with J. W. Ledou as chief engineer.

The marsh at the dam site consisted of an "alluvia deposit" of a "peaty nature," having an average depth o 9 ft. This was underlain with 10 ft. or more of "fin sand lying on a marly deposit." Goose Creek at the dam site was about 80 ft. wide and had an extreme depth of 20 ft. The total length of the dam was about 2,300 ft Each of the two spillways shown on the plan was 100 ft long, had a normal water depth of 2½ ft. and was buil of timber cribwork, with sheet piling "extending down t solid material." The dam was built of "excellent material principally composed of clay," dumped from cars runnin on a track extending the length of the dam. Drill hole sunk after the dam was completed "showed the clay fill to extend down to a depth of about 22 ft., or some 15 ft below the marsh level." Knot grass was used to protec the slopes of the dam. Owing to wave action, Mr. Ledoux stated in 1906, this protection was insufficient on the upstream slope, "and hence it is proposed to cover th slope with a layer of granite riprap." Apparently, this was never done.



PLAN AND SECTIONS OF GOOSE CREEK DAM

Under date of July 25, 1916, J. W. Ledoux, chief engineer of the American Pipe and Construction Co., 112 North Broad St., Philadelphia (successor to the company that built the dam) sent *Engineering News* an account of the rainfall that preceded the failure of the dam, together with a description of the failure and of the emergency repairs. Mr. Ledoux's notes except for a few sentences duplicating information taken from his article, as cited, follow:

> On Friday, July 14, the rain gage at the pumping st [located close by the dam.—Editor] showed a rainfall

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[1] These facts, with the accompanying plan and sections, are taken from a long paper on "The New Water Supply for Charleston, S. C.," read in 1906 by J. W. Ledoux before the Engineers' Club of Philadelphia and abstracted in "Engineering News," June 7, 1906, pp. 630-640.

3½ in. during the 24 hr., and this followed a rainfall of over 2 in. during the early part of the week. During the 24 hr. from Friday night to Saturday night there fell something over 16.3 in., the exact amount being unknown, as the gage was overflowed. According to observations made by a contractor living in the vicinity, the intensity of the rainfall at one time during Saturday was at the rate of 2 in. in 10 min.

Early on Saturday the water began to overflow the spillways and run over the earth dam. Dr. J. M. Worthen, superntendent in charge of the plant, did everything possible to prevent the erosion of the earth embankment, but at 7:30 Saturday evening, when the water was at the highest point and still rising rapidly and had a depth of about 14 in. over he earth dam, the downstream slope began to erode fast, and within half an hour a breach was washed clear across he dam, which at that point was approximately 50 ft. wide. The breach was about 100 ft. wide on top and approximately 3½ ft. deep. The top of the embankment was at El. 13.5 above ocean tide. The bottom of the breach was approxinately zero. The crest of the spillways was 10½ ft. above ide, and at that point the capacity of the dam was 2,800,-000,000 gal.

On Monday morning, July 17, the elevation of the water was 8 ft. above tide, and on Tuesday morning 7 ft. The capacity of the dam at El. 7 was 782,000,000 gal. Ordinarily, he water in Goose Creek downstream from the dam ranges n elevation from zero to 6 ft. above tide, but during the heavy rainfall, just before the dam broke, the elevation of he water below the dam was approximately 10 ft. above ide.

The storm was very intense; telephone and telegraph lines were down, and streams were very much swollen between Goose Creek pumping station and Charleston, so it was dificult to get word into the main office concerning the danger. Finally they succeeded in sending a messenger, and a pileriving plant and other apparatus were shipped out over he railroad. The water company succeeded in getting a wrecking crew from the Seaboard Air Line, which worked ontinuously to make such repairs as would prevent the ity from getting out of water. This work was directly uner the personal charge of W. R. Bonsal, Vice-President of he Seaboard Air Line. The water company was fortunate to ave such an able crew of riggers, wreckers and rivermen nder such efficient management.

The first work consisted in a coffer-dam composed of sandbags laid at the upstream end of the breach, where the epth of the water ranged from 4 to 9 ft. This coffer-dam was started Tuesday morning, July 18, and reached the oposite side of the creek at 3 a.m., July 19. At that time he water was rising at the rate of 1½ in. per hr. Fortunately ne high tide occurred about the time of completion, so that here was little current. However, by the next morning at o'clock, when the tide had receded 2 ft., the velocity over he coffer-dam was so great that the sandbags began to how signs of displacement. For half an hour it looked as if he whole coffer-dam would fail. The expedient was then dopted of covering the worst places of the coffer-dam with canvas, weighting it down on the upstream side and letting lap entirely over the structure. This proved so successful hat it was decided to cover the whole coffer-dam with canvas n the same way.

When finished, the bottom of the coffer-dam was aproximately 25 ft. wide, the top 6 ft. and the length about 20 ft. It has stood successfully a flow of water over the op of about 6 in., which was sufficient at that time to take are of the flow of the creek.

Considerable fear was felt among the inhabitants of harleston concerning the continuance of the supply of water, nd it was thought the water company would have difficulty n preventing the salt tide from backing up into the imounding reservoir, but on account of the quick work this was safely prevented.

Permanent repairs are now being made by means of heavy iling driven clear across the breach and on both sides of ame. These piles were driven on 8-ft. centers and 8 ft. part in the direction of the stream. Four-inch sheet piling was driven on each side, and the space within and on each ide filled with sandbags, after which the earth filling will e completed.

The maximum flow of the stream must have been nearly 0,000 cu.ft. per sec. when the break took place. The remainder of the embankment was very little damaged, although he water had run over the entire structure to a depth of ver 1 ft. for a considerable time.

For several years it has been recognized that [the two 00-ft.—Editor] spillways were inadequate to carry off flood ows, as their discharging capacity was only 3,500 cu.ft. per ec., or 70 cu.ft. per sec. per sq.mi.

On Sept. 13, 1912, the water ran over the dam, which was then at El. 12.34, to a depth of approximately 0.7 ft., without causing any damage. It was then decided to construct an adequate concrete spillway, but for legal and other reasons, well known to the parties most interested, it has been up to date impracticable to do this, but it is hoped now that immediate steps will be taken to carry out such an essential improvement.

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Cerro Prieta Irrigation Canal

The Imperial Irrigation District is building a canal 22 mi. long, 60 ft. wide and 8 ft. deep as an emergency project, under the direction of C. R. Rockwood, Chief Engineer, Calexico, Calif. The canal will head in a gate placed in the levee of Volcano Lake and will extend along the west side of New River. The lake is filled by overflowage from the Colorado River. This section of the Cerro Prieta canal as it is called, is designed to prevent a water shortage in August, due to the silting up of the upper four miles of the main canal and the resulting possibility that the district may be unable to obtain a sufficient supply of water through the Alamo canal during the months of August and September.

Mr. Rockwood says further regarding this project:

> It is the intention this winter to extend this canal from the Cerro Prieta gate, at the west end of the levee, eastward along the levee to a connection with our Alamo canal, at a point known as the Cudahy Check. This will permit us during the low-water season, if we have water to spare, to continuously draw a large volume through the Alamo canal from the river and carry it through the Volcano Lake, and by that means not only deposit the silt from the river along the Volcano Lake levee where it is necessary for our protection, but at the same time it will permit us to deliver to all lands on the west side of New River, water from which the heavy silts have been removed, thereby very greatly decreasing our cost of maintenance.
>
> This canal, when finally completed, will become a very important part of our distribution system, as it will permit us to eventually do away with the flume across New River and will also relieve the Alamo canal of its overload for the lower 20 miles.

The entire canal construction now in progress is in earth that is being moved with Fresno scrapers. In July there were 1,700 mules on the work. The work was then being prosecuted with great difficulty on account of the heat and also because the unsettled conditions across the border line in Mexico, where the work is being carried out, make it very difficult to obtain labor.

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A Serious Shortage of Electric Power occasioned a temporary stoppage in the operation of the Ontario Hydro-Electric system on July 17, affecting 140 municipalities on the Niagara circuit. This has been anticipated for some time, owing to the steadily increasing demands of the municipalities dependent on the system. Sir Adam Beck, chairman of the Commission, states that there is an actual present shortage of 25,000 hp., and that before the end of the year 50,000 hp. will be absolutely necessary if the requirements of the public are to be met. The Ontario Government, on being appealed to to secure additional power from development companies which now export it to the United States, referred the matter to the Canadian Government which has the power of stopping the exportation. The power companies at Niagara Falls are bound to supply the Commission with half of their output at the price obtainable in the American market. The Canadian Niagara Power Co., which sends its entire output of 75,000 hp. to New York State, receives therefor $18 to $20 per hp., which is double the price the Hydro-Electric Commission has been paying. They offered the Commission 35,000 hp. at American rates, but the proposition could not be accepted, as it would have meant a proportionate increase in the price charged to the municipalities. Pressure was brought to bear upon the company by the Canadian Government, and rather than incur the risk of having their export trade cut off the Canadian Niagara Power Co., has agreed to furnish the Hydro-Electric Commission with 12,500 hp. immediately, 50,000 hp. by the end of the year and 100,000 hp. if required thereafter at $12 per hp.

News of the Engineering World

Detroit-Superior Viaduct at Cleveland Makes Progress

Visibly rapid progress is being made this season on the concrete-viaduct portion of the Detroit-Superior bridge across the Cuyahoga River in Cleveland, Ohio. A recent view is reproduced herewith. The portion nearest the 591-ft. steel river arch still lacks the deck construction. Completion is expected this year. The Hunkin-Conkey Construction Co. is building the concrete viaducts on both banks.

The original plan for carrying the street cars from the lower deck to street level by inclines on the approaches was abandoned last year. Street-car subways are to be built for a length of several blocks beyond either end of the bridge.

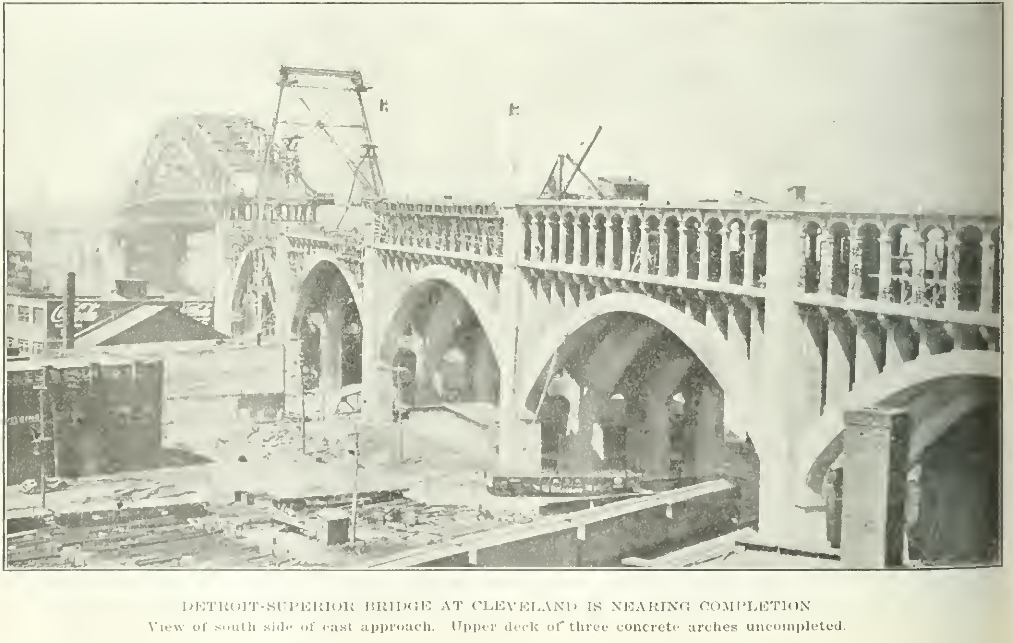
Several remarkable phenomena marked the progress of the concrete work. The plan of operations necessarily involved the omission of the concrete arch adjoining the steel river arch while the steelwork was under erection. Therefore the placing of the landward concrete arches produced unbalanced thrusts on a series of piers, which resulted in some longitudinal deflection of the piers, either elastic or permanent. No serious effects of this deflection are known. Within the past two weeks, however, a crack developed in one of the four arch ribs of one span. This is now being cut out and concreted, after reducing the rib to a no-stress condition by jacking up on falsework. A. W. Zesiger, county bridge engineer, is directing the work, under W. A. Stinchcomb, county surveyor. K. D. Cowen is resident engineer.

* * *

Engineer Becomes President of New Bridge Company

As announced in the last issue of *Engineering News*, George H. Blakeley has been made President of the newly organized Bethlehem Steel Bridge Co., which is to carry on the structural business of the Bethlehem Steel Co. and the business formerly conducted by the bridge department of the Pennsylvania Steel Co. Mr. Blakeley has long been a prominent figure in the field of structural engineering and his appointment as the executive head of this new organization is a notable recognition of the ability of the technical engineer to fill positions of high responsibility.

Mr. Blakeley became widely known to the profession as Chief Engineer of the Passaic Rolling Mill Co. of Paterson, N. J., where he carried the chief engineering responsibility for fifteen years. He graduated from the Scientific Department of Rutgers College in 1884. After two years' work in various lines of field engineering he engaged in bridge construction, first with the Riverside Bridge Co., of Paterson, and later as assistant engineer



DETROIT-SUPERIOR BRIDGE AT CLEVELAND IS NEARING COMPLETION

View of south side of east approach. Upper deck of three concrete arches uncompleted.

f the Erie R.R. in charge of bridge construction under e late C. W. Buchholz, then Chief Engineer. He was ppointed Chief Engineer of the Passaic Rolling Mill Co. 1890, and during his connection with that company he d charge of the building of many important structures. mong them was the Harlem River Bridge at 155th St., f which the late Alfred P. Boller was consulting engieer. This bridge at the time it was built was the heavist swing span in existence, and the first to have a double rum and double ring of bearing wheels.

In 1893 Mr. Buchholz invited Mr. Blakeley to come ck to the Erie as Assistant Chief Engineer, but he referred to continue in his work in structural engineerg. In 1897 the Passaic company issued a structural eel handbook compiled by Mr. Blakeley, containing a rge amount of original information on structural steel. his received a hearty welcome from the engineering rofession, and the precedent set by it was later followed y other steel companies in the preparation of their handooks.

Blakeley

The years Mr. Blakeley remained with the Passaic ompany were years of great development in American ridge engineering. The typical American pin-connected russ of the '80's was replaced by riveted structures of nodern type with carefully designed details. During this eriod also, steel-frame construction for modern buildings had its development. Mr. Blakeley was a prominent figure in both these fields of progress.

It is the rule, rather than the exception, for civil engineers to stick closely to their specialties and fight shy of work in other fields of engineering. Mr. Blakeley, however, while with the Passaic company, was placed in charge of the mechanical engineering work in connection with the company's steel mills, and made a thorough study of rolling-mill methods. In 1902 the late Henry Grey returned to the United States after his successful work abroad in placing in operation the first Grey mill for rolling heavy steel beams at Differdingen. Mr. Blakeley came in touch with Mr. Grey and took a lively interest in the Grey mill and its possibilities for producing heavy structural sections. In 1906 Mr. Charles M. Schwab started to develop the Grey mill process in the United States at the Bethlehem Steel Co.'s plant, and Mr. Blakeley severed his connection with the Passaic Rolling Mill Co. and became connected with this enterprise. For the following two years Mr. Blakeley and Mr. Grey were engaged in the work of building the mill and studying the problem of the sections most available for structural purposes, the result being the development of the broad flange "Bethlehem" sections now so widely used. The mill was put in operation in 1908, and Mr. Blakeley was made Manager of Structural Steel Sales of the Bethlehem Steel Co.

With the acquisition of the Pennsylvania Steel Co. by the Bethlehem company, the responsibility for the structural work of that organization is now added to Mr. Blakeley's former tasks. Mr. Blakeley is a director of the Bethlehem Steel Co., a member of the American Society of Civil Engineers, of the American Society of Mechanical Engineers, and of the Engineers' Club of New York City.

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Launch of a Survey Steamer

The steamship "Surveyor" for the U. S. Coast and Geodetic Survey was launched July 22 at the plant of the Manitowoc Ship Building Co., Manitowoc, Wis., in the presence of Dr. E. Lester Jones, Superintendent of the Survey, whose daughter Elizabeth performed the christening ceremony. The ship was launched sideways, in accordance with general practice at lake shipbuilding yards, and the accompanying view shows it entering the water.

LAUNCHING THE NEW SURVEY STEAMER

It is a steel vessel 186 ft. long, 31 ft. beam and 11½ ft. draft, with a displacement of about 1,000 tons. It has a triple-expansion engine of 1,000 hp., and will use oil fuel. The officers and crew will number about 66, and the vessel will carry enough fuel and supplies for a 3-months' cruise.

Although the vessel was built on the Great Lakes it is intended for service in the Pacific, surveying and charting the Alaska Coast and Behring Sea during the summer, and the Pacific Coast during the winter. It is expected to have the ship finished this fall and sent through the lakes and the St. Lawrence to the Atlantic before the navigation season is closed. The contract price for the hull and machinery was $189,000, but when fully equipped the vessel will represent a cost of about $200,000.

Cleveland Tunnel Accident Not Yet Explained

The Cleveland intake-tunnel accident of Monday, July 24, 1916, has not yet been investigated fully enough to give any real information as to its nature or origin. At the time of going to press no one had penetrated to the end of the heading driven landward from the outer crib. That an explosion occurred is considered proved by the distorted and disordered condition of rails and cars, etc., so far as the search parties had advanced. No explosive was used in the tunnel. Just two days before the accident, on Saturday evening or Sunday morning, trouble with gas had been reported by the last shift of the week, on coming out; the men said they felt the effects of gas. So far as now known no analysis of the air was made. The system of working required, in case gas was noticed, using such ventilation as could be secured by blowing through the 8-in. compressed-air supply pipe and drawing off air through the 4-in. blowpipe or through the airlock valves, before the next shift entered. No shift went in Monday morning, after the Sunday stop. The Monday night shift was taken in by an assistant engineer (who had previously himself worked in the heading gang), acting as heading foreman, in the absence of the regular foreman.

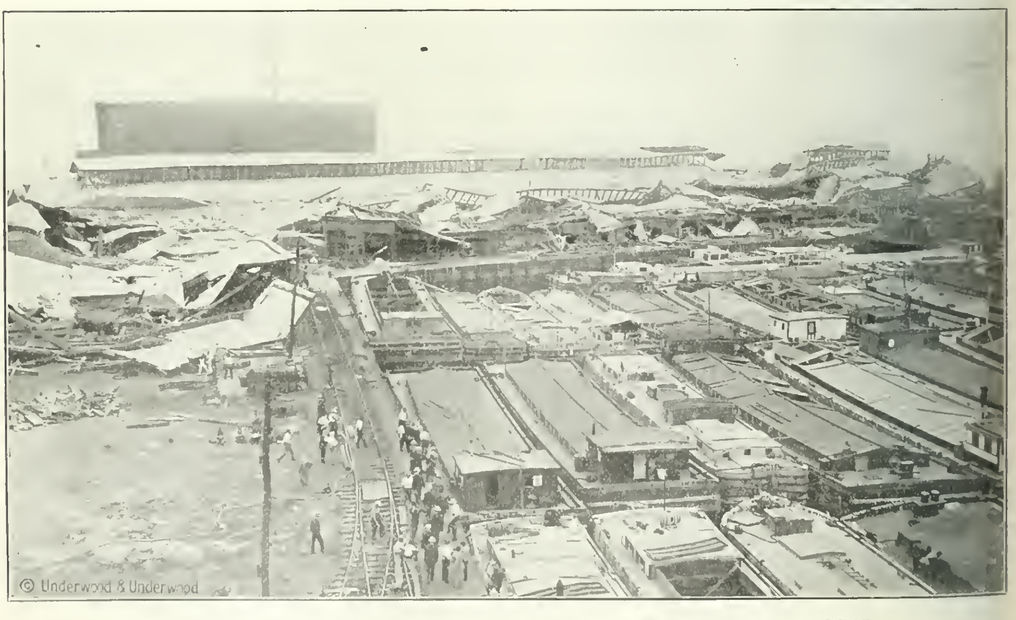
As noted last week, the superintendent of the tunnel work enforced strict rules against any use of matches, open lights, photographers' flashlights or other source of flame, in both land and crib headings. The occasional occurrence of gas was known, and its dangers were recognized from earlier experiences in tunneling in the same ground. On the other hand there was no regular check kept on gas occurrence, chemical analyses being made only occasionally.

The nature of the clay in which the tunnel is located makes it probable that damage to the tunnel at the face will be found to be slight.

Explosions in New York Harbor Wreck Many Structures

Two tremendous explosions in the munitions stored at and around a freight terminal in New York Harbor in the early morning of July 30, completely wrecked most of the structures in the immediate vicinity, broke about half a million dollars worth of glass in New York and New Jersey buildings, caused the death of an unknown number of persons (listed as six on Aug. 2) and the injury of a great number of others. The main explosion at 2:08 a.m., was felt over a radius of at least 50 mi., and was followed by a second about 30 min. later, which while not of equal force caused most of the local damage.

The explosions took place on Black Tom, a peninsula jutting out from the New Jersey shore just off Bedloe's Island, where is located the Statue of Liberty, and about two miles south of west of the Battery. On this point of land is located a large terminal, consisting of a number of warehouses fed by the Lehigh Valley R.R. and



SOME OF THE WRECKED WAREHOUSES ON BLACK TOM IN NEW YORK HARBOR ıany piers from which are loaded the barges and lighters sed in harbor transhipment. About midnight on July 9 a fire broke out either in one of the barges or in a ier shed or waiting freight car. The Jersey City fire epartment was called out to the fire but found it beyond ontrol among the barges and freight cars, many of which ere loaded with munitions awaiting shipment to the uropean battlefront. One of the barges was being towed vay from the pier when it exploded, at 2:08 a.m., caus-ıg the concussion which shook up the whole surrounding rritory and scattered the burning débris all over the eninsula. The fires so set reached a train containing gh explosives which blew up about 2:30 a.m., and recked most of the structures in the terminal. Some this local damage is shown in the accompanying view. he fire spread by this explosion added to the destruction. Subsequent damage was caused by exploding shells on e drifting and burning barges, which continued until ell beyond daylight.

The money value of the damage is not yet known, but estimated at from $20,000,000 to twice that amount. sponsibility for the storage of so much high explosive ar the city—contrary to law—is also not fixed, but the ual multiplicity of investigations is assured.

⁂

Earth Fill Coffer-Dam Fails at Boston Dry Dock

About 100 ft. of the coffer-dam at the new South Bos-a dry dock failed at high tide during the night of July . The site had been excavated by dredging before the ffer-dam was closed, and the section across the outer d, some 500 ft. long, had been only recently completed. mping had been begun and the level of the water had en reduced to about 8.5 ft. below low tide when work pped on the afternoon of July 25. The coffer-dam ve way during the night under a head of about 18.5 , when no one was working in the basin, so that no mage was done except to the structure itself.

The coffer-dam consists of two lines of 6-in. sheetpiling, pported by round piles and spurshores, cross-braced d tied inside, filled with puddle, and banked up outle with earth and riprap. At this location the harbor t is underlain by a stratum of hard blue clay, resting soft material which overlies the rock. The coffer-m piling is driven about 5 ft. into the blue clay.

All ordinary precautions had been taken to make the ucture stable, and the design was one which had been d with entire success elsewhere about Boston. The ison for the failure is therefore not clear. At the sent time the entire section of the coffer-dam carried t is below low water level, so that it cannot be readily mined. The work is being done by the Holbrook, bot and Rollins Corporation as contractors working retofore for the Directors of the Port of Boston, one of commissions which recently has been superseded by new Massachusetts Commission on Waterways and blic Lands. No attempt will be made at the present ne to pull up the old coffer-dam and a new one will built outside of it.

⁂

A Municipal Electric Lighting Plant for St. Louis is planned A. M Branch, Commissioner of Light, Heat and Power. vestigations to determine its feasibility are to be underken.

Bids for Water-Power Rights at the dam at Joliet, Ill., have been received by the Illinois and Michigan Canal Commission at Springfield, Ill., the lease held by the Economy Light and Power Co. (a subsidiary of the Chicago Edison Co.) having expired. The Sanitary District of Chicago bid $15.01 per hp. per year and Andrew Cooke bid $3; the latter is understood to have represented the Economy company. It is stated that if its bid is accepted the Sanitary District will be able to install 10,000 additional street lights in Chicago and that it proposes to double the present 3,000-hp. development.

Boston Paving Squabbles—In order to obtain the kind of pavement which they want, residents of Commonwealth Ave. in Boston have paid to the city the difference between the prices bid for bitulithic and for sheet asphalt. A short time ago bids were received by the Public Works Department for paving Commonwealth Ave. with sheet asphalt, Topeka pavement, or bitulithic. The bid for the sheet asphalt was the lowest, and the mayor had decided to accept it, when the Commonwealth Ave. residents took up a collection amounting to $7,907.90 and sent a check for that amount to the mayor. He at once signed a contract with Warren Brothers Co. for the bitulithic pavement which the abutters desire.

The Waterways and Public Lands Commission of Massachusetts, a new institution which supersedes and will handle the work of the old Harbor and Land Commission and the Directors of the Port of Boston, has been named by Governor McCall. The members of the new commission are: John M. Cole, Chairman, long prominent in state politics as Speaker of the House of Representatives, Chairman of the State Board of Efficiency and of the Boston Industrial Development Board; Jesse B. Baxter, also a prominent politician, a member of the Republican State Committee, and William S. McNary, who has been Chairman of the Harbor and Land Commission for several years. Their terms are three, two and one years respectively.

The Engineers Club of Philadelphia has set a high mark in the issue of its "Proceedings" for July. The size of the publication has been enlarged to 9x12 in. and it contains no less than 112 pages of matter including advertisements. The club has carried through with remarkable success a broad campaign for increasing its own membership, which has raised its list from 500 to nearly 2,500, and a plan under which seven local sections of national engineering societies, with a resident membership of some 1,500 engineers, have affiliated with the club. Each of these seven sections has its own department in the "Proceedings" in which to present matter of special interest to its members, including records of its current meetings. The "Proceedings" are conducted by the Publication Committee of the club, with Joseph Caccavajo as Editor-in-Chief.

New Pittsburgh Terminal Plans—The plans which were announced some time ago ("Engineering News," March 23, 1916) for the reconstruction of the Pennsylvania R.R. station in Pittsburgh to provide largely increased office space have now been modified. It is reported that the railroad is working on a plan that would bring the station three blocks nearer the center of the business district, and which would involve rather extensive street changes. Grant St. would be extended through to Liberty Ave. in a tunnel under the Pennsylvania tracks, and the present narrow alley known as Cherry Way would be widened 30 or 40 ft. to give a second main thoroughfare across town to the outer Penn Ave. district. The new station, according to this plan, would be located on the very edge of the district improved by the cutting of the Pittsburgh "Hump."

New Belle Isle Bridge—Acting on the suggestion of George H. Fenkell, Commissioner of Public Works, Detroit, Mich., Mayor Marx has appointed a consulting board to assist the Commissioner of Public Works in the preparation of plans and estimates for construction of a new bridge to connect Belle Isle with the mainland. This board, which serves without compensation, consists of the following: Mortimer E. Cooley, Dean of the College of Engineering and Architecture, University of Michigan; William R. Kales, Civil Engineer, Detroit; Francis M. McMath, Civil Engineer, Detroit; Emil Lorch, Professor of Architecture, University of Michigan; Henry E. Riggs, Professor of Engineering, University of Michigan. Offices have been opened at 34-36 West Congress St. The Belle Isle bridge was destroyed by fire Apr. 29, 1915 (see "Engineering News," May 6, 1915). A temporary timber structure in place of this bridge is now under construction.

Closer Relations between the National Engineering Societies and the National Academy of Sciences have been under discussion for some time and a joint committee has now been appointed to consider plans for coöperation in any work of mutual interest. The representatives appointed on this joint committee are as follows: American Society of Civil Engineers, Gen. Wm. H. Bixby; American Institute of Mining Engineers, Sydney J. Jennings, New York City; American Society of Mechanical Engineers, Ira N. Hollis, Worcester, Mass.; American Chemical Society, Dr. L. H. Baekeland, Yonkers, N. Y.; American Institute of Electrical Engineers, Dr. J. J. Carty, New York City; Engineering Foundation, Gano Dunn, New York City. Representatives of the National Academy of Sciences are Jos. S. Ames, Johns Hopkins University; John F. Hayford, Northwestern University; Edward L. Nichols, Cornell University; M. I. Pupin, Columbia University; E. B. Rosa, Bureau of Standards; Elihu Thomson, Lynn, Mass.; C. R. Van Hise, University of Wisconsin; Chas. D. Walcott, Smithsonian Institution; Robert S. Woodward, Carnegie Institute; George Ellery Hale, Chairman, Pasadena, Calif.

Nashville Water-Works Superintendent—A legal fight of interest to water-works men is the successful suit of George Reyer, former superintendent of water-works of Nashville, Tenn., for reinstatement. By a resolution adopted in 1913 the Board of Public Works abolished the office, the resolution stating that the failure of the reservoir wall in November, 1912 (see "Engineering News," Nov. 14, 1912), had been due to the superintendent's negligence. Mr. Reyer contended that the abolition of the office was merely a desire to oust him. The case was carried to the court of civil appeals and on the second trial in the circuit court the city contended that the position of superintendent had been absorbed by the office of commissioner of water-works, street-cleaning and workhouse. This question was also carried to the higher court, which remanded it for a rehearing in the circuit court on the issue whether a separate water-works superintendent was necessary or not. The charter of the commission-form government provides for a water-works superintendent, and the reports of the National Board of Fire Underwriters and of James Cameron and H. M. Brinkerhoff on an efficiency survey of the municipal government, both urge strongly the appointment of a technically trained water-works superintendent. Mr. Reyer's record as a water-works superintendent was put in as evidence, and he contended that the position required the services of a man of such technical training. The circuit court ordered Mr. Reyer reinstated with accrued salary. The Board of City Commissioners has voted to acquiesce in the decision of the court without appealing the case, and Mr. Reyer was reinstated Aug. 1 with back salary to May, 1913. Following the publication of reports that an appeal would be taken, the Nashville Section of the Engineering Association of the South, at a special meeting, adopted a resolution declaring that the welfare of the city demanded that a competent engineer be appointed superintendent of the water-works immediately.

Apportionment of Federal-Aid Road Funds—On July 21 the Secretary of Agriculture announced the apportionment of the $5,000,000 Federal-aid road appropriation as follows:

Alabama	$104,148.90	Nevada	$64,398.30
Arizona	68,513.52	New Hampshire	20,996.62
Arkansas	82,689.10	New Jersey	59,212.68
California	151,067.92	New Mexico	78,737.81
Colorado	83,690.14	New York	250,720.27
Connecticut	31,090.44	North Carolina	114,381.92
Delaware	8,184.37	North Dakota	76,143.06
Florida	55,976.27	Ohio	186,905.42
Georgia	134,329.48	Oklahoma	115,139.00
Idaho	60,463.50	Oregon	78,687.37
Illinois	220,926.23	Pennsylvania	230,644.17
Indiana	135,747.62	Rhode Island	11,665.71
Iowa	146,175.60	South Carolina	71,807.64
Kansas	143,207.40	South Dakota	80,946.02
Kentucky	97,471.91	Tennessee	114,153.48
Louisiana	67,474.66	Texas	291,927.81
Maine	48,451.50	Utah	56,950.15
Maryland	44,047.22	Vermont	22,844.47
Massachusetts	73,850.95	Virginia	99,660.71
Michigan	145,783.72	Washington	71,884.28
Minnesota	142,394.06	West Virginia	53,270.46
Mississippi	88,905.84	Wisconsin	128,361.07
Missouri	169,720.41	Wyoming	61,196.82
Montana	98,287.19		
Nebraska	106,770.81	Total	$4,850,000.00

These funds are available for the fiscal year ending June 30, 1917. The sum of $150,000 or 3% is deducted for the expenses of administration, that is, for the United States Office of Public Roads and Rural Engineering. The remaining sum is apportioned among the states, one-third in ratio of area, one-third in ratio of population and one-third in ratio of mileage of rural mail delivery and star routes.

The Committee on Industrial Preparedness of the Naval Consulting Board, through Howard E. Coffin, its Chairman, announces that it has nearly completed the industrial inventory of the United States which has been made through the coöperation of members of the National Engineering Societies and has been in progress during the last three months. The inventory covers more than 30,000 manufacturing plants in the United States which do a business of over $100,000 a year, besides many smaller plants producing equipment especially useful in time of war. The committee further states that legislation will probably pass Congress during the present session to carry out the entire program of the committee, including the plan for training manufacturing plants in the production of war munitions by the distribution of annual "educational orders" which will enable works to have actual experience in the processes necessary to produce munitions. Legislation is also hoped for providing for the organization of an "industrial reserve," so that skilled mechanics, toolmakers, etc., may be kept at work in the shops in the event of war instead of taken away for service in the fighting line—a matter of the utmost importance to a nation's military efficiency. The necessity of legislation by Congress is apparent from a statement by Mr. Coffin, made in a recent address before the Engineers Club of Philadelphia, to the effect that under a law enacted Feb. 27, 1906, the United States Government cannot accept voluntary service from persons not in the Government's employ. The language of the statute is:

> Nor shall any department or any officer of the Government accept voluntary service for the Government, or employ personal service in excess of that authorized by law, except in case of sudden emergency involving the loss of human life or the destruction of property.

A way to give authority to the Committee on Industrial Preparedness, however, has been opened by the passage of the National Defense Bill on June 3. In this bill the Secretary of War was authorized to cause to be made a complete list of all private plants in the United States equipped to manufacture munitions and the President was authorized to appoint a board on mobilization of industries essential for military preparedness.

PERSONALS

L. H. Talbot has been appointed Construction Engineer o the Shawinigan Water and Power Co., Shawinigan Falls, Que.

S. M. Hate has been appointed Engineer of the Kansas City Stock Yards Co. to succeed Henry A. Wise, resigned, as noted elsewhere.

E. Y. Smith, Manager and Treasurer of the Florida Pile and Timber Co., Jacksonville, Fla., has been placed in charge of the company's plant at Natchez, Miss.

Melbert W. Taber, M. Am. Soc. M. E., formerly Construction Engineer, Packard Motor Car Co., has been made Manager of the Detroit office of the Asbestos Protected Metal Co. of Pittsburgh.

William G. Sloan, M. Am. Soc. C. E., chief engineer of MacArthur Brothers Co., general contractors, 120 Broadway, New York City, has been elected vice-president to succeed F C. Hitchock, resigned, as noted elsewhere.

Samuel Murray, Assoc. M. Am. Soc. C. E., Acting Chief Engineer of the Oregon-Washington Railroad and Navigation Co., Portland, Ore., since the retirement of J. R. Holman in September, 1915, has been appointed Chief Engineer.

Francis R. Shunk, Lieutenant-Colonel, Corps of Engineers, U. S. A., formerly in charge of the Pittsburgh district, has been made Resident Member of the Rivers and Harbors Board, Washington, D. C., succeeding Col. Henry C. Newcomer.

Howard W. Morgan, recently Senior Engineer with the Sewerage Commission of the City of Milwaukee, Wis., has become associated with the Dorr Co., Engineers, 17 Battery Place, New York City, and will specialize in sewage disposa problems.

A. H. Bogue is Chief Engineer of the proposed Oregon California & Eastern Ry., which is being promoted by Robert E. Strahorn, former Vice-President of the Oregon-Washington Co. The general offices of the company are in Portland, Ore.

George A. Ricker, M. Am. Soc. C. E., Consulting Engineer of Albany, N. Y., has accepted a position with the Portland Cement Association in charge of its Kansas City office. M Ricker is a former Deputy Highway Commissioner of New York State.

E. G. Lane, Assoc. M. Am. Soc. C. E., formerly Distric Engineer, Maintenance-of-Way, Baltimore & Ohio Southwestern R.R., Cincinnati, Ohio, has been promoted to be Engineer of Maintenance-of-Way. His headquarters will remain at Cincinnati.

A. L. Hoerr, M. Am. Soc. M. E., former Steam and Hydraulic Engineer of the National Tube Co., Pittsburgh, Penn., has been appointed Chief Engineer of the National Works of the company. He is succeeded as Steam and Hydraulic Engineer by Frank E. Leahy.

Samuel J. Hoexter, Assoc. M. Am. Soc. M. E., Instructor in Mechanical Engineering at the University of Michigan, has been made Manager of the Engineers' Society of Pennsylvaia, Harrisburg, Penn. He is a graduate of Stevens Institute f Technology, class of 1909.

Edward P. Burch. F. Am. Inst. E. E., Consulting Engi-eer, Detroit, Mich., has been selected by Mayor Davis, of leveland, Ohio, to represent the city as electric lighting xpert at a hearing before the state public utilities commis-ion in support of a 3c. per kw.-hr. electric-lighting rate.

F. C. Hitchcock, M. Am. Soc. C. E., has resigned as vice-resident and general manager of MacArthur Brothers Co., eneral contractors, 120 Broadway, New York City. He has ecome vice-president and general manager of the Siems arey Railway and Canal Co., which has extensive work in hina.

S. T. DeLaMater, M. Am. Soc. C. E., Consulting Engineer, hicago, Ill., is now President of the Chicago General Con-ruction Co., Manhattan Bldg., Chicago. He was previously ith Graham, Burnham & Co., James Stewart & Co., L. P. and A. Smith and other well known engineering construction mpanies.

Henry A. Wise has resigned after 20 years' service as En-neer of the Kansas City Stock Yards Co. He became En-neer of the company in 1892 and in 1896 was made City ngineer of Kansas City, which position he held for four ars. He returned to the Stock Yards Co. in 1900 and s been there ever since.

Henry C. Newcomer, Colonel, Corps of Engineers, U. S. A., rmerly Resident Member of the River and Harbor Board at ashington, D. C., has been made Principal Assistant to Gen. illiam M. Black, Chief of Engineers, and has been placed charge of the rivers and harbors division, relieving Col. rry Taylor, who has been transferred to Governors Island, Y.

Stuart K. Knox, M. Am. Soc. C. E., Consulting Engineer. w York City, has recently become a member of the firm of ll & Ferguson, Consulting Engineers, 100 William St., New rk City. For the past eight years Mr. Knox has been as-iated with the senior member of the firm (Nicholas S. Hill,) as Principal Assistant Engineer. He is a graduate of the iversity of Michigan.

W. R. Armstrong, M. Am. Soc. C. E., General Manager and ef Engineer of the Salt Lake & Utah R.R., Salt Lake City, th, has been appointed Engineer of Maintenance-of-Way of Union Pacific R.R., with headquarters at Omaha, Neb. He s formerly Superintendent of the Montana division of the on Pacific and has had about 25 years' experience in rail-y engineering and operation.

Michael Edward Brian, Assoc. M. Can. Soc. C. E., City En-eer of Windsor, Ont., has been made Chairman of the board engineers which will prepare plans for joint water-sup-and sewerage systems for Windsor, Walkerville, Ford City, dwich, Ojibway and Sandwich West. Plans will be pre-ed in time for a vote by the taxpayers of the several towns t January. Leonard Rice, Assistant Engineer, of Ojibway, ecretary of the board.

John I. Mange has been elected vice-president of the J. G. ite Management Corporation, New York City. Mr. Mange been associated with the J. G. White Management Cor-ation since 1912, at which time he was elected vice-presi-t of the Associated Gas and Electric Co., a holding com-y of electric and gas properties in New York, Kentucky, and Tennessee, managed by the J. G. White Management poration. He was born in Pembroke, Me., in 1876. He nded the public schools in Pembroke and Kingston, Mass., was graduated in 1899 from Tufts College, with the degree achelor of science.

Joseph L. Nobre and **Richard D. McFadden,** who were ped from the engineering forces of the Philadelphia De-ment of Public Works by former Director Morris L. Cooke uly, 1913, on charges of political activity, have been rein-ed by Director George E. Datesman. Mr. McFadden has connected with the Department of Wharves, Docks and ies as a state appointee. Both engineers will be given r old positions as District Surveyors of the Bureau of eys at salaries of $4,000 per annum. William H. Reeder Charles F. Puff, who have held these offices since 1913, be assigned to other work.

OBITUARY

Ioward Macrum, General Superintendent of the Otis Steel Cleveland, Ohio, died recently at his home in Cleveland, 43 years.

Villiam Alexander Park, a civil engineer of Knoxville, n., died July 19, aged 53 years. He was born in 1863. He was graduated from the University of Tennessee and spent the greater part of his life in the vicinity of Knoxville.

S. H. Volks, Assistant Engineer of Construction of the Cleveland, Ohio, Water Department, was among those who lost their lives in the tunnel accident, July 24, 1916. He was a 1911 graduate of the Case School of Applied Science.

William Rodney Patterson, M. Am. Soc. C. E., of the firm of Patterson & Davidson, Consulting Engineers, Chicago, Ill., died July 20. He was 62 years old and had been a resident of Chicago for 39 years. He was an inventor of lead covered electric cables.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION
Oct. 3-5. Convention in New York City. Secy., C B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C A Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The Traveling Engineers Association will hold its 24th annual convention in Chicago, at the Hotel Sherman, Sept 5 to 8. Among the topics is: "Difficulties Accompanying the Prevention of Dense Black Smoke and Its Relation to Cost of Fuel and Locomotive Repairs." W. O. Thompson is secretary.

The Providence Engineering Society will occupy new rooms at 29 Waterman St., Providence, when it opens for its fall and winter seasons next September. The entire second floor of the building has been taken over and will be remodeled and equipped attractively. The secretary is Albert E. Thornley.

Society of Automobile Engineers.—At the semi-annual meeting held in June definite proposals were made to change the name to Society of Automotive Engineers, in order to include engineers engaged in aëronautic, motor-boat, and similar work involving the use of internal-combustion engines. The society's Committee on Standards held a meeting in July, with the National Advisory Committee for Aëronautics at the Bureau of Standards in Washington, at which plans were discussed for bringing about coöperation between the Federal government and designers and manufacturers of engines suitable for air craft.

Appliances and Materials

Valve for Dry-Pipe Sprinklers

A new model of dry-pipe valve for fire-protection sprinkler systems has been devised by the General Fire Extinguisher Co., Providence, R. I. This ("Model C") is the third type evolved in connection with the Grinnell automatic dry-pipe system for use where freezing temperatures prevent use of the ordinary or wet-pipe system. In the dry-pipe system compressed air is used to fill the pipes until a fire opens a sprinkler head; a special check valve is employed to hold back the water.

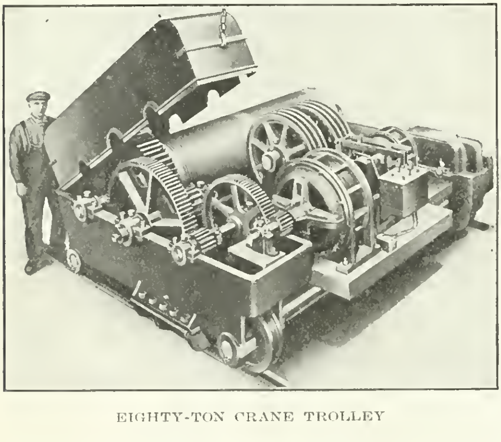
The new valve has a cast-iron body and a dished malleable hand-hole cover. The only essential moving part is a bronze clapper with a rubber air valve seating on babbitt and a bronze water valve and seat. The intermediate space between the two seats is a drain chamber vented to the air. The valve will admit water when the air pressure has dropped to ⅙ the water pressure. Unlike the earlier valves, the area of the air valve is only three times that of the water; the air-valve leverage is increased to compensate, giving as a net result a smaller and lighter valve.

* * *

Large Alternating-Current Crane

One of the largest alternating-current cranes ever installed for handling locomotives has been furnished recently by the Whiting Foundry Equipment Co., Harvey, Ill., to the Seaboard Air Line Ry. for its new shops at Portsmouth, Va. The crane is of 160 tons capacity with two 80-ton trolleys, one of which is equipped with a 10-ton auxiliary hoist. The trolleys are of the construction shown in the accompanying view.

Among the features of the trolley may be noted the entire train of gears inclosed and run in oil; the motor pinion with outboard bearing; the idler-sheave mounting, which allows the operator to inspect and oil while standing on top of the trolley and which increases the lift of the crane by about 30 in. With the exception of the drum shaft, no shafts extend across the trolley. All shafts in the gear train are on the same line and are of cast steel, machine cut. Pinions are forged, as is the drum gear. Trolley sides and separator are of cast steel, the housing of structural steel and provided with proper hand holes to allow inspection and easy removal in making repairs.



EIGHTY-TON CRANE TROLLEY

* * *

Pump and Generator Outfits with Automobile Engines

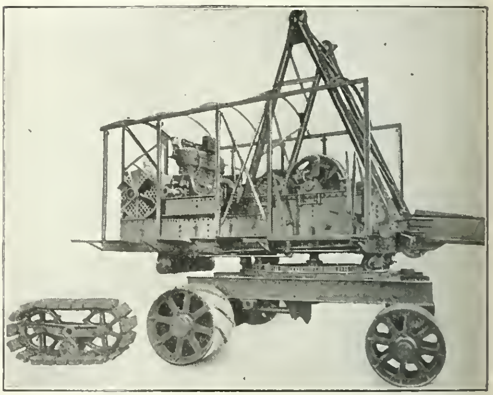
An outfit recently introduced consists of an automobile-type gasoline engine and horizontal-shaft centrifugal pump, both mounted on a bedplate and having their shafts connected through a flywheel and clutch pulley. A connection to the pump supplies cooling water for the cylinders, but if the pump is handling dirty water a separate circulating pump or a circulating tank may be fitted. A four-cylinder engine of 7 hp. drives a pump with 4-in. suction and 3-in. discharge, and at a speed of 1,000 r.p.m. the outfit can deliver 260 gal. per min. against 50 ft. total head. The same type of engine can be connected to a 110-volt direct-current generator of 3 kw., mounted on the end of the bedplate. This can be used for a 10-in. searchlight, to operate lights up to 3,000 watts, or to drive a 4-hp. motor. These outfits are built by the Zin-Ho Manufacturing Co., of Chicago.

* * *

New Dragline Excavator

The traveling dragline excavator is being used very extensively and for a variety of purposes, and a new design of excavator of this type is shown in the accompanying view. It was designed by G. N. Crawford, excavator expert for the Pawling & Harnischfeger Co., of Milwaukee, Wis., and is built by that company.

In this machine the revolving frame has as its main element a pair of heavy plate girders, carrying the A-frame, boom and all machinery. It has a pivot and center casting of annealed steel, and is supported by rollers traveling on a circular track of 60-lb. T-rail riveted upon the lower frame. This frame is built up of I-beams and plates. The eight rollers are arranged in pairs, each pair being mounted in a truck frame. A pinion on a vertical shaft gears with a circular rack inside the roller path. The boom is composed of a pair of steel channels, with top and bottom bracing, and is heavily reinforced at the end for the head sheave and the eye-bar links carrying the crosshead to which the topping-lift block is attached.



FRAME CONSTRUCTION AND MACHINERY OF CRAWFORD EXCAVATOR

The excavator is shown equipped with a multicylinder gasoline engine, but it can be fitted with a steam engine or electric motor, the current for the latter being taken from an outside source or generated on the machine. There are three drums, operating the dragline, the hoisting line and the topping-lift for the boom. The band frictions of the drums are operated by compressed-air rams. The equipment includes a tubular water-cooling radiator with fan, an air compressor, a centrifugal circulating pump, a gasoline tank and a receiver for compressed air. The tank and receiver are placed beneath the revolving frame. The gears are of annealed cast steel and all spur gears are cut from solid steel blanks. Water circulation and force-feed lubrication are effected automatically.

The machine can be mounted either on wide-tired wheels or on four caterpillars known as corduroy grips. Power is supplied from the engine through bevel gears to the rear shaft. The caterpillars are driven from the live axle by internal steel sprockets and chain drive from the rear axle. The wheels are of cast steel and have three rows of spokes. The rear or driving axle is built up of 12-in. I-beams, with stub ends which admit of renewal in case of wear. The axles are so arranged as to give a three-point support to the upper frame when traveling, but when the excavator is working, this frame is held rigidly in position by means of jacknuts.

The excavator illustrated has a 40-ft. boom handling a 1-yd. bucket, and is operated by a four-cylinder vertical gasoline engine of 70 hp. The turntable track is 8 ft. in diameter and the machine can be swung at the rate of 2½ r.p.m. The weight in working order is 30 tons.

Engineering News

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Wabash Grade Elimination in Fort Wayne

The Wabash R.R. origin-
ly ran at grade through
ırt Wayne, Ind. Four or
'e years ago the three
ıcks were raised on a fill,
d a fourth track added.
:er streets the tracks were
rried on pile bents. The
ıstruction of permanent
ıssings began in 1914, and
being carried on at the
esent time by the Car-
chael-Cryder Co.; W. R.
rmichael, Superintendent
the job. Traffic on the
lway has not been inter-
ıted. A typical crossing
this elimination, and one
unusual interest, is that
Taylor St., shown under
ıstruction in the accom-
ıying views. The three
ıcrete bents shown were
lt in 1914 to 1915; the
ıtments were started in
spring of 1916. The
l is clay, but the footing
avations were in fill.

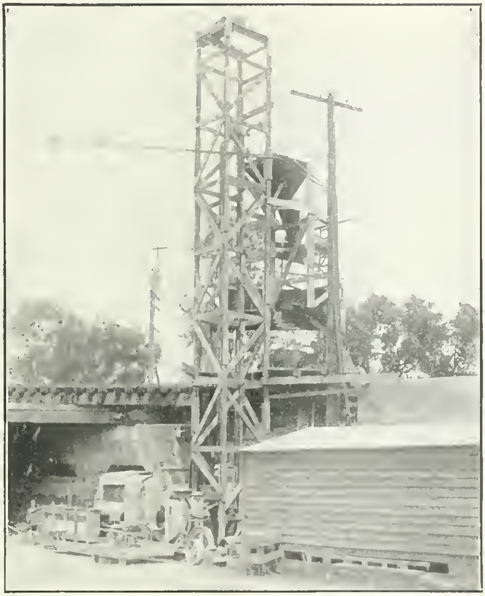

FIG. 1. CONCRETING PLANT NEAR NORTH ABUTMENT

The mixer plant is shown in Fig. 1. Concrete for the footings was wheeled in hand carts from mixer to site. The piers were concreted from the top of the temporary crossing. A concreting tower was erected at the same time as the forms for the north abutment and adjacent, as shown (Fig. 2). This abutment was placed by a chute from the tower. The footing for the south abutment was placed using hand carts wheeled from the mixer. The abutment itself was concreted by use of these same carts running on a plankway on the trestle deck. Gravel for the concrete was bought from the Carmichael Gravel Co., Attica, and shipped to the job in hopper-bottom cars. At the site the cars were dumped through the tracks into a storage pile between

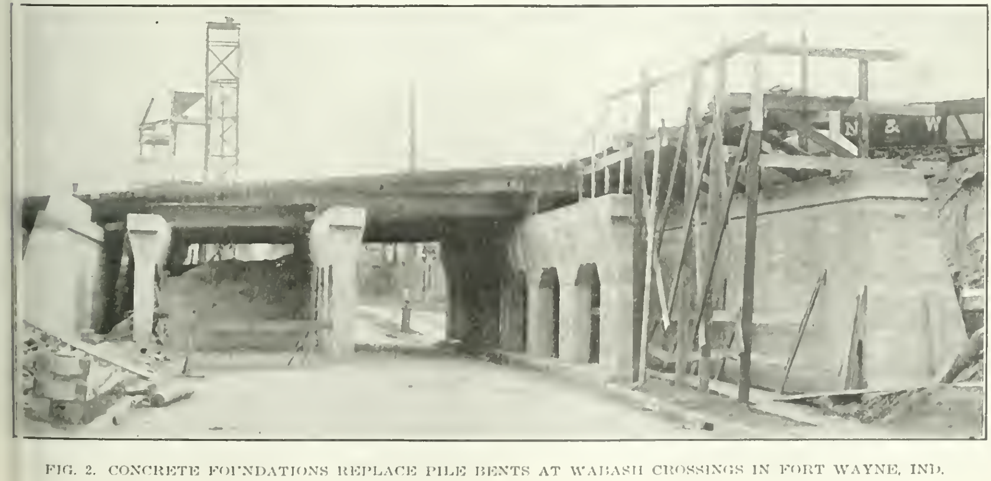

FIG. 2. CONCRETE FOUNDATIONS REPLACE PILE BENTS AT WABASH CROSSINGS IN FORT WAYNE, IND.

two piers. Sand was dumped in the same manner but on the west side (shown in Fig. 1) of the work, the gravel being on the east. The sand and gravel were transported from storage piles to mixer by means of wheelbarrows. The cement was stored in a shanty adjacent to the tower. An electric hoist was used in the tower.

The deck of the crossing was constructed of reinforced-concrete slabs, 20 ft. long by 6½ ft. wide and 3 ft. deep. These slabs were cast on the fill adjacent to the crossing, as shown in Fig. 3. They were then allowed to set for 28 days, when they were placed in permanent position by a wrecking crane. Hydrated lime was used in the concrete, and Mr. Carmichael states that it "helped immensely in working the concrete, making the 1:3:6 mix handle as easily as a 1:2:4."

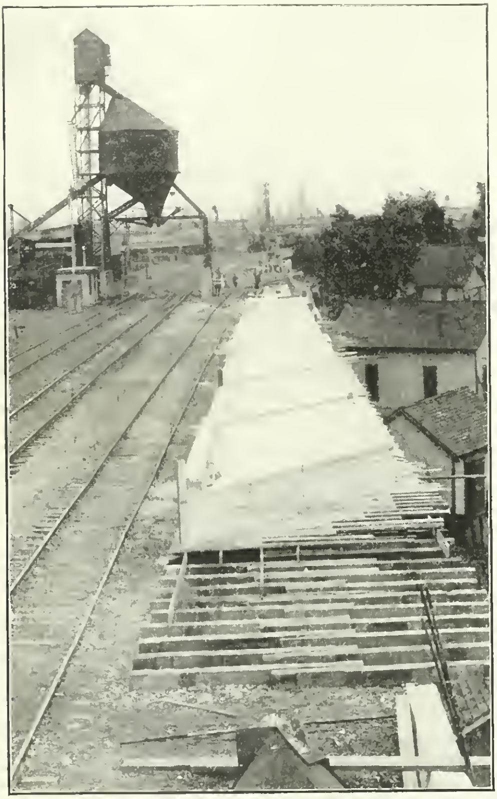

FIG. 3. LARGE DECK SLABS CAST ON EMBANKMENT ADJACENT TO CROSSING

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Ecuador Uses More American Cement now than formerly owing to the construction of culverts and foundations for new railway bridges, the work on the sanitation of Guayaquil, and a recent municipal building ordinance requiring concrete foundations for all new buildings. The consul general, Frederick W. Goding, states that although the cement imported at present is almost exclusively American, due to war conditions, there are serious problems relative to its sale after the war that ought to be solved. American cement barrels are not so strongly made as those of European competitors. Empty barrels of German and British origin in good condition bring about 19c. each, whereas the American barrel never sells for more than 14c. Mr. Goding believes steel barrels with wood heads to be the true solution of this question.

Reinforced-Concrete Ore Dock at Ashland, Wis.

By W. E. King*

Among the notable pieces of reinforced-concrete construction to be erected this year is the ore dock now being built by the Minneapolis, St. Paul & Sault Ste. Marie R.R. at Ashland, Wis. It is 80 ft. high above water level, 1,132 ft. long and is to be built almost entirely of reinforced concrete. This type of dock, for the transfer of iron ore from trains to vessels, has been developed largely on the Great Lakes, and a general description of the docks previously constructed will show the unique features of the Ashland dock.

Stated briefly, a modern ore dock is generally a four-track elevated trestle from 60 to 80 ft. high above water level, so located that vessels may be loaded at two sides of the structure. The arrangement is such that ore may be dumped from bottom-dump cars to bins situated under the tracks, whence it may be spouted by gravity to the holds of vessels. To this end the floors of the ore bins are usually inclined at a slope of about 45° and surfaced with hard maple.

There are some thirty docks of this type on the Great Lakes. Of these, all but seven are of timber construction, the earlier docks being of smaller capacity and less height. Timber construction has the advantage of a smaller first cost, but because of the extremely heavy loads to be carried the depreciation of a timber dock is very rapid, the average life being from five to ten years. To be added to the expense of repairs are the extremely high insurance rates charged and the risk of the loss of business and profits sure to accrue in the event of fire.

These considerations have more recently led to the construction of semifireproof docks, of which there are seven now in existence. Four of these docks—two at Duluth, Minn., and two at Two Harbors, Minn.—are of steel-frame construction. Two docks at Allouez Bay, Superior, Wis., are built of concrete up to the underside of the bins, and of structural steel, wood and concrete above. The upper decks, platforms and bin floors are generally of wood, although two of these docks have concrete upper decks and one has concrete bin floors supported by a steel frame. One dock at Marquette, Mich., is of concrete reinforced with a steel frame.

In the design of the Ashland dock a radical change in the materials of construction was found to be economical because of present market conditions. Structural steel, which forms a large part of the semifireproof docks previously built, has increased in price to an almost prohibitive figure. Reinforced concrete, on the other hand, has not increased in nearly the same proportion.

This relative change in the price of materials renders a concrete dock more economical in spite of the difficulties inherent in the material. These difficulties are of two kinds—those of design and those of construction. The excessive loads to be carried, the problem of temperature stresses and of the unreliability of the material used are the most serious considerations of design. The expense and necessity of expansion joints are coniderably greater for a concrete than for a steel dock.

The peculiar difficulties of construction lie in the complicated formwork, the intricate reinforcing to be placed, ıe extreme concrete pressures to be encountered and in ıe short working season during which concrete can be ıfely poured in such an exposed position.

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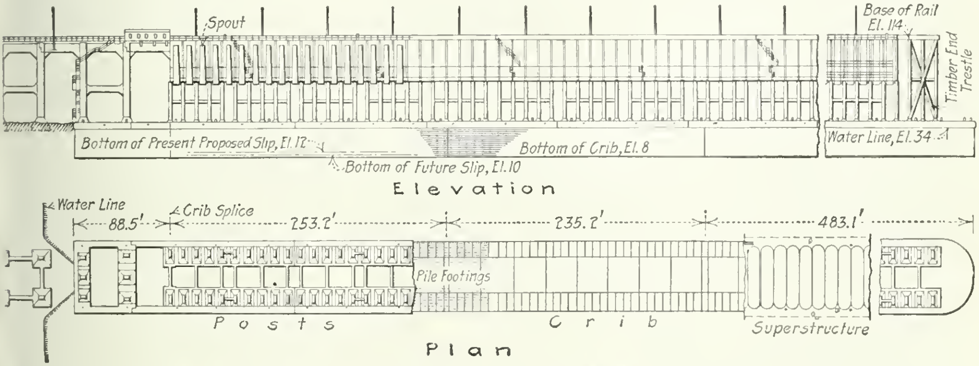
*Toltz Engineering Co., Pioneer Building, St. Paul, Minn.

All these difficulties are susceptible of a monetary valution; and when so considered, a reinforced-concrete dock considerably cheaper than any other type of fireproof re dock. It is also to be expected that the depreciation nd cost of maintenance will be considerably less for a ɔncrete than for a steel-frame dock.

Design of Ashland Dock

Reference to Fig. 1 will show that the Ashland strucıre consists of 160 lin.ft. of concrete approach trestle,)0 lin.ft. of ore dock proper and 72 lin.ft. of fender dock. his total length is separated by nine expansion joints ıto lengths of about 120 ft., provision being made for in. of expansion at each joint. The dock contains 150 ns, having a capacity of 9 cars each, making a total ıpacity of nearly 60,000 tons of ore.

The total load of the structure is carried on piles from) to 60 ft. long, driven into sand. In order to provide teral stability these piles are surrounded by a timber ib filled with coarse sand. Crib timber is to be native mlock, except the long cross-timbers, which are Oregon .



IG. I. GENERAL PLAN AND ELEVATION OF NEW ORE DOCK FOR MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE R.R. AT ASHLAND, WIS.

The intention is to build these cribs in suitable lengths d float them to the point of final location as soon as the ·nch for the slip, 25 ft. in depth, has been completed. ıey will then be sunk by filling certain compartments th sand. After the sinking of the crib the piling will be iven and cut off and the crib then completely filled with nd.

The construction of the crib is shown in Fig. 3. It is be built of 12x12- and 10x12-in. timbers, securely driftlted together. The crosswall timbers are to be doveıled into the front-wall timbers, in addition to the driftlting. The specifications call for the cribs to be made rmanently sand-tight, by means of 1x4-in. battens ıerever necessary.

The concrete substructure up to the top of the pyraıdal column bases is to be built of 1:3:5 concrete. It quite heavily reinforced to distribute contraction resses and stresses due to shocks from vessels striking e concrete fender, which is built as a part of the subructure. Attention is called to the convex cross-section the fender, which thus determines the exact elevation at which the shocks from the vessel will be received by th dock. The fender is protected by two lines of steel beams bedded into the concrete.

The columns of 1:2:4 concrete spaced 12 ft. on centers longitudinally by 42 ft. 3 in. across the dock, are figured as unreinforced-concrete piers. Such reinforcin as is provided is designed to distribute bending stresses due to shocks from vessels, contraction of concrete and wind load.

Two lines of 18x24-in. concrete struts running lengthwise of the dock between columns provide lateral stiffness for the columns in that direction. At bays midway between expansion joints the space between two columns is filled in with a 16-in. wall, properly reinforced to carry traction stresses from the structure above to the foundations.

Details of the Bin Walls and Floors

Extending across the dock and between columns are the 16-in. walls of the bins. These walls serve primarily as arch ribs carrying the loads from the trains, the ore in the bins and the dead-load of the structure directly to the columns. Arch computations have been based upon an elastic arch, due consideration being given to the deflection of the supporting columns. Temperature stresses in the arch have been neglected. The thrust of the arch is to be carried by a heavily reinforced concrete tie 16x30 in., running between the columns at the springing line of the arch.

In addition to the arch function these crosswalls serve as retaining walls to take the thrust of the ore when a single bin is filled, the adjacent bins being empty. These walls also serve as columns to carry the weight of the trains from the deck above to the columns below. They are so designed that the compressive stress due to bending acts at right angles to the compressive stress due to column action. This permits the use of much less reinforcing than would be necessary with the usual design where bending and direct stresses act in the same direction.

The inclined bin floors, carrying a load of over 5,00 lb. per sq.ft., span directly between the bin walls, which are 12 ft. c. to c. The floors are 18 in. thick at the lowe ends and taper to 12 in. at the upper ends. The usual maple wearing surface has been omitted from these floors. The upper surface of the concrete is to be made as smooth as possible by the use of good form lumber and well-tamped concrete. Rough places are to be chipped smooth and filled with cement grout. All corners in the bins are to be filled out with concrete fillets, thus doing away with all woodwork in the construction of the bins. The circular front walls for the bins, which are the characteristic feature of the Toltz ore-dock patents and which in previous designs have been made of steel plates, are to be built of concrete. Because of their circular shape the principal stresses from the thrust of the ore are tensile stresses, which are taken care of by running the band rods well back into the bin walls. The concrete structure up to the under side of the steel track stringers is designed to be structurally complete without dependence upon any of the structural-steel parts. The concrete is to be poured in three separate operations. The foundations up to the top of the column bases will be poured first, then the columns up to the under side of the bin floor. The concrete of the bins is to be poured at one continuous operation, one section of dock between expansion joints being carried up simultaneously.

Forms are being designed for a fluid pressure of 600 lb. per sq.ft., which, according to Prof. Adolph Meyer's experiments (see "Journal" of Association of Engineers' Societies, p. 199, Vol. 50), corresponds to a rate of pouring of not to exceed 3 vertical feet per hour at a temperature of 45° F. Forms for 360 lin.ft. of dock superstructure are to be made at the mill in suitable sections for handling, according to detail plans now being prepared in much the same way as shop drawings for structural steel. The large number of parts that are exact duplicates makes this unusual procedure economical. Because of the fact that the floor of the upper deck must be placed in the winter time, thus making the pouring of concrete slabs very expensive, it has been decided to build the upper deck of fir planking laid on steel beams, which form the bracing for the track stringers. All structural steel is arranged to be bolted in place at any time after the completion of the concrete work. The track stringers are made of structural steel, because concrete stringers would take up too much room, thus lessening the storage capacity of the ore bins. The track rails are to be riveted to the track stringers to prevent slipping. Steel doors of the patented Dickerson self-closing type are provided. They are so arranged that a part of a bin of ore may be run and the remainder cut off at will.

The 34-ft. steel chutes are of the type first used on the Great Northern Dock No. 4 at Superior, Wis. Attention is called to the straight sides of these chutes, which form girders not unlike the "pony trusses" of a through high-

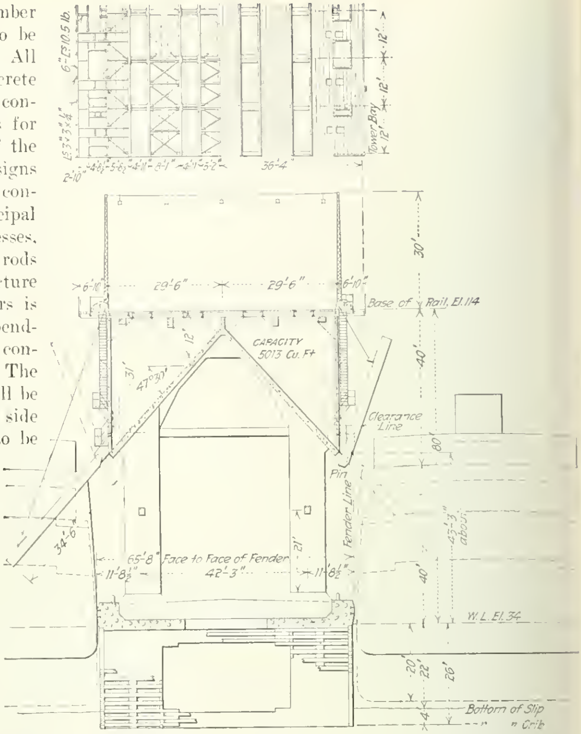
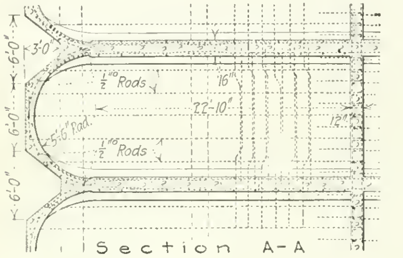


FIG. 3. SECTION THROUGH BINS AND PART PLAN



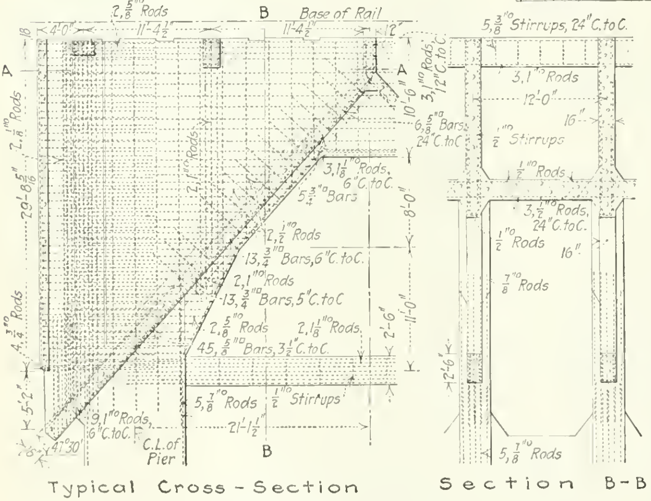


FIG. 2. DETAILS OF SUPERSTRUCTURE OF MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE R.R. DOCK

way span. They are designed to carry the load resulting from the chutes clogging full of ore weighing 170 lb. per cu.ft. The chutes are not counterweighted, but are raised and lowered by means of electrically operated hoists, located on the upper deck. These hoists are designed to raise or lower each chute in 32 sec. They are arranged in groups of ten, connected with a lineshaft which in turn is geared to a 25-hp. Crocker-Wheeler motor.

The upper deck is lighted by fifteen rows of five incandescent lights each, suspended from wire cables running across the dock between 30-ft. steel poles. The interior of the bins, the door platforms and the dock fender are all well lighted with incandescent lights provided with suitable reflectors.

The dock is to be reached by approximately 1,000 lin.ft. of double-track timber approach trestle. Connecting this timber approach to the dock proper is provided 160 ft. of reinforced-concrete trestle with ballasted deck, arranged to give rigid support for the necessary switches leading to the four tracks of the dock proper. As before stated in the case of the dock, a four-track trestle, 80 ft. high, would ordinarily be built of structural steel, but the present market conditions now render reinforced concrete more economical.

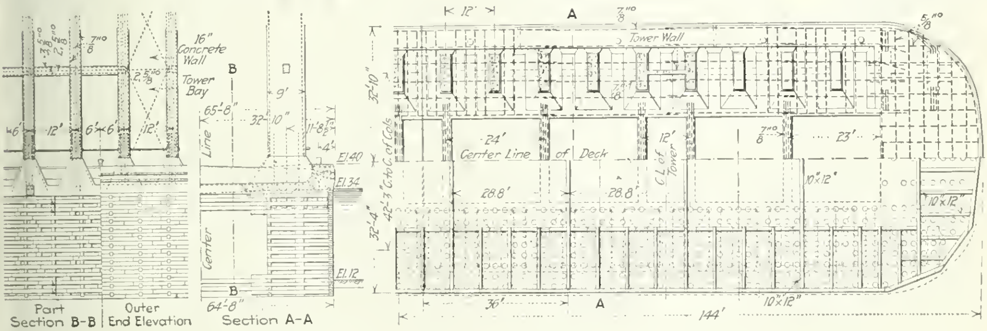


FIG. 4. FOUNDATION DETAILS OF ORE DOCK AT ASHLAND, WIS.

The trestle is made up of four 40-ft. spans supported on two two-column bents and two three-column bents. Expansion joints are provided at two points. The foundations are supported on piles and are rigidly fastened together to prevent relative motion between the various piers.

Provision is made at the outer end of the dock for a future extension. To provide for present needs a temporary wooden trestle is to be built. Upon this trestle will rest the bumping posts of the tracks and the signal lights of the dock.

SPECIFICATIONS FOR LOADS AND STRESSES

The dock is designed according to the following specifications:

1. Upper Deck Floor—Live-load, 125 lb. per sq.ft.
2. Trainloads—Cooper's E-50 engine loading or a loaded ore car weighing 160,000 lb.
3. Allow 25% impact in design of all track stringers and girders.
4. Figure wind loads at 30 lb. per sq.ft. on loaded structure and 50 lb. per sq.ft. on unloaded structure.
5. Weight of ore in bins considered in design estimated at 7 cars of 110,000 lb., 770,000 lb. Bin floors figured to carry this entire weight.
6. Lateral pressure of ore to be figured at $p = 30h$, where p is the horizontal pressure per square foot and h is the depth of ore to the point in question.
7. Bin walls are to be figured as an arch to carry all the loads enumerated except No. 1 and No. 3, which are to be disregarded.
8. Unit stresses in steel and concrete shall be figured according to American Railway Engineering Association specification.
9. Substructure to be figured to carry all the foregoing loads except No. 1, No. 3 and No. 4, but shall be designed to care for the effect of the horizontal wind stresses.

Concrete in the substructure is to be 1:3:5 mix and for the superstructure 1:2:4 mix, using gravel for the aggregate.

The general contractors for the substructure and concrete work are Foley Bros., Peppard & Fulton, of St. Paul, Minn.; for the structural-steel work, the Minneapolis Steel and Machinery Co., of Minneapolis, Minn.; for the hoists, the Clyde Iron Works, of Duluth, Minn.; for the electric wiring, W. I. Gray Co., of Minneapolis, Minn.

The dock was designed by the Toltz Engineering Co., Consulting Engineers, St. Paul, Minn. (of which Max Toltz is the president and mechanical engineer and W. E. King the structural engineer), under patents belonging to Mr. Toltz. All work is being done according to the direction of C. N. Kalk, Chief Engineer for the Minneapolis, St. Paul & Sault Ste. Marie R.R.

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Motor Vehicles in the United States have increased fiftyfold in the past ten years. Statistics just made public by the Office of Public Roads and Rural Engineering, based on state registration of motor vehicles, show that while there were only 18,000 vehicles registered in 1906 there were 2,445,664 registered in 1915. In view of the well-known heavy production of motor-car factories during the present year, it is probable that there are nearly 3,000,000 motor vehicles in service in the United States at the present time. In 1905 little had been done in the systematic registration and licensing of motor vehicles, and the total revenue collected by the various states amounted to only $62,500. In 1915, the state revenues from motor-vehicle licenses, permits to chauffeurs, dealers, etc., amounted to $18,245,000. Of this total revenue, fully 90% was applied to road work and a little over 70% was expended under the control of the state highway departments. The annual registration of motor vehicles is required in nearly all the states. In South Carolina, Texas and the District of Columbia, however, a car is registered once for all. In Mississippi, one registration by the state is sufficient, but an annual county license is also required. In Minnesota, motor vehicles are registered for three-year periods. The proportion of motor cars to population varies widely. Iowa has one for every 16 persons while Alabama has only one for every 200. The license fees in many states are still very low. In only 15 states is the average gross return from motor-car registration over $10, and many large states receive less than $5 per car. Vermont's average return from motor-car licenses is $18.10.

Compensation in Kind Involved in Hartford Water Case

By Caleb Mills Saville*

SYNOPSIS—United States Supreme Court holds private property can be condemned for compensation purposes in Hartford water-rights case. Compensation in kind is a public use.

For many years the proposition to replace water diverted from a stream by other water stored in reservoirs during periods of flood flow has been a difficult question in this country, and until recently there seemed little hope of obtaining favorable consideration in law for such a plan.

By mutual agreement this method has been employed in a few cases, but the broad principle of compensation in kind has never been established in the United States. In England compensation in kind in lieu of money damages has been practiced for many years, and an Act of Parliament or a commission sitting as a court may determine the amount of compensating water which must be provided. In the United States the usual method has been the payment of money damages, on account of the legal difficulties pertaining to the employment of the method of compensation in kind. Principally, this has been due to rulings of the United States Supreme Court that the just compensation guaranteed by the Constitution in the case of property taken by process of law can be provided only by payment of money.

With changing conditions, a new era in water-supply development has appeared, and by a recent decision the United States Supreme Court seems to have established a principle that will greatly smooth the way for the substitution of compensation in kind in place of money damages in cases of necessary diversion of water.

The United States Supreme Court (Manchester vs. Board of Water Commissioners of the City of Hartford, Conn., 863, 864 and 865, Supreme Court of the United States, October Term, 1915) has recently handed down a ruling relative to condemnation of property for compensation purposes that is most important in its present bearing and may be far-reaching in its future application. This ruling upholds the decision of the Supreme Court of Errors of Connecticut (Water Commissioners vs. Manchester, 87 Conn., 206, and 89 Conn., 677) and affirms that the condemnation of land for a compensating reservoir is a "taking for a public use" within the meaning of that expression in the first article of the Constitution of the State of Connecticut and is not contrary to the provisions of the 14th Amendment of the Constitution of the United States.

In 1909 the City of Hartford, Conn., petitioned the General Assembly of the state for authority to appropriate the waters of the Nepaug River and Phelps Brook and to construct an impounding reservoir for the purpose of obtaining an additional supply of water. These streams are tributary to the Farmington River and enter it in the vicinity of Collinsville, a manufacturing village situated in the north central part of Connecticut, about 37 mi. above the junction of the Farmington and Connecticut Rivers. The Farmington River is a rather fully utilized stream with ten principal power developments between the point of diversion and the confluence with the Connecticut. The total fall in this length is said to be about 168 ft. and the approximate amount of power developed or available in the neighborhood of 11,600 hp.

Because of the claim of the power owners along the river that the taking of the Nepaug River and Phelps Brook would deplete the flow in the main stream to such an extent as to occasion irreparable damage to their interests and those of the villages situated below the point of diversion, the petition of the city to take the water was denied by the General Assembly.

The necessity of the City of Hartford to obtain an additional supply of water, however, was well recognized, and as most of the power interests were owned or controlled by very public-spirited citizens of Hartford, the matter of an amicable adjustment of differences was worked out in a manner satisfactory to the principal mill owners.

In brief, the final solution of the problem provided for a compensating reservoir, so-called, located on a large tributary of the Farmington River, farther up stream. This reservoir would be filled in times of excess flow, and was of such size that its discharge during periods of low flow in the Farmington River would make up the deficiency caused by the diversion and be used in lieu of the waters taken for the supply of the city. In 1911 the General Assembly was again petitioned, and at this session an act was passed authorizing the taking of the Nepaug River and Phelps Brook for the supply of Hartford and also including authority to build a compensating reservoir.

ford and also including authority to build a compensating
General Assembly, the City of Hartford proceeded to acquire the land necessary for the purpose. Most of this was purchased at figures considerably in excess of assessed values, or at those estimated by impartial appraisers, and the Water Board was not at all niggardly in its settlements, recognizing the hardship to land owners on the one hand and the expense of litigation on the other.

The owners of two large and important properties at first would set no price, though later on they named figures that were absurd even in consideration of other settlements. Subsequently, one of these settled with the board for a large sum. The other carried his case through the state courts and up to the United States Supreme Court. This court approved the opinion of the state courts and gave final judgment in favor of the city. The matter then came back to a committee appointed by the state court for assessment of damages and is now in its final stage before that body.

The first legal move in this case was made Aug. 12, 1912, when a copy of the petition of the City of Hartford for the appointment of appraisers was served on the respondents and final judgment was given on Apr. 17, 1916, by the United States Supreme Court.

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*Chief Engineer, Hartford Water-Works, Hartford, Conn.

The respondents demurred to the appointment of ap- aisers on the following grounds: That the water of the mpensating reservoir was not for the use of the City Hartford; that the city was not required but simply thorized to return water to the river; that the mainte- nce of the flow of the river was not a public use but a ivate benefit to lower riparian owners; that the real rpose of the compensating reservoir was to enable the ty of Hartford to trade off the impounded water in lieu paying money damages; that such a purpose was un- rtain of accomplishment because lower riparian owners uld be legally entitled to take their compensation in oney; that the resolution, in so far as it purported to ke the respondent's land for the purposes of a compen- ting reservoir, was in violation of the constitutions of nnecticut and of the United States.

This demurrer was sustained by the judge of the perior Court, but on appeal the Supreme Court of rors of the state overruled the decision, holding that the king was for a public use and not contrary to the con- tution of the state or of the United States (87 Conn., 3 et seq.) and remanded the case to the Superior urt to be proceeded with according to law. Under this ling appraisers were appointed to establish the value of e land. Appeal was again made to the Supreme Court points of law. This appeal was not sustained. Appli- tion was then made to the Supreme Court of the United ates for a writ of *supersedeas*, and it was ordered issued Associate Justice Charles E. Hughes, Feb. 10, 1916, ree and a half years after proceedings were begun.

In sustaining the appeal from the judgment in the spondent's original demurrer, after disposing of other puted points, the court took up the principal question to whether the maintenance and regulation of the flow the Farmington River was or was not a public use, her in itself or in connection with and by way of com- nsation for the diversion of a part of the flow of the er to another watershed, for the use of the City of rtford. Especial notice was taken by the court of the portance of this river, the populous manufacturing vns and cities built up around its water powers, and its pability for use in other ways for industrial, commercial d municipal purposes, and that its floods and droughts st annually affect, directly or indirectly, many persons er than the riparian owners along its banks.

The principle was brought out that "public use" means blic usefulness, utility or advantage, or what is produc- e of general benefit, and in a previous case (Olmstead Camp, 33 Conn., 532, decided in 1866) the court said: t would be difficult to conceive of a greater public bene- than garnering up the waste waters of innumerable eams and rivers and ponds and lakes and compelling em with a gigantic energy to turn machinery and drive ills and thereby build up cities and villages and extend e business, the wealth, the population and the pros- rity of the state." and (87 Conn., 206) "It lies within e constitutional power of the General Assembly to de- re whether by general flowage acts or by special char- r, under what circumstances the right of eminent main may be employed to that end."

In sustaining the appeal of the petitioners the Supreme urt of Connecticut said (87 Conn., 209):

> We must recognize that the problem of securing sufficient d suitable water-supplies for our larger cities is an in- easingly difficult one; that in reaching beyond its immediate tershed a city encounters the opposition of localities seeking to retain their own water courses for their own benefit; that our New England streams no longer possess their former constancy of flow; and that the greatest demand on a municipal water-supply comes at the very time when the natural flow of the stream is likely to be lowest. A separate storage reservoir to impound freshet water and return it to the stream in times of low water may therefore be a logical and consistent engineering factor in a plan for improving a municipal water-supply as well as an instrumentality for conserving the flow of the stream.

What Constitutes Public Use

What constitutes a "public use" was the single Federal question involved. From the nature of the case this can be neither definite nor fixed, but must depend upon that which the public necessity, convenience or the welfare of society at a particular time may demand. To quote again:

> What is public use? Our historical research discloses the meaning of the term "public use" to be one of constant growth. As society advances, its demands upon the individual increase, and each demand is a new use to which the resources of the individual may be devoted (Tuttle vs. Moore, 3 Ind. Ter., 712).
>
> The definition of the term "public use" for which land may be appropriated should comprehend not only all existing public purposes justifying such appropriation, but should anticipate the further exigencies of society, demanding new laws and varied exercise of the protecting and fostering aid to the state (Concord Railroad Co. vs. Greely, 17 N. H., 47).

In the brief for the petitioners the following different classes of "public use" were given:

1. When the United States, a state or a municipal corporation seeks to acquire a parcel of land on which to carry out its proper public functions, or to perform some act directly enhancing the security or health of the community, as taking land for forts, schoolhouses, etc.

2. When the public is supplied with some commodity or convenience, as takings for railroads, water supplies, parks, etc.

3. When individual members of the public are enabled to cultivate their lands or carry on their business to better advantage, as construction of dams, building of levees, swamp and irrigation districts.

The opinion of the Supreme Court of Errors of Connecticut, sustained by that of the Supreme Court of the United States, while not establishing the principle of compensation in kind in lieu of money damages, does sanction the taking of land by eminent domain for the purpose of conserving waste waters and returning them to a stream, and it also holds that such action is for "public use" and not a violation of the Constitution of the State of Connecticut or that of the United States.

The United States Supreme Court affirmed judgment *per curiam* in these cases (Manchester vs. Board of Water Commissioners of Hartford, 863, 864 and 865, October Term, 1915, Apr. 17, 1916), upon authority of several previous cases, the last being that of the Mt. Vernon Cotton Co. vs. Alabama Power Co. (240 U. S., 30, 32). Mr. Justice Holmes, in delivering the opinion, said:

> In the organic relations of modern society it may sometimes be hard to draw the line that is supposed to limit the authority of the legislature to exercise or delegate the power of eminent domain. But to gather the streams and rivers from waste and draw from them energy, and so to save mankind from toil that it can be spared is to supply what, next to intellect, is the very foundation of all our achievements and all our welfare. If that purpose is not public, we should be at a loss to know what it is.

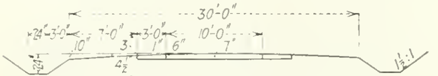
This judgment plainly shows that the right of state legislatures to condemn lands under eminent domain rests on the broad principle of public benefit, irrespective of how few there are who avail themselves of the privilege.

Planning and Organizing for Paving County Roads

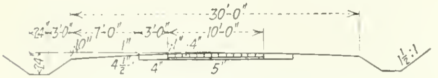
SYNOPSIS—Organizing to spend $1,500,000 in paving 166 mi. of county roads within two working seasons. Vermilion County, Illinois, organization and preliminary work are described as examples.

A county votes a $1,500,000 bond issue for paving 166 mi. in a system of main roads serving over 800 sq.mi. of territory. There is the usual objection on the part of some few disgruntled taxpayers, and the legality of the bond issue is in doubt for several months. The courts at length establish the legality of the bonds; meanwhile the public has become urgent in its demand to see the completed roads.

Starting without an engineering department or any engineering employee, other perhaps than a county surveyor, the problem is to plan, organize and start in operation an engineering staff that will have to determine the character and kind of pavements to be built, bearing in mind that all the roads of the predetermined system must be paved from the funds available; prepare detail plans, profiles and specifications, divide the work into convenient contracts, advertise for bids and let contracts, start work on numerous contracts almost simultaneously and keep everything running so smoothly that there will be no extras and so that these 166 mi. of pavement will be practically completed in a minimum of two working seasons—such is a not unusual demand of American communities.



Ten-Foot Concrete Road with Three-Foot Macadam or Gravel Shoulders



Ten-Foot Brick Road with Three-Foot Macadam or Gravel Shoulders

FIG. 1. STANDARD ROAD TYPES ADOPTED BY VERMILION COUNTY, ILLINOIS

To accomplish efficient results with such a lack of preliminary obviously requires some intensive executive work, system and accurate and careful planning. The problem of getting started promptly is often more difficult than that of design and supervision. Therefore, a somewhat detailed description of how the identical conditions described were met in Vermilion County, Illinois, should prove of interest. A general description of the work to be done and the method of financing it was published in *Engineering News*, Dec. 2, 1915, p. 1079.

Preliminary Surveys; Appointment of Engineer

The bond issue of $1,500,000 was voted in November, 1914, and in the spring of 1915 surveys were made by the county surveyor, and the system of roads to be improved was selected. It became evident to the authorities that the work would be of such magnitude as to require the services of a man who was both organizer and engineer, and in the agitation to secure such an expert the general public through the Danville Chamber of Commerce took a leading and insistent part. (Danville, with a population of 30,000, is the principal city and the county seat.) P. C. McArdle, acting chief engineer of the Illinois State Highway Department, was induced to become superintending engineer for the county in August, 1915.

At that time the courts had not passed on the bond issue and an engineering staff could not be organized nor detail work started until that was settled, which was nearly the first of the present year. For his staff the new superintending engineer was fortunate in being able to draw largely upon state highway employees with whose work he was familiar. The previous surveys and plans were first gone over and corrected. The road system to be constructed was divided into nine divisions.

Preparation of Plans and Specifications

Plans, profiles and cross-sections, about 1,800 drawings in all, were prepared in less than two months. These were plotted on Plate A 4x20 profile paper cut into 32-in. lengths. The horizontal scale of both plan and profile is 1 in. = 80 ft.

The scale at right-angles to the center line on the plan is double the longitudinal scale, or 1 in. = 40 ft. The vertical scale of the profile is 1 in. = 4 ft.

The plans show all section corners with references (the monuments are generally in the center of the road), bench-marks, fence lines, shade trees, farm entrances, property owners' names, location of drains and culverts to be built, and other data as necessary. About fifty of these sheets comprise a division. Five blueprint sets of each division were bound in brown paper covers for the use of bidders.

Cross-sections were plotted on sheets of the same cross-section paper, the scale being 1 in. = 4 ft. horizontal, and 1 in. = 4 ft. vertical. Ten cross-sections are plotted on a sheet 42 in. long. Sets of blueprints of these were also bound into books, one book for each division. The use of the same profile paper for plans, profiles and cross-sections materially simplified plotting as well as giving uniform-sized sheets for filing and handling.

The earthwork computations and estimates of each division were made by the engineer who later was to take charge of the construction in that division. His computa-

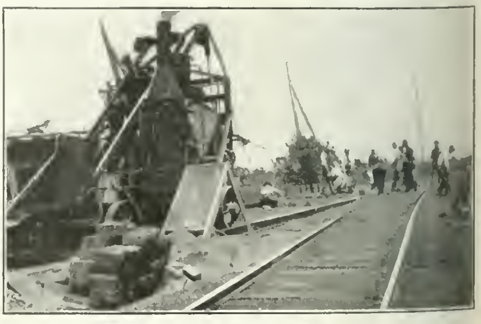


FIG. 2. BEGINNING THE FIRST MONOLITHIC BRICK PAVEMENT, JUNE 3, 1916

ns when completed were checked by one of the other vision engineers. This scheme not only rapidly familrized the engineers with the work ahead of them but s an additional inducement to thorough work. Each vision engineer was given a complete copy of his estites for use during construction should disputes and fferences arise. All estimates were made on standard rms and all computations so far as possible by mechanil devices. The same forms were later given to contracs upon which to submit their bids. The superintendg engineer gave a large part of his own time to the eparation of the specifications, proposals, advertisents for bids, etc. His principal assistant and the idge engineer prepared plans of standard culverts and rshaled data to assist bidders, as will be described later. ie other office employees include a draftsman and a rk.

Helping the Contractors to Make Close Bids

A thorough investigation was made of all the sources of istruction material. Available sand and gravel plants the adjoining part of western Indiana were inspected, ted and plotted on a small map 8½x11 in., which owed fourteen of these material bases as well as pavingck plants, and all the railroads connecting them and ving the territory in which the roads were to be built. ieprints of this were furnished gratis to prospective ders.

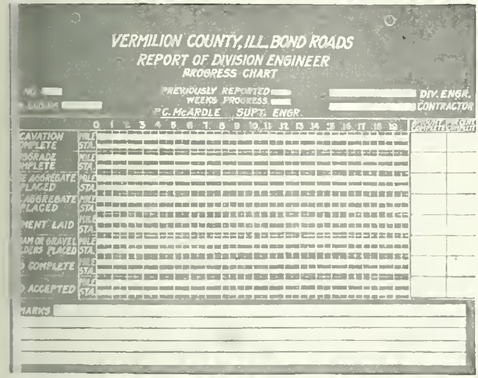


FIG. 3. PROGRESS REPORT BLANK, VERMILION COUNTY ROADS

onferences were held with the operating and engiring officers of the several railway companies whose s would be used for handling freight. Many special ings for the use of the highway contractors were agreed on, some of which were installed wholly at the cost of railways. It was also desired to secure the coöpera of the railways in eliminating certain grade cross. The officials of the Chicago & Eastern Illinois R.R. particular adopted a generous policy of coöperation l assistance.

Special maps 24x20 in. were prepared of each highway ision, showing all the roads, railroads and the sidings ilable for contractors' use. These were furnished tis to prospective bidders. Small maps were also preed on which all the important existing road grades e designated, the object being to assist bidders in planning the hauling of materials, or laying out narrow-gage railway lines. Similar plans were prepared showing the location and size (by an index number) of bridges and culverts to be built. To supplement these a small summary sheet was prepared listing all culverts, farm entrances and catchbasins and the quantity of material required for all structures including pavements for each division; so that the bidder had at his finger ends all the data to be gathered from a study of the detail plans and profiles. Bidders were not furnished copies of the highway plans and profiles, but five sets of blueprints of each division were available for inspection at the office of the supervising engineer.

Specifications and Types of Pavement

One set of specifications comprising a book of 24 pp. covered all the work. Proposals were all made on the standard forms furnished by the county. Unit prices were asked on four types of pavement—6-7-in. (6 at the side and 7 in. at the center) concrete, 6-7-in. monolithic brick (4-in. brick with 2-in. concrete base), 7-8-in. monolithic brick and 8-9-in. monolithic brick. All four types were designed 10 ft. wide with 3-ft. gravel or macadam shoulders. Unit prices were asked per square yard for each type of pavement complete, also per square yard for macadam shoulders, gravel shoulders, earth shoulders, concrete gutter and excavation, per cubic yard for reinforced concrete, plain concrete and gravel in the present road (to be paid for by contractor); also for catch-basins and tile drains per linear foot in sizes from 6 to 24 in. A lump sum covering the whole was asked. Bidders could make proposals on one or more of the nine divisions of 19 mi. each, and the proposals could be made on brick or concrete or both.

Brick was the preferred type and the method of choice between the two types after bids had been received was merely to build as much brick pavement as the available funds would permit, placing these pavements on the heaviest-traveled roads, and paving the remainder with concrete.

Copies of the specifications and small maps of the road system with the other data mentioned were mailed to 200 prospective bidders, and the work was advertised in *Engineering News* and other journals.

Large Numbers of Bidders and Low Prices

In response to these advertisements bidders appeared from all over the country and from Canada; in all 135 bids were received. For one division twenty-three bids were received; eight was the least for any one division. The number of firms or individuals bidding was forty. Bids for 6-7-in. concrete ranged from 60c. to $1.13 per sq.yd.; for 6-7-in. monolithic brick from $1.28 to $1.85; for 7-8-in. brick from $1.38 to $1.94, and for 8-9-in. monolithic brick from $1.48 to $2.04 per sq.yd. In every case the bids were received on the basis that the county was to furnish the necessary cement without charge to the contractor.

The average contract price for the 150 mi. of 6-7-in. concrete pavement (Fig. 1) for the nine divisions is 66c. per sq.yd. The average price for the 21¼ mi. of 8-9-in. monolithic brick pavement (Fig. 1) is $1.59. Only one contractor has contracts for more than one division. The great number of reliable bidders made it possible to distribute the contracts and yet keep very close to the minimum bids. The object of this was to engender competition in speed and workmanship on the different divisions, where work is to be done in every case under almost identical conditions.

The other two types of monolithic pavement, the 6-7-in. and 7-8-in., for which bids were received were approved by Illinois State Highway Department, but the county determined to select the heavier type. Mr. McArdle, however, is confident that these types could have been used with success. An experimental pavement including all three types was described by him in *Engineering News*, Jan. 27, 1916.

Quick Work After Letting

Within a few hours after the bids were opened blueprints giving a tabulation of all bids—a sheet 20x24 in.—and the awards were given to all parties desiring them. The contracts were all awarded on Mar. 17, and in accordance with the specifications work was begun on each division within fifteen days. In the meantime new data sheets were prepared, $7\frac{1}{4}$x$4\frac{1}{4}$ in., notebook size, giving quantities of all material required, culverts, etc., for each division as well as small scale reproductions of all standards. These were furnished to both field engineers and contractors.

A complete but simple cost-keeping system has been installed. All report blanks are letter-paper size, 8x10 in. There are division engineer's daily reports covering merely labor employed and materials used in different classes of work, daily reports of materials received, weekly reports on materials, labor, and weekly reports on progress of work and payments made, and final report blanks for culverts completed.

The progress report blanks (Fig. 3) are of Mr. McArdle's own design and show at a glance the progress of every stage of the work to within a few feet. Numerous shortcuts and labor-saving devices are in use. For instance, on a small cloth-mounted map of the county road system the superintending engineer has inserted in the proper places the names of all local road officials with whom he must coöperate from time to time. This furnishes a ready reference in time of need without consulting a notebook.

The inspectors report to and are responsible to the division engineers. Motor cars for the division engineers are not furnished by the county, but it is recommended that the division engineers purchase them, in which case the county makes an allowance of $30 per month for their operation. This appears the fairest and most economical solution of the problem, for the engineering staff will go out of existence on the completion of the roads, and the county does not want nine second-hand automobiles to dispose of. Moreover, it is impossible to restrict the use of publicly owned cars to public service.

Construction work is only touched on here as it is intended in a later article to describe how the work on the various divisions is being handled. Practically every contractor is using entirely new equipment. On all but two divisions, contractors are using narrow-gage trac with cars and dinkeys for hauling. One is using the track and cars but hauling by teams, while another is using tractors with wagon trains. Altogether the work will furnish some interesting studies in road building and methods of accomplishing results with a short space of time.

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Quarries for Kensico Dam

By Wilson Fitch Smith*

SYNOPSIS—Quarries produced 900,000 cu.yd. stone; two-thirds for concrete aggregate. Two types of drills used; spacing and depth of holes. Heavy blasting. Arrangement of crusher plant and cutting yard.

For the construction of the Kensico Dam (see *Engineering News*, Apr. 9 and May 21, 1914, and May 20, 1915) about 900,000 cu.yd. of stone for masonry was required as follows: Concrete aggregate, 635,000 cu.yd.; cyclopean stone, 235,000 cu.yd.; roughly squared stone masonry, 8,000 cu.yd.; dimension stone masonry, 22,000 cu.yd.

Although the land acquired for the reservoir included several possible areas that would yield the necessary stone, the most favorable site for a quarry was a ridge of Yonkers gneiss adjacent to the reservoir lands, about ¾ mi. from the east end of the dam. Being at a somewhat higher elevation than the top of the dam, it afforded an advantageous railroad location on about 2½% descending grade to the dam. After determining the nature and extent of the rock by core borings, the contractor, H. S. Kerbaugh, Inc., purchased about 50 acres on the ridge, constructed a two-track, standard-gage, stone-ballasted railroad between the dam and the quarry and developed the site on a large scale. Fig. 1 shows the quarry area and the plant layout. A small valley about 50 ft. lower than the top of the bridge divides it near the middle of the area. This the main track enters and the quarry has been opened to the general level of this track.

The rock is a gneissoid granite of grayish color having a streaked appearance. The upper layers are somewhat discolored and vary in color; the lower portions are more uniform in color and are very sound and clear. Across the grain it resembles closely the Barre granite. It

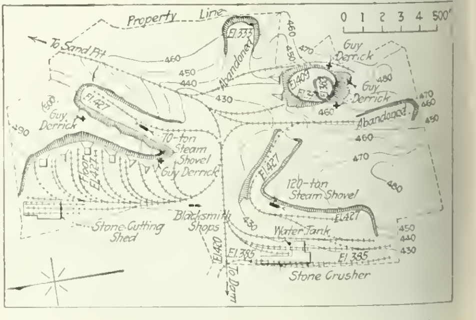

FIG. 1. PLAN OF QUARRIES FOR KENSICO DAM

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*Division Engineer, Board of Water-Supply, Valhalla, N. Y.

FIGS. 2 AND 3. (LEFT) PLUGGED DRILL HOLES DISTRIBUTED OVER THE UNCOVERED YONKERS GNEISS LEDGES; DRILLS IN DISTANCE. (RIGHT) AFTER THE BLAST

lishes well, and where accessory minerals occur, it esents a varigated appearance.

As concrete aggregate and cyclopean stone were the st products needed, the development began with these view. North Hill was stripped, revealing several res of glacial worn ledge (Fig. 2). A through cut is made on the western side at the level of the valley. he blasted rock (Fig. 3), loaded by a 120-ton Marion ovel with 5-yd. bucket into side-dump cars of 8-yd. pacity, was hauled to the crusher in 6-car trains. Siultaneously six other openings were made, where cycloan stone was quarried and loaded by derricks onto -yd. flat-cars. During the first season (1913) about 220,000 cu.yd. of crushed stone and 75,000 cu.yd. of cyclopean stone were produced.

The succeeding winter was spent in developing the quarry for the following working season. The east side of North Hill and the west side of South Hill were drilled and blasted for crusher stone, providing work for two steam shovels. The cut on the west side of North Hill was developed for cyclopean stone and equipped with 10 derricks and Southeast Hill was opened for the dimension-stone quarry. A very good quality of rock in thick sheets was found here at a depth of 30 ft. below the general surface. In 1914 340,000 cu.yd. of crushed stone and 120,000 cu.yd. of cyclopean stone were pro-

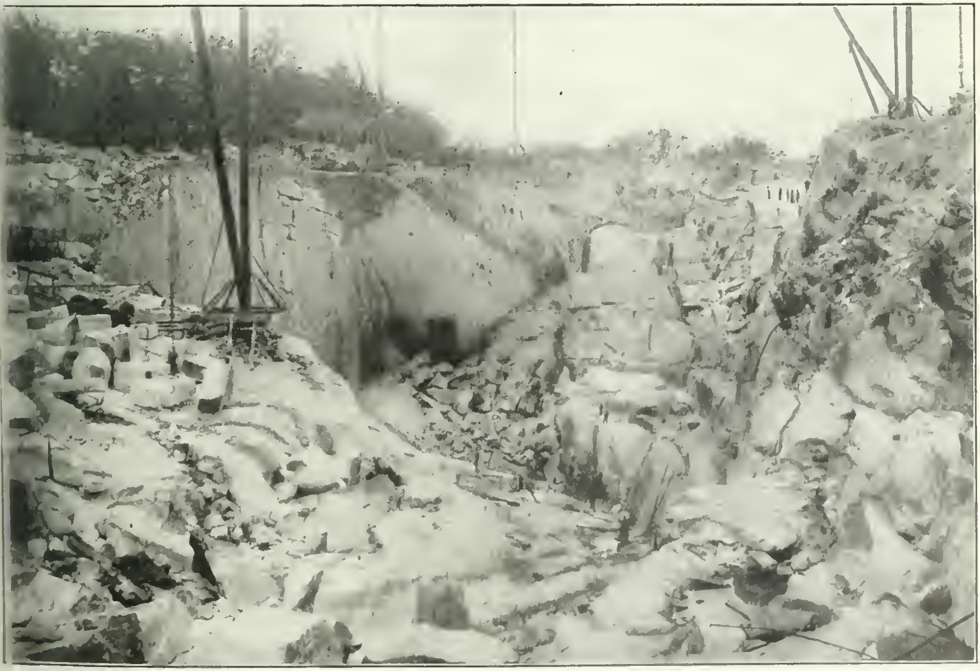

FIG. 4 QUARRY IN SOUTHEAST HILL WHERE THE 8x12-FT. PIECES WERE OBTAINED

duced. During this year active work on the dimension stone was begun and 9,000 cu.yd. was cut and dressed.

During the past season the principal product was for dimension stone. The west face of North Hill was worked for the smaller sizes. Southeast Hill was quarried for the larger stock and at a depth of 50 ft. some remarkably thick, clear and uniform sheets were developed, providing stock for the largest stones required, which were 8x12 ft. (Figs. 4 and 6). The byproduct from these two quarries provided all of the crushed stone and cyclopean stone required. From the beginning the quarry has been operated so as to utilize the entire product, and there has been practically no waste.

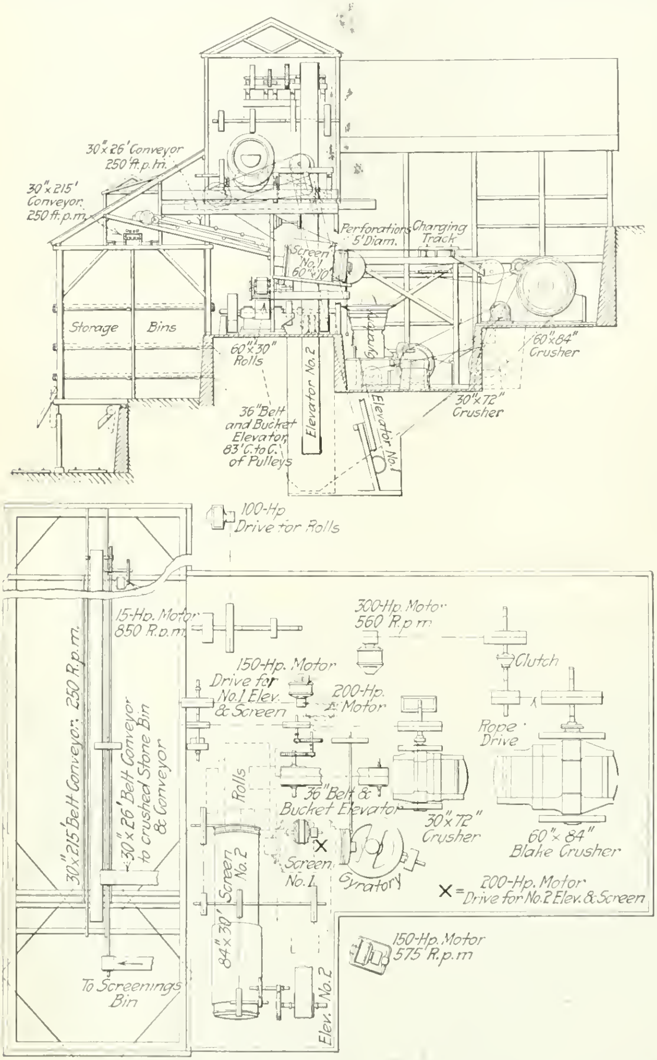

FIG. 5. CROSS-SECTION AND PLAN OF LARGE TEMPORARY CRUSHING PLANT

Two distinct types of drills were used for drilling the deep holes for large blasts in the quarries for crusher stones—the Temple-Ingersoll electric air wagon drill (type 5-F), and the Star drilling machine of the oil-well type, using a bit 4½ in. in diameter. The Temple-Ingersoll drills were effective only to a depth of 48 ft., and averaged 30 ft. a day. The well drills were effective to any depth and averaged about 7 ft. a day.

As a result of two years' experience, it was found that for the crusher stone the most economical spacing of the holes was 15 ft. c. to c. up to 45-ft. depth. Deeper holes were spaced 20 ft. Where it was desired to obtain some cyclopean stone in the large blasts, the well drills gave the better results. With these the most economical spacing of holes was 25 ft. in lines 50 ft. apart, parallel with the axis of the cut. This spacing averaged 46 cu.yd. of rock per foot of depth. Both types of holes were heavily sprung. This operation was more easily accomplished in the larger holes of the well drills, and this considerable advantage tends to the favoring of the well drill for this class of work. For the regular quarry work the Type 5-F Temple-Ingersoll electric air tripod drill was used for holes up to 25-ft. depth. The equipment consisted of four electric carriage drills, four well drills and nine tripod drills. Electric current was furnished from the transformer house at the dam at 2,000 volts and stepped down to 250 volts at the quarry. In the crusher-stone quarrie it was desired to break up the stone to a size convenient for the steam shovels to handle. The first year three large blasts were fired in North Hill, the charges and spacing of holes varying somewhat in order to determine which would give the best results. The holes were all drilled by the Ingersoll-Rand drills and were from 15 ft. to 40 ft. deep. The quantities are as shown in the table below. The average charge of dynamite per cubic yard of rock loosened for all three blasts was 0.15 lb. for springing and 0.52 lb. for blasting. In the second season the well drills were used. The average depth of hole was 40 ft., and on the adopted spacing of 25x50 ft. each hole represented about 1,840 cu.yd. of rock. The normal charge of 0.6 lb. dynamite per cu.yd. required about 1,100 lb. in each hole. It was therefore necessary to spring, or chamber, the holes at the bottom to a size that would receive the charge. In the deep holes this meant a chambe 5 ft. in diameter, and to obtain this each hole had to be sprung a number of times. In some instances as much a 750 lb. of dynamite was used to obtain the require chamber.

No. of Holes	Lin.Ft. Holes	Cu.Yd. Loosened	Lb. Dynamite Springing	Lb. Dynamite Blasting	Electric Exploders
85	2,028	32,670	6,050	20,150	505
135	2,416	36,968	4,000	24,100	550
200	8,000	120,000	22,000	65,000	4,100

The crusher was located on the steep westerly slope of outh Hill, with the floor 45 ft. above the track level ader the bins. It consisted of a primary 60x84-in. w crusher of the Blake type. The product passed to e secondary crusher of the same type, 30x72-in. This duced the stone to about a 4-in. size. The product as raised in a 36-in. bucket elevator and delivered to a :12-ft. revolving screen having 5-in. holes. The stone ssing this screen fell to the foot of a second bucket evator. The rejections went to a No. 8 McCully gyrary crusher and to the second elevator. This took the mbined product and lifted it 80 ft. to a revolving reen 7 ft. in diameter by 30 ft. long, equipped with st jacket and 3-in. holes. The material passing this een was delivered to the storage bins by belt convors, the rejections falling to a pair of 60x30-in. crush- rolls and returning to the main bucket elevator. All the parts are operated by electricity, there being seven its with a combined horsepower of 1,115 (Fig. 5).

The bins, with a capacity of 8,000 cu.yd., are of framed iber fireproofed on the outside with cement stucco (on re lath) applied with a cement gun. The crusher se is partly steel frame covered with corrugated iron. T stone cars dump directly into the hopper of the nary crusher. The average output of crushed stone 110 cu.yd. per hr., with a maximum of 200 cu.yd. ing the season of 1914 the crusher was operated t shifts per day in order to maintain the supply to l dam.

IG. 6. ROOFED-OVER PORTION OF CUTTING YARD

Stone-Cutting Yard

he exposed downstream surface of Kensico Dam is d with stone masonry (see *Engineering News*, Sept. 2, 915). The design emphasizes the magnitude of the cture by the use of large stones and rough cutting, le the architectural details of pavilions, fountains, t require dimension stones of elaborate shape and fine ing. To prepare the 22,000 cu.yd. of dimension e of all classes, a cutting yard was established at north end of the quarry. This is 60 ft. wide by ft. long, and is covered by a 25-ton Shaw electric ge crane. For 185 ft. the yard is roofed over (Fig. About 75 stone cutters with attendant labor have employed for two years in dressing the required e. Pneumatic tools are used to the extent possible. equipment includes nine Oldham surfacing machines 50 plug drills.

The Massachusetts Lien Law as Revised

The agitation to obtain modification of the lien laws of Massachusetts at length resulted in a new law being passed, in 1915, which became effective on Jan. 1, 1916. The old law provided that no liens should attach for materials "unless the person furnishing them, before so doing, gives notice in writing to the owner of the property to be affected by the lien (if such owner is not the purchaser of such materials), that he intends to claim such lien." The new law does away with the requirement of notice to the owner and contains three provisions described by the Master Builders' Association of Boston, as follows:

1. That any person who enters into a written contract with the owner of land, for the whole or any part of the erection, alteration, repair or removal of a building or structure upon land, or for furnishing material therefor, shall have a lien upon said building or structure, and upon the interest of the owner in said lot of land as appears of record at the date when notice of said contract is filed or recorded in the registry of deeds for the county or district wherein such land lies, to secure payment for all labor and materials which shall thereafter be furnished by virtue of said contract.
2. That any person who shall, subsequent to the date of filing or recording notice of a contract as above described, furnish labor or materials for the property involved under a contract with a contractor, or with any subcontractor of a contractor, shall be entitled to a lien upon the premises described for any labor performed or labor or materials furnished subsequent to the filing or recording of said notice and prior to termination of contract as stated in notice.
3. The notices of the existence of such contracts with an owner may be filed or recorded by any person entitled to a lien under the Act.

The right of lien of a personal laborer remains as under the old statute, save that his right is limited as to extent of his lien, by the proviso that it shall not hold for more than 18 days' work actually performed during the 40 days prior to the filing of his statement of claim.

The Association appears to feel that the law as amended should satisfy all parties concerned, claiming that the contractor is given right of lien, which he never had before, dependent only upon the filing at the Registry of Deeds of a simple form of notice of the fact of his contract. The subcontractor and the supply man have the right of lien dependent only upon filing notice of the existence of the general contractor's contract with the owner. The loaner of money on security which real estate furnishes has the record to guide and protect him, while the owner has definite and certain rules to govern him.

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A Motor Road Train equipped with the Thomas transmission system, a combined electrical and mechanical system of speed-varying power transmission, has been built by Armstrong, Whitworth & Co., and is now in operation in Yorkshire, England, according to the "London Times." The train consists of a tractor and two trailers. The total dead weight is about 14 tons. The tractor carries a 75-hp. gasoline engine which drives an electric generator, and also drives mechanically the driving axle of the tractor. In starting, most of the power of the engine is converted into electricity and drives motors on the two trailers. After the train is once started, so long as the adhesion of the tractor is sufficient to haul the trailers, the entire power is transmitted mechanically to the tractor axle so that there is no loss in electrical transmission. The various steps in the mechanical and electrical transmission give ten intermediate speeds. The steering of the trailers is automatic so that they follow in the track made by the tractor. The brakes on the trailers are operated electrically by the driver of the tractor. The train is capable of carrying a load of 20 tons which may be increased to 36 tons. The ordinary speed is 12 mi. an hour. It is claimed that 75 to 80 ton-miles can be obtained from a gallon of gasoline. Plans have been made for a five-vehicle train capable of carrying a maximum load of 60 tons. The equipment is controlled by the Thomas Transmission Co. of 14 Leonard Place, Kensington, London.

Jacketing a Railway Tunnel by Mining Methods

SYNOPSIS—A railway tunnel settled, dropping portions of the brick lining on the tracks. To keep traffic moving, it was decided to reinforce the lining from the outside. Working headings were driven on each side of the tunnel and material over arch excavated for from 7 to 10 ft. in height. Concrete was blown into this space, forming a thick jacket about the arch. The working drifts were then blown full of concrete.

A remarkable piece of tunnel reinforcing is nearly complete on the Pennsylvania R.R. main line at Greensburg, Penn., some 30 mi. east of Pittsburgh. For a number of years constant trouble has been experienced with the brick lining of portions of the Radebaugh tunnel. Parts of the lining became misplaced and fell on the tracks from time to time, but it finally developed that at least 850 ft. of the tunnel—which is about 2,050 ft. long—must be rebuilt or else the tunnel should be abandoned and an open cut made in its place. The cover over the tunnel is 150 ft. in maximum thickness. The cause of the trouble is that there is a vein of coal in the hill which the tunnel penetrates, and for 800 ft. or more the tunnel lining is supported on this vein. This soft coal gradually crumbled under the weight imposed and the tunnel settled.

After studying various plans of remedying the difficulty, it was decided to inclose the brick lining of the tunnel, where settlement had occurred, with a concrete jacket placed from outside the brick arch. This work is necessarily expensive. It is being done by the John A. Kelly Co., of Philadelphia, by force account. In spite of the novel nature of the work, there have been no accidents due to falls of brick during the 10 months of construction, and traffic has continued without interruption.

Working Heading Driven on Each Side of Tunnel

Excavation at the east end commenced in September, 1915. Headings were driven along the outside of the lining parallel to the tunnel and 10 ft. above top of rail. These drifts were 6x6 ft. inside the timbering. They advanced 3 ft. per shift, there being two shifts per day on each heading.

Some time previous to the contract, railway forces, in order to repair one of the breaks, sank a shaft at a point 850 ft. from the east portal and placed a concrete slab over the break and filled up the shaft. The contractor dug out and retimbered the shaft and used it as a means of access to the west end of the working drift. The headings started eastward from this shaft on Oct. 1, meeting at Sta. 4 + 50 in January, 1916.

The timbering of these drifts was never more than 6 ft. behind the face and consisted of 12x12's placed on 3-ft. centers. In January general excavation was started in both the north and south drifts making crossover galleries over the tunnel arch at seven points, the first being Sta. 3 + 45 (see Fig. 2). The muck was thrown down from the arch into the drifts, picked up by muckers, loaded into 4-yd. cars and hauled out by dinkey on a 3-ft. gage.

Timbering of the arch followed the excavation. The timbers were sawed by carpenters in the daytime and were erected in the daytime, 3 ft. each day, by the timber force. There were nine segments to the set, and every tenth ring of segments (at every 30 ft.) was omitted to make room for the blower pipe, all concrete being placed by the pneumatic system.

Pneumatic Concreting Plant

The concreting plant was laid out as simply as possible and was located about 200 ft. west of the portal. The sand and gravel bins were built over the feeding hopper above the blower, from which an 8-in. steel pipe ran through the north drift to the shaft. Thus the maximum distance of blow exceeded 1,000 ft.

There were two inclines in the piping, a 16-ft. rise to the drift and a 10-ft. rise to the top of the arch. The grade of the drifts, which was 0.4% (being the same as the grade of the tunnel) produced another and continuous rise in the piping. These rises, or inclines, are given great credit by the contractor for the fact that the batches were discharged without separation or distribution along the pipe run. The rate of placing concrete varied according to the length of the piping. When the work went on at its best speed, a ½-yd batch was placed every 1½ min. In the longer runs 4 min. per batch was required. The batch must be out of the pipe line before another can be admitted.

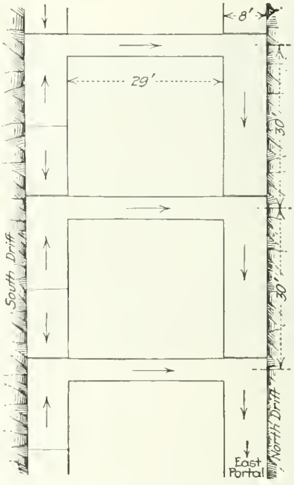

FIG. 1. HOW THE WORKING DRIFTS AND JUMPOVERS WERE CONCRETED

The compressor station has a capacity of 2,700 cu.ft. of free air per minute. There is plenty of air for blowing the concrete, for drilling the rock and for any other work requiring air power. This sufficiency of air is a vital point in the smooth progress of the work. Sand and gravel used in the concrete were brought by rail, as was also the cement, which was stored in a shed near the concreting plant.

The concreting proceeded in sections 30 ft. long between bulkheads. The 8-in. pipe was carried up to the center of the arch, and the concrete flowed out and ran down on either side. This scheme was carried out wherever feasible, in order to maintain an approximately equal pressure on both sides of the arch. At some points a flexible metal hose was used to distribute the concrete over the arch. The concrete flowed down to the side forms, filling these and then running over the roof of the drift, down the other de of the working drift and ıder the floor the drift, un l the latter ıs entirely inɔsed in conete and formed erely an openg in the monothic jacket. hen concreting ıs first started, e floors of the orking drifts re concreted 200 ft. on th sides. All e timbering s left in, of urse. The avage thickness the jacket ies from 5 to ft. above the h, with a maxum of 10 ft. e arch conting was nearl complete by y 1. It was n time to beto fill the king drifts, l this work carried on a shown in Fig. 1 First, the ext e m e western t of the north ft was filled, t e concreting e being withwn in an erly direction ing this option. As indid by the arr ws, at the jumpover, which w a space left ween the bulkds over the to allow for ing the blowpipe, this pipe w carried over the south headn, which was creted in an erly direction u l the jumpwas reached. T concreting D was then

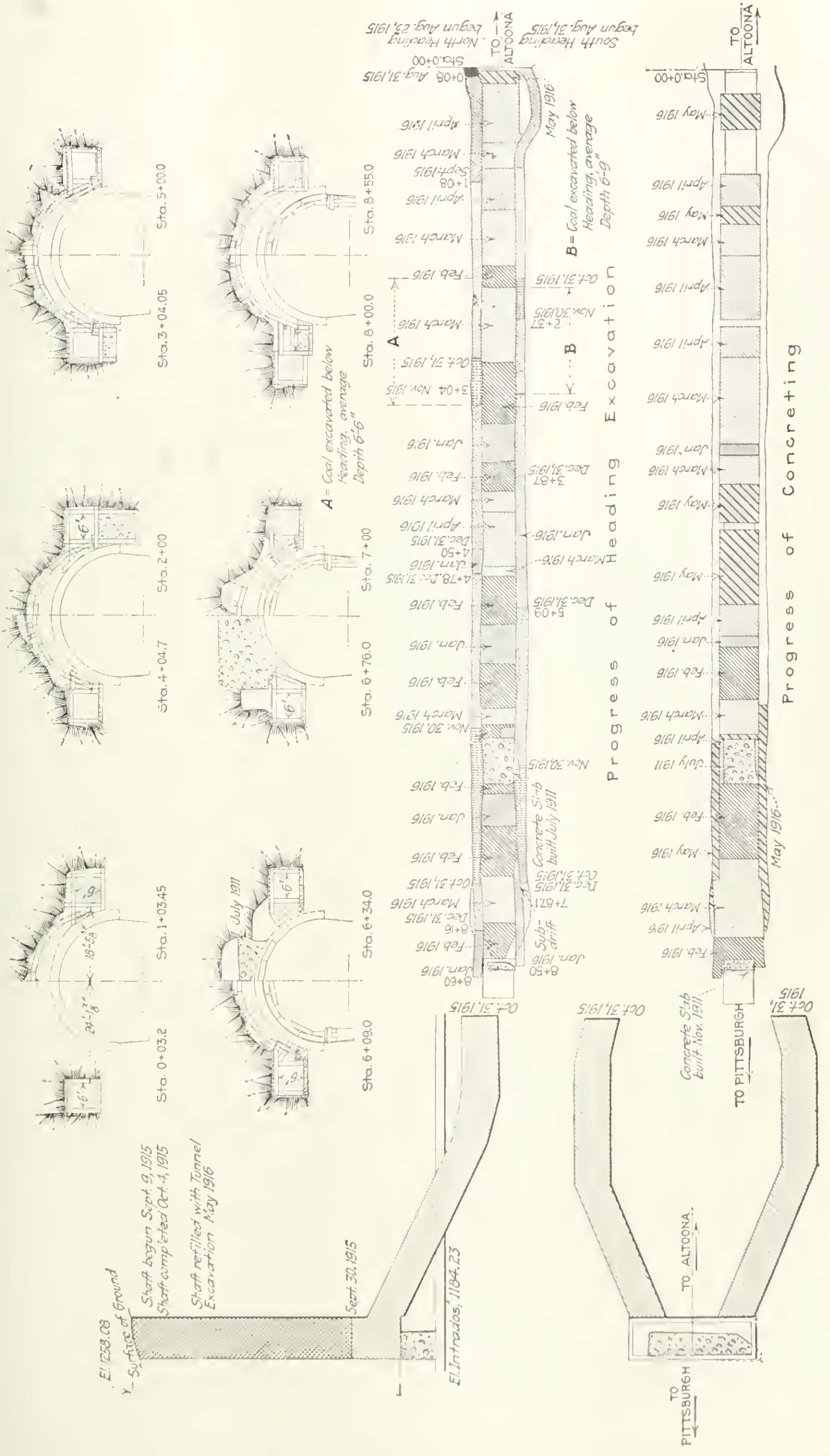
Sta. 5+00.0
Sta. 3+04.05
Sta. 2+00
Sta. 4+04.7
Sta. 1+03.45
Sta. 0+03.2
Sta. 8+55.0
Sta. 8+00.0
Sta. 7+00
Sta. 6+76.0
Sta. 6+34.0
Sta. 6+09.0
July 1911
6'
18'-5"
24'-
A = Coal excavated below Heading, average Depth 6'-6"
B = Coal excavated below Heading, average Depth 6'-9"
North Heading begun Aug. 23, 1915
South Heading begun Aug. 31, 1915
TO ALTOONA
Sta. 0+00
0+08 Aug. 31, 1915
May 1916
Concrete Slab built July 1911
Sub-drift
Progress of Heading Excavation
Progress of Concreting
El. 1258.08
Surface of Ground
Shaft begun Sept. 9, 1915 Shaft completed Oct. 4, 1915
Shaft refilled with Tunnel Excavation May 1916
Sept. 30, 1915
El. Intrados, 1184.23
Oct. 31, 1915
Concrete Slab built Nov. 1911
TO PITTSBURGH
TO ALTOONA

FIG. 2. PROGRESS OF THE EXCAVATION AND THE CONCRETING WITH NUMEROUS CROSS-SECTIONS OF THE CONSTRUCTION IN REPAIR OF RADEBAUGH TUNNEL

carried to a point half way between that bulkhead and the one just east of it. The pipe was withdrawn in a westerly direction, the drift being filled with concrete in this manner. When the concreting had reached the jumpover, the pipe was drawn through and the concreting continued. In the north heading the pipe was withdrawn in an easterly direction until the next jumpover was reached, when the pipe was carried across to the south heading and concreting started at the point where the last concrete in this heading had been placed, the pipe being withdrawn in an easterly direction until the bulkhead was reached and then being carried to the halfway point between bulkheads and withdrawn in a westerly direction until the jumpover was reached, when it was once more carried through to the north heading. This procedure was maintained until the two working drifts were filled with concrete. Meanwhile the shaft at the west end of the drifts was filled up.

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Rectification of the Catenary

By Frederic R. Honey*

The catenary, which is the curve assumed by a perfectly flexible rope or chain whose extremities are fastened at the points a and b, the weight of a unit length being constant, is represented at aob in Fig. 1. Since plotting and rectifying the curve involve a great deal of numerical work, it is desirable to devise a means by which its length may be measured without reference to its equation. If plotted on a large scale the drawing may thereafter be used for any catenary the proportions of which are assigned, and its length may be determined by the application of approximate measurements which give a result suitable for all practical purposes.

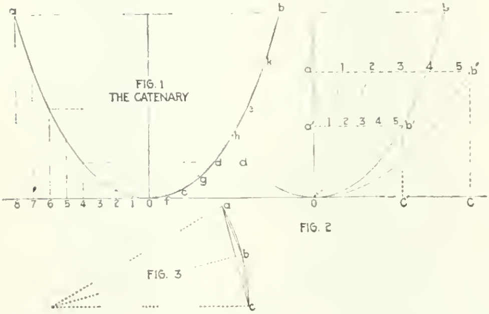
FIG. 1 THE CATENARY

FIG. 2

FIG. 3

When the origin is taken at the lowest point o the equation of the catenary is $y = \frac{c}{2}\left(e^{\frac{x}{c}} + e^{-\frac{x}{c}}\right) - c$. In this equation any value may be assigned to the constant c, and ϵ is the base of the hyperbolic system of logarithms $(= 2.7183)$. The logarithm of this base is 0.4343. Making $c = 4$ the equation becomes $y = 2\left(e^{\frac{x}{4}} + e^{-\frac{x}{4}}\right) - 4$. For $x = 0$, $y = 2\ (e^0 + e^{-0})\ - 4 = 0$. The values of the ordinates for the corresponding abscissas are given in the table, which may be extended indefinitely. Fig. 1 is a plot of the curve, in which the unit $0 - 1 = 1 - 2$, etc., may be assumed of any convenient length.

If it be required to plot a catenary whose lowest point is o (Fig. 2), which shall pass through any assigned point b'' whose abscissa is oc and ordinate cb'', join ob'' intersecting the curve which is a reproduction in part of Fig. 1, at b'. The part of the catenary between the points o and b' is similar to the required curve ob'', which is a magnification of ob' in the proportion $ab'' : a'b'$. The length of the new unit on ab'' is determined by producing the lines drawn from o through the points 1, 2, 3, etc., on $a'b'$ intersecting ab'' in the corresponding abscissas for the enlarged curve.

Fig. 2 illustrates the catenary curve when the extremities are fastened at different levels b and d. So far as it is plotted it is a copy of the original, Fig. 1.

To Rectify the Catenary

The formula for rectification is $\frac{c}{2}\left(e^{\frac{x}{c}} - e^{-\frac{x}{c}}\right)$. Huygens'[1] approximation to the length of a circular arc is illustrated in Fig. 3, in which ac is the chord of the arc, and ab $(= bc)$ the chord of half the arc. The length of the arc is $\frac{8ab - ac}{3}$. The error—which may easily be discovered by trigonometry—when the radius of the arc which subtends an angle of 30° is 100,000 ft., is only about 2 in.—a negligible quantity in a measurement of about 10 mi. The length of an arc of a circle through the points o, f and c is practically equal to the part of the curve between the points o and c. Similarly the parts cd, de and eb may be measured; and the total length of the curve $ocdeb$ will be equal to

$$\frac{8(of + cg + dh + ek) - (oc + cd + de + eb)}{3}$$

VALUES OF x AND y

x = 1 y = 0.14   x = 3 y = 1.18   x = 5 y = 3.55   x = 7 y = 7.85
x = 2 y = 0.51   x = 4 y = 2.17   x = 6 y = 5.40   x = 8 y = 11.04

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Flow of Water Into Wells; Approximate Theory

By N. Werenskiold*

When open wells are sunk to a horizontal impervious stratum and pumped to their maximum, the water table will be lowered to depression curves with very steep slopes, as is indicated in Fig. 1.

Assume that the original water table is horizontal, that the water-bearing sand is uniform and that the original depth of the groundwater is H. Let k = transmission constant for sand; r = radius of well; R = radius of depression (influence) circle; d = depression and h = depth of water in well when operated; x and y = coördinates of any point of the depression curve; z = height above impervious stratum of any particle flowing through vertical section y; α = angle with horizontal of depression curve at point (x, y); β = angle with horizontal of direction of flow at point (x, z); q = rate of flow through vertical section y with unit width; Q = rate of flow into well; $A = \frac{Q}{2\pi k}$; $B = \sqrt{0.384\ A^2} = 0.62\ A$.

With reference to point (x, z), Fig. 1, it seems reasonable and permissible to assume $\frac{\tan \beta}{\tan \alpha} = \frac{z}{y}$, and consequently the small amount flowing through a vertical sec- ion dz is

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[1] See "Williamson's Differential Calculus," p. 67.

*Trinity College, Hartford, Conn.

*Civil Engineer, Flateau Building, Dallas, Tex.

$$dq = kdz \tan a \cos^2 \beta$$

Integrating by the formula

$$\int \frac{dx}{1 + c^2x^2} = \frac{1}{c} \tan^{-1} cx$$

ve get, since x and y remain constant,

$$q = k \tan a \int_0^y \frac{dz}{1 + \left(\frac{\tan a}{y}\right)^2 z^2} = kya$$

hen $Q = 2\pi xkya$, and $a = \frac{A}{xy}$.

Within a maximum error of 2% of the arc, as may be eadily checked by the use of trigonometric tables, the

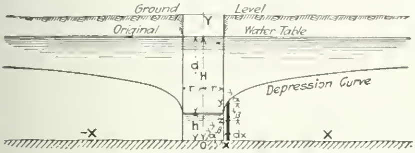

FIG. 1. DEPRESSION CURVE OF A WELL
For r = 0.2H, R = 50H, h = 0.265H, and d = 0.735H

lation between the tangent and the arc of an angle may expressed by

$$\tan a = \frac{a}{1 - 0.384a^2}$$

hus, approximately, the differential equation of the pression curve becomes

$$\frac{dy}{dx} = \tan a = \frac{A}{xy\left[1 - \left(\frac{B}{xy}\right)^2\right]}$$

There seems no way in which to integrate this directly; t since the last term in the denominator, and with it y error in this term, may be neglected with increasing lues of x, it appears permissible to substitute (in this m only) an approximate value for y, such that $y = h$ r $x = r$. The hyperbola $y = H - \frac{(H - h)r}{x}$ gives fficiently accurate results. It leads to

$$\frac{dy}{dx} = \frac{A}{xy} \frac{1}{1 - \left(\frac{B}{Hx - rd}\right)^2} = \frac{A}{xy} \frac{(Hx - rd)^2}{(Hx - rd)^2 - B^2}$$

$$y = A\left[\frac{1}{\left(1 - \left(\frac{B}{rd}\right)^2\right)x} + \frac{1}{2\left(1 + \frac{rd}{B}\right)\left(x - \frac{1}{H}(rd + B)\right)} + \frac{1}{2\left(1 - \frac{rd}{B}\right)\left(x - \frac{1}{H}(rd - B)\right)}\right] dx$$

$$y^2 = H^2 + 2.3A\left[\frac{2}{1 - \left(\frac{B}{rd}\right)^2} \log \frac{x}{R} + \frac{1}{1 + \frac{rd}{B}} \log \frac{Hx - (rd + B)}{HR} + \frac{1}{1 - \frac{rd}{B}} \log \frac{Hx - (rd - B)}{HR}\right]$$

Where $rd + B$ and $rd - B$ can be neglected as com- red with HR, this equation may be reduced to

$$y^2 = H^2 + 4.6A \log \frac{x}{R}$$

Where the depression and slope are small, say a less than 0.524, $\cos \beta$ in the foregoing expression for dq may be assumed equal to 1, so that $dq = kdz \tan a$. From this, $q = ky \tan a$, $Q = 2\pi xky \frac{dy}{dx}$, $\frac{dy}{dx} = \frac{A}{xy}$, and $y^2 = H^2 + 4.6 A \log \frac{x}{R}$, as before. On this assumption is based the theory which has been used for more than 30 years and which is ably treated in Turneaure and Russell's "Public Water Supplies" and in other works.

The relation between h and A, or Q, must be such that:

$$h^2 = H^2 + 2.3A\left[\frac{2}{1 - \left(\frac{B}{rd}\right)^2} \log \frac{r}{R} + \frac{1}{1 + \frac{rd}{B}} \log \frac{rh - B}{HR} + \frac{1}{1 - \frac{rd}{B}} \log \frac{rh + B}{HR}\right]$$

$$= H^2 + 2.3AM$$

By first inserting an approximate value for B, or h, in the expression for M a more accurate value will be obtained by solving for A, or h. By substituting the value thus found in M a still more accurate value will be found, till the equation is satisfied. The first approximation may be obtained from the more approximate theory.

By assuming r, h and d as parts of H, R as multiple of H, and A and B as parts of H^2, a general and useful diagram, as shown in Fig. 2, may be prepared and used to compare the values of different wells.

While the transmission constant has been determined experimentally under certain conditions, it depends on so many factors that in practice it is merely a matter of judgment or assumption. Therefore a test well seems the only safe guide. If for $H = 17$ ft. and $R = 850$ ft., a 12-in. test well with $h = 11.5$ ft. and $A = 9.225$ gives $Q = 43{,}500$ cu.ft. per day, then a 10-ft. well with $h = 3.4$ ft. and $A = 25.85$ can be expected to yield 121,500 cu.ft. per day; $k = 750$.

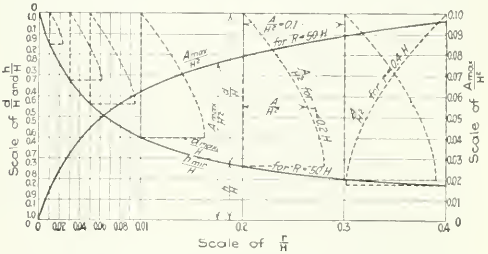

FIG. 2. DIAGRAM FOR COMPUTING THE RELATIVE FLOW INTO OPEN WELLS

No material increase in yield can be expected by lowering the level below the h shown on the diagrams. The effect of R should be tested.

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A Path to Success in Engineering—The engineer who is neat and insists upon neatness from his subordinates in all work, whether in the office or field, will receive recognition from his superiors, favorable comment from the public, and will, whether he realizes it or not, have applied simple business principles, resulting in economical administration, which will stand out prominently in the larger projects he undertakes.—D. E. Henry, Acting Chief Constructing Engineer, Bureau of Public Works, Philippine Islands.

Experience with Applications for Employment

By C. A. Bock*

The advice contained in an article entitled "The Applicant's Difficulty," in *Engineering News* of June 8, by R. Fleming, deserves the careful attention of engineering graduates. The flood of applications from technical graduates following the June commencements tempts one to recommend that our colleges and universities prescribe a course of instruction in writing applications.

Application for an engineering position is commonly made by letter. As the prospective employer has no knowledge of the existence or qualifications of the applicant, except what is set forth on that particular sheet of paper, the applicant's future and his ultimate success depend largely upon the reaction produced by that letter. If the job is worth having, it must surely be worth the necessary time and effort to write a consistent application for it. Considering the vital importance of such application to both employer and applicant, it is surprising to find that the majority of such letters are carelessly written, poorly composed and are not prepared for by analysis of the factors involved.

During the past two years the Morgan Engineering companies have received and examined over 3,000 applications coming from engineers and technical graduates in all parts of the United States. A careful reading of these letters and a comparison as to their form, diction, spelling, punctuation, general arrangement, clearness and other qualities bring out some interesting information.

In the applications from college graduates common faults are poor spelling, careless handwriting, lack of definiteness, poor composition and a generally slovenly appearance. While it is not to be expected that a young and inexperienced man will turn out a faultless composition, it is assumed that if he has potential ability he will not exhibit gross carelessness in a letter of this kind. The habit of error and carelessness is particularly disqualifying for engineering work and will not be tolerated by competent engineers.

The applicant's greatest difficulty probably arises from his inability to appreciate the employer's point of view. He should remember that all the employer has to judge from is just what he sees in the letter. If he sees poor writing, spelling and diction, lack of definite information or meager information, presented in a disorderly manner, it is but reasonable to expect that he will form an indifferent opinion of the writer's ability. It is usually desired that the first letter give full information as to the applicant's qualifications. While often a number of letters may be exchanged before the man is engaged, the first letter makes the greatest impression.

The applicant must ask himself just what are the things that the employer would want to know about the man he wishes to employ. He must analyze the requirements of the opening he wishes to fill and then set forth his qualifications logically, in the order of their importance. This does not mean that qualifications should be manufactured to meet the requirements, nor that he should unduly enlarge upon his previous experience. Such expedients generally are very easily detected and reflect little credit on the man who resorts to them.

The letter should be concise and should come to the essentials without prelude, but must not be brief to the point of sacrificing pertinent information. A common mistake is that of devoting a long paragraph to stating that "I realize that a large number of applications will doubtless be received and that it will require a great deal of your time to read through them all, and it will probably be very difficult to decide," etc. Simple, direct statements, neatly written in well-balanced sentences, will nearly always make a favorable impression, and much can be accomplished by logical paragraphing.

A very short letter is not likely to accomplish much for the writer unless he is already personally known. Single-sentence letters or brief inquiries asking detailed information concerning the vacancy and telling nothing of the writer's qualifications at once give the impression that he would be more interested in personal advantages than in serving his employer and that he is not overanxious to secure the position. An illustration of this is, "Replying to your ad, I am interested in learning your needs and requirements. Upon receipt of same, if they impress me, I shall further communicate with you." This was received in reply to an advertisement for an experienced engineer to fill a responsible, well-paid position and requesting full information to be furnished in the first letter.

We do not mean to suggest that engineers should make a special study of writing applications in order that, by reason of their proficiency in this alone, they may be able to secure lucrative positions. Many capable and deserving men, however, do not realize the bearing that the writing of an application may have upon their prospects. Men of indifferent ability frequently secure positions simply through a favorable presentation of their supposed fitness, and it is often the case, especially with younger men, that the one who makes the neatest and best presentation of his qualifications secures the position rather than the one who has greater ability, but lacks the faculty of presenting his qualifications.

In replying to an advertisement or to a letter, any requests for certain items of information should be fully complied with. A point illustrating this requirement, which has repeatedly come to the writer's observation, is the fact that draftsmen, when asked for a small sample of their lettering, seem to think it necessary to submit several large bulky drawings even though these may have few lines and letters on them, instead of submitting a smaller sheet that would easily contain a fair sample of their work. They often aggravate the situation by requesting such large drawings to be returned to them immediately or by sending them under separate cover, with no distinguishing marks to indicate their source. It manifestly is impossible to give such applications a mature and careful consideration.

The hiring of men is a matter of first importance to the employer, as well as one of considerable difficulty. As the success of any undertaking depends to a very great extent upon the efficiency, both individually and collectively, of the men employed, it is to the advantage of both employer and employee that the man seeking employment shall not underrate his ability by a failure properly to present his case.

The following notes are taken from a careful examination of the applications received in reply to an advertisement in *Engineering News* for an experienced ngineer. The advertisement requested full particulars ı the first letter, but the name of the employer did not ppear.

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*Secretary, Morgan Engineering Co., Dayton, Ohio.

otal applications examined	209
umber stating age	112
umber indicating training and education	133
umber stating years of experience	103
umber giving any references	77
umber giving indication of character and habits	40
umber stating salary desired	13
umber stating whether married or single	58
verage age of 112 applicants	35 yr.
verage experience of 103 applicants	12½ yr.
verage salary desired, 13 applicants	$280 per mo.

The significant fact of the foregoing summary is that, hile each of the applicants presumably had some hope of curing the position, over 50% of them had no possible ıance. Their letters were so lacking in essentials that ey were at once barred from consideration by this infficiency.

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California Board Urges State Control of Dams

The Reclamation Board of California has just issued a port covering two years of its work in the supervision private irrigation developments so that they may not terfere with the plans for flood control or with other lamation works in the Sacramento and San Joaquin ılleys, in California. California has already taken the tial step in establishing state control over the con- uction of dams and similar structures whose building ıy affect the public safety. The board in its report ints out, however, that to be effective the law should so amended that the state can exercise a thorough pervision, not only of the dams during construction, t of their condition after completion. The President the board is V. S. McClatchy, and its engineers are ıte Engineer W. F. McClure and Flood Control En- eer E. A. Bailey. The recommendations of the board arding state control of storage reservoirs are as lows:

> Storage reservoirs, whether operated in the interests of f d control, or power, or irrigation, or municipal supply, are a ource of grave danger to the people and property below t dams. The use of such a reservoir creates a danger which not exist prior to its construction, since it may hold hack t flood and normal flow of its entire drainage area for one e ire season or more. If the dam breaks, the flood precipi- t :d on the country below the dam in a few hours may be t ce, ten times, twenty times, in volume that which would e been precipitated in the absence of the reservoir by t forces of nature, and that much in excess of any protective n ısures adopted or possible to safeguard life and property ow.
>
> The public safety is entirely dependent on the strength of t dam. At the critical moment it may prove insufficient b ıuse of poor planning, or poor construction or defects w ch develop after construction. Concrete structures are p ticularly liable to develop defects (even when dishonest n nt is lacking) because of poor judgment, poor material, afficient proportions, improper mixing or climatic condi- t s. Lack of vigilance may permit grave defects to develop u oticed, and it may be even possible so to operate a reser- v as to constitute a public nuisance if not a serious danger.
>
> t would seem to be the duty of the state to exercise such trol of the planning, construction, maintenance and opera- of such structures that they may not offer menace to lives property below them, and to forbid their construction or if the necessary safeguards cannot be applied. The State ineering Department, under existing conditions, would n the logical department in which to repose the necessary ıority. The legislature of 1915 provided that plans for ı structures should receive approval of that department, provided no penalty for failure to comply with the law gave no power to the department to enforce its ruling as lans, and no authority to supervise construction; nor did rovide for future inspection to detect the development of cts, or the right to prevent use of a dam if it seemed dangerous. In the judgment of this board, the law should confer powers and responsibilities such as are indicated and should impose the most stringent penalties, not in the way of fine, but of imprisonment, on those who, through intent or carelessness, violate or evade the intent of the provisions suggested or otherwise seriously endanger the safety of the people and property below the reservoirs.

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State Highway Work in Florida

The law providing for a State Highway Department in Florida was passed more than a year ago, but it is only recently that a working organization has been created. The law provided for a commission of five members appointed by the governor—one member to represent the state-at-large, and one member each from the four congressional districts of the state. This commission has authority to appoint and fix the salary of a state road commissioner, "who shall be a competent and efficient road builder and well versed in the building of good roads." In April of this year the commission appointed William F. Cocke to this office.

The work of the department is now on a fairly permanent working basis, Mr. Cocke states, although it has not expanded sufficiently to require the services of an assistant commissioner, for whom the law also provides. This work of the Florida State Highway Department differs in some details from that of similar organizations. Aside from the usual functions of collecting statistics and furnishing advice it does more than other similar state highway departments whose jurisdictions do not include actual supervision of construction. It is constituted as a kind of headquarters inspection bureau. The following Section 5 of the law explains these duties:

> The department shall as often as practicable have the road commissioner, or an assistant, visit the several counties and inspect the roads therein and the methods of road construction and repair and the materials used in building and repairing roads by the county commissioners therein, and make reports thereof to the department. All their records, books, contracts, machinery, implements, materials, properties and premises under the control or jurisdiction of the several boards of county commissioners, relating to or used in the construction or repair of roads, shall at all times be subject to inspection by the State Road Department, and shall be submitted by such county commissioner for inspection to the state commissioner, or such assistant as may be detailed to make such inspection. The county commissioners of the several counties in the state shall make and file with the department quarterly reports of and a detailed statement of all moneys expended on such work. Such reports and statements shall be made in such form as the department may prescribe and shall be filed with the department not later than 10 days after the last day of the quarter.
>
> In all cases where the department shall learn that road repair or construction work is being improperly or extravagantly done, or improper or inferior materials are being used in such work, in any county, so as to cause a loss or waste of public funds, it shall be the duty of the department to notify the county commissioners of the same and point out to them the defects discovered, and if, after such notice is given, the county commissioners continue in the use of such improper methods or materials, the matter shall be reported to the governor by the department.

The law does not specify whether the governor shall reprimand or hang the offending county commissioners. But doubtless he could give them a good deal of unfavorable publicity, and this would be a strong factor in promoting better work.

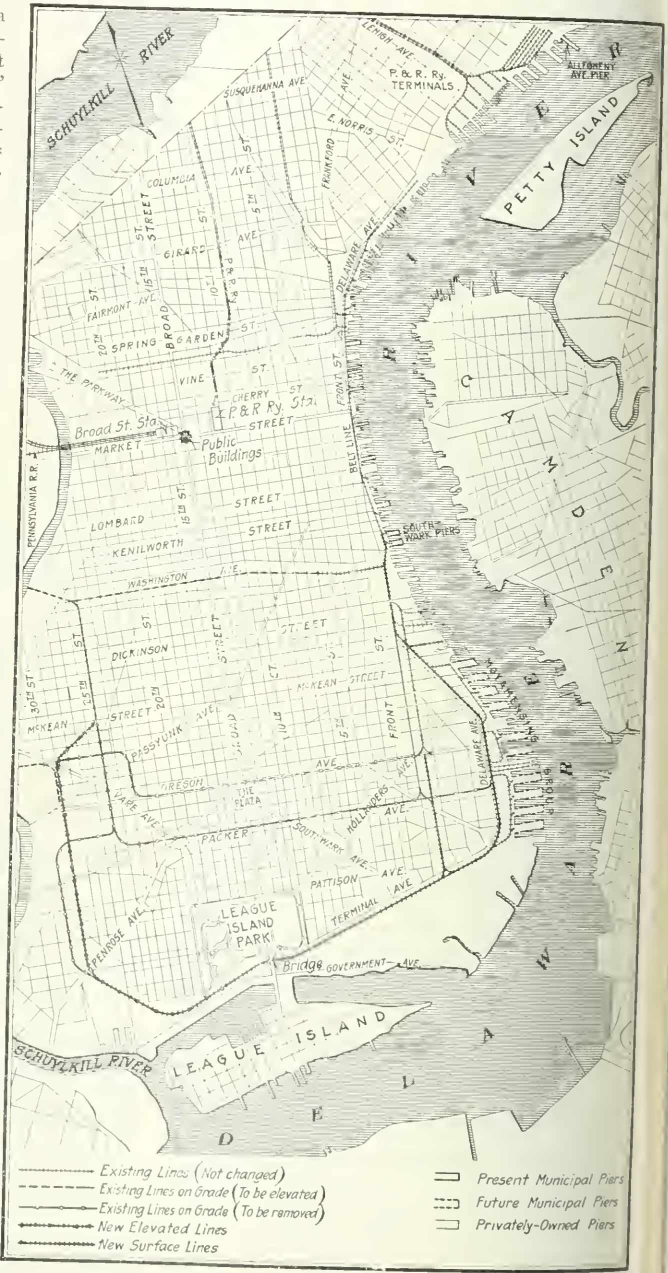
⁂

Official Inspection of All Bridge Structures owned by railway companies within the limits of New York City are to be made by competent officials or employees of the companies and certified reports of the inspection report are to be filed with the Public Service Commission within thirty days after the end of each calendar year, according to an order just prepared by the Commission.

Terminal Railway and New Piers at Port of Philadelphia

Of the $115,000,000 voted in May by the citizens of Philadelphia, Penn., for public improvements, about $19,000,000 is to go toward port improvement, the money to be spent in new wharves and piers recently decided upon and for a large terminal railway project and rearrangement of the terminal lines at the docks, a scheme of some years' standing. As shown in the accompanying drawing, the Philadelphia riverfront along the Delaware River is highly developed commercially. Of the great number of piers, however, only a few are under municipal ownership. The new appropriations are to be put into municipally owned piers under the following program: Ten million dollars is to be used for the construction and improvement of wharves and docks, including the acquisition of land and the construction of bulkheads. The items are as follows (the locations of various piers noted may be found in the drawing): (1) To complete the McKean St. pier which is now under way, $300,000. This pier will be 250 ft. wide by 900 ft. long. It is of the two-story type with pile foundation and structural steel and reinforced-concrete superstructure. (2) For the purchase of a site and the construction of a one-story pier about 80 ft. wide and 530 ft. long near Cherry St. in the center of the city, for small river traffic, $750,000. (3) For the purchase of property and the construction of a double-deck pier 80 ft. wide by 550 ft. long similar to the new piers in the Southwark group (See *Engineering News*, Aug. 26, 1915, p. 420), $1,000,000. This pier is to be used for general commercial purposes and is to be located near the foot of Kenilworth St. (4) For purchasing property and extending the Allegheny Ave. pier at the northern part of the city, this pier to be used as a general freight landing for river steamers and for recreation purposes, $500,000. (5) For the purchase of property and extension of the pier at Penn Treaty Park and also the pier at Bridge St. in Bridesburg in the northern part of the city, for general freight purposes and for river steamers and recreation purposes, $100,000. (6) For the completion of the bulkheading of the Schuylkill River, $750,000, and (7) for the acquisition of property and the erection of modern piers on the Delaware River front 1,000 ft. from the new McKean St. pier and what is known as the Moyamensing group, and possibly for the erection of new piers in the north and central portions of the waterfront, estimated cost $6,600,000.

The Moyamensing group project, noted in the last item, is the most important development in the Port of Philadelphia, and is tied up with the new terminal railway schemes for which nearly $9,000,000 additional



MAP OF PHILADELPHIA, SHOWING PROJECTED MUNICIPAL PIERS AND PORT RAILWAY DEVELOPMENT has just been appropriated. The south end of the City of Philadelphia has never been properly developed. At the extreme south end of Broad St. is League Island, with its Government Navy Yard, lying off the peninsula between the Schuylkill and Delaware Rivers. Extending therefrom along the Delaware River north is a large stretch of waterfront occasionally developed by big factories, but very little used for wharf purposes. The commercial pier development extended from the north end of the city to the railway terminals about halfway between the center of the city—that is, Market St.—and League Island. These terminals were approached through two cross-streets on grade—Washington Ave. and Oregon Ave.—and for many years the southerly extension of the city had been effectively stopped by these crosstown grade lines. Under an agreement made with the Pennsylvania Railroad Co., the Baltimore & Ohio Railroad Co. and the Philadelphia Belt Line Railroad Co. (the latter operating a marginal jointly used line along the waterfront street) the city and the railways exchanged property along the southern end of the Delaware River waterfront, so that the new system of municipal piers would be built and the railway terminals shifted farther south. By this same agreement, the tracks on the Washngton Ave. approach to the river are to be elevated and he Oregon Ave. approach removed so that all grade crossings in this part of the city are to be eliminated.

The new terminal yards will be approached by a fourrack line around the south end of the city and parallelng the river up to the yards. For this project the sum of $3.300,000 is to be devoted to buying property from he railroads for the erection of municipal piers; about ,400 ft. of waterfront from the Pennsylvania R.R. and bout 925 ft. from the Baltimore & Ohio R.R. The emaining $5,600,000 is to go toward construction.

Delaware Ave., the marginal street, is now being exended to the southward in a width of 200 and 250 ft., which is believed to be ample for the present and future ccommodation of both railroad and vehicular traffic. There is now being constructed in the bed of this street four-track railroad made with 159-lb. grooved girder ails for the joint or Belt Line R.R., with provision for two additional tracks when business shall demand. This venue is being paved for its entire width with dressed ranite blocks upon a heavy concrete base, thus providing smooth surface for trucks and other vehicular traffic.

A bridge has been constructed along the line of Broad St. over the joint or Belt Line R.R., just outside the League Island Navy Yard, thus avoiding the necessity f crossing tracks there at grade. By the removal of he present surface tracks of the Baltimore & Ohio Railroad Co. on Oregon Ave. and the tracks of the Greenwich ranch of the Pennsylvania Railroad Co., and by the levation of the railroad in Washington Ave., fifty-six rade crossings will be abolished and an unimproved erritory covering over 4,000 acres, located within a comaratively short distance from the center of the city, a erritory which has been hampered in its growth by reason f barriers which the railroads formed, will be capable f development for industrial and residential purposes.

As a part of this proposed development, League Island Park is now under construction, as shown in the map. This park is to be a highly ornamented city development with a boulevard extending on the line of Broad St. to the gate of the League Island Navy Yard. Radiating from the plaza at the head of the park are to be wide avenues reaching the two rivers and opening up the new area which will be provided with regular cross-streets with somewhat larger blocks than is customary in old Philadelphia practice. It is hoped, then, that this new area will speedily be built up with small residences of the type so familiar to those who have visited Philadelphia, and that the waterfront areas will be taken up by industrial works.

The harbor development in Philadelphia is under the direction of George S. Webster, Director of the Department of Wharves, Docks and Ferries. The railway grade elimination was under Mr. Webster's direction also when he was Chief Engineer of the Bureau of Surveys, in which place he has been succeeded by Chester E. Albright.

* * *

Municipal Alum Manufacture; Kingston-on-Thames

The manufacture of sulphate of alumina from bauxite by boiling the bauxite with sulphuric acid and water appears to have been carried on by the Borough of Kingston-on-Thames, England, since 1910. The plant at the place named was described some time ago by R. H. Clucas, Borough Surveyor of Kingston-on-Thames, in a paper read before the Institution of Municipal and County Engineers. Mr. Clucas states that he visited the similar plant being operated by the Borough Surveyor of Chorley, England, before he was authorized by his own borough to proceed with the erection of an alumina plant.

The Borough of Kingston-on-Thames uses its sulphate of alumina for treating sewage. Prior to the installation of the plant it employed aluminoferric. A total of 800 long tons per year was used, and the cost was 49½s. per ton. The municipally manufactured alumina cost 30s. per ton, showing a balance, according to Mr. Clucas, of £780 a year, or well toward $4,000. The amount of sewage treated a year is about 2,000,000 U. S. gal., the rate of application averaging 25 grains per Imp. gal.

The boiling vats at Kingston-on-Thames, two in number, are each 5x5 ft. in plan by 4 ft. high, made of 1½-in. lumber lined with lead. In each tank there is a coil of 1½-in. lead pipe having a total length of 42 ft. Steam for these coils is supplied from a boiler, and compressed air is used for agitation. The bauxite is first broken up by a rotary crusher and then ground to 80- to 100-mesh fineness in an emery mill.

To produce one long ton of sulphate of alumina, there are used 672 lb. of bauxite, 1,008 lb. of water and 1,008 lb. of sulphuric acid. These are boiled in one of the vats at 220° F. for about 7 hr., after which the material is run into molds. The bauxite is bought on the basis of 40% alumina, samples dried at 212° F.

The existence of these English plants of comparatively long standing is of interest in view of the establishment of a municipal plant at the Columbus, Ohio, water-purification works a couple of years or so ago.

* * *

Tunnel Ventilating Plants are being installed on the St. Louis line of the Baltimore & Ohio R.R. between Clarksburg and Parkersburg, W. Va. The system is similar to that at the new westbound tunnel at Kingwood, large steam-driven fans at the portals driving a fresh-air current in the direction of the train. One such plant has been completed at Eaton, another is being built at West Union and two others are to be built this season at Silver Run and Ocean.

Flat-Slab Floor Failure Due to Poor Brick Wall Columns

SYNOPSIS—A series of collapses beginning Mar. 24, 1916, wrecked the shop building of the Boys' Industrial School at Roxbury, Mass., a structure with concrete interior columns, brick wall piers and girderless concrete floor slabs. The article herewith is a brief summary of a report made by Sanford E. Thompson, from an investigation soon after the accident.

The shop building of the Boys' Industrial School at Roxbury, Mass., as shown diagrammatically in Fig. 1, is a reinforced-concrete structure 202 ft. 8 in. long, 62 ft. 8 in. wide and three stories high at the north end and two stories at the south. The structural elements are approximately square panels (22x20 ft. 3 in. in general) of flat-slab floors resting on the octagonal column heads of longitudinally reinforced square columns. The walls, of brick, were broken by brick wall piers which took the reaction of the wall panels of the flat slabs, as shown in detail in Fig. 2. On the roof, to give proper slope, a cinder concrete fill with a 2-in. mortar surface had been placed. This varied in thickness from 17 in. to 3 in.

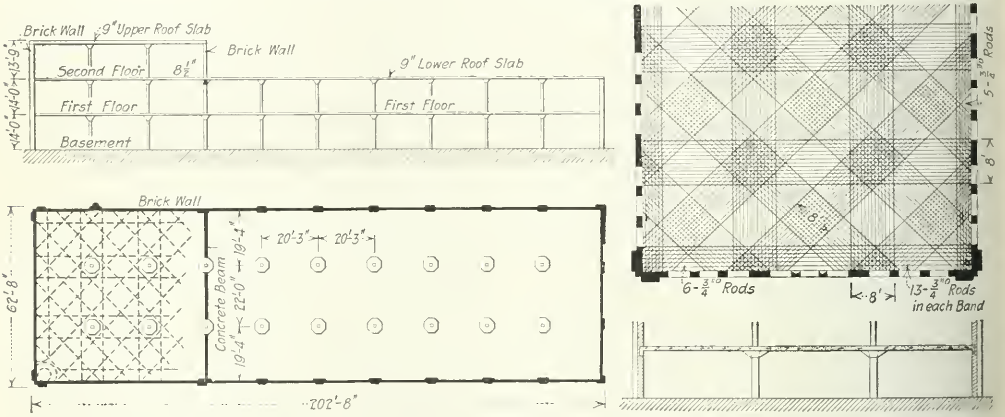


FIG. 1. DIAGRAMMATICAL LAYOUT OF FRAMING OF SHOP BUILDING, BOYS' INDUSTRIAL SCHOOL, ROXBURY

Following the first collapse a thorough investigation of the building was made by Sanford E. Thompson, Consulting Engineer, Boston, Mass. The following report is in Mr. Thompson's own words:

Report by Sanford E. Thompson

From inspection of the original records on the job, I have the following information:

Location	Concrete Poured	Forms Removed
Basement columns....	Nov. 24, 1915	Dec. 9, 10, 1915
First-floor slab...	Dec. 1, 3, 4	Dec. 24, 27, 28, 31
Columns supporting second floor and lower roof . .	Jan. 5, 6, 1916	Feb. 10, 11, 12, 1916
Second floor and lower roof	Jan. 6, 7	Mar. 6, 7, 8, 9, 20, 22
Columns supporting upper roof and upper roof itself	Feb. 2, 5	Feb. 29 (column)
Cinder fill on lower roof......	Jan. 24, 25, 26	Mar. 22 (posts next to wall)
Cinder fill on upper roof.	Mar. 23	

Collapses occurred Mar. 24, 25 and 29.

I understand that the sand and stone for the concrete were thoroughly heated. I am advised also that the brickwork was laid in advance of the concrete construction, that the window openings were protected by canvas, that salamanders were used on the floors, and the fresh concrete protected.

The foregoing table shows that the forms under the second floor and lower roof were left in place more than eight weeks. Occasional 3x4-in. posts, spaced about 11 ft. apart, were under the lower roof, at the time of my first visit after the first collapse. Before removal of any of the forms, I am advised that the concrete was examined and tested by blows in the presence of the city building inspector.

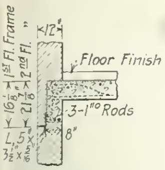
At the time of my first visit on Saturday, Mar. 25, I found the roof and the second floor of the high portion of the building had collapsed and were hanging on the reinforced-concrete beam which was designed to support the rear wall of the second story of the high portion. The remainder of the building was intact. On the following day, Sunday, Mar. 26, I was advised of a further collapse at 7 o'clock the night previous, and again visited the job. I found the lower roof had fallen, bringing with it a part of the first floor at the south end of the building. The first floor in the north end, although badly deflected and cracked, and the column cap badly cracked, held the weight of the entire material of the second floor and roof, besides having sustained the impact of the fall. This is shown in Fig. 3.

Not till three days later, on Mar. 29, did this portion of the first floor finally fall, leaving even then the basement columns still in a nearly vertical position.

Examination of Structure

During my different visits to the job, I examined the brickwork and the concrete carefully, and took various samples, the tests of which are described later.

The mortar in the brickwork was much of it frozen, and the part which had thawed was easily crumbled in



Detail of Continuous Wall Beam

COLUMN SCHEDULE

	2nd Story Portion		1st Story Portion	
Roof	Mix.	Size	Mix.	Size
2nd Floor			1:2:4	12"x12" 4-$\frac{7}{8}$"⌀ Rods
1st Floor	1:2:4	12"x12" 4-$\frac{7}{8}$"⌀ Rods	1:1$\frac{1}{2}$:3	15"x15" 6-$\frac{7}{8}$"⌀ Rods 24"
Basement	1:1$\frac{1}{2}$:3	16"x16" 8-$\frac{7}{8}$"⌀ Rods 24"	1:1$\frac{1}{2}$:3	18"x18" 8-1"⌀ Rods

Use $\frac{1}{4}$"⌀ hoops, 12" C. to C.

FIG. 2. DETAILS OF A TYPICAL FLOOR

he fingers. From the appearance, it was evidently a me and cement mortar, with a preponderance of lime. his afterward proved to be the case by chemical test, s noted further on. The brickwork was not constructed ith the care required for piers, or for a wall supporting long-span slab. The horizontal joints varied in thickess ranging up to 1⅝ in. The vertical joints were any of them open for a depth of several courses. eaders in some cases were blind instead of being full. he face brick in many cases was peeled off from the cking, and cracks between them are frequent. The ers between the windows in the top story of the main ilding, which were laid under conditions correspondg to those of the shop building, were found by measureent to have buckled, the face course being bulged out om the backing. As a whole, the brickwork in the shop building was very poorly constructed for carrying out the intent of the design.

The concrete in the second floor and the roof slabs was not thoroughly hard. It contained moisture and some frost. I found a marked difference in the concrete, however, in different portions of the structure. The columns both in the basement and the first story appeared well hardened. This was shown by inspection and also by the fact that in places the surface of the column had been chipped with a cold chisel, without splintering. The concrete in the lower roof slab was least hard and very much weaker than the concrete of the second floor which was laid as a part of the same slab. The harder condition of the floor slab was due evidently to the better protection from the cold and the opportunity to dry out.

The concrete of the roof slab was well bonded with the cinder concrete fill, so well, in fact, that they would act together in resisting stress.

My criticism of the design relates chiefly to the improper combination of the reinforced-concrete flat slab with the brickwork. Such combination is a poor construction at the best, and, if unavoidable, special precautions should have been taken to provide for eccentric stresses and bending moments. Even the slight normal deflection of the slab which occurs under working loads tends to throw excessive stresses on the brick piers because of the eccentricity.

In the slab design, I would criticize especially the shape of the haunch which is flatter than required by

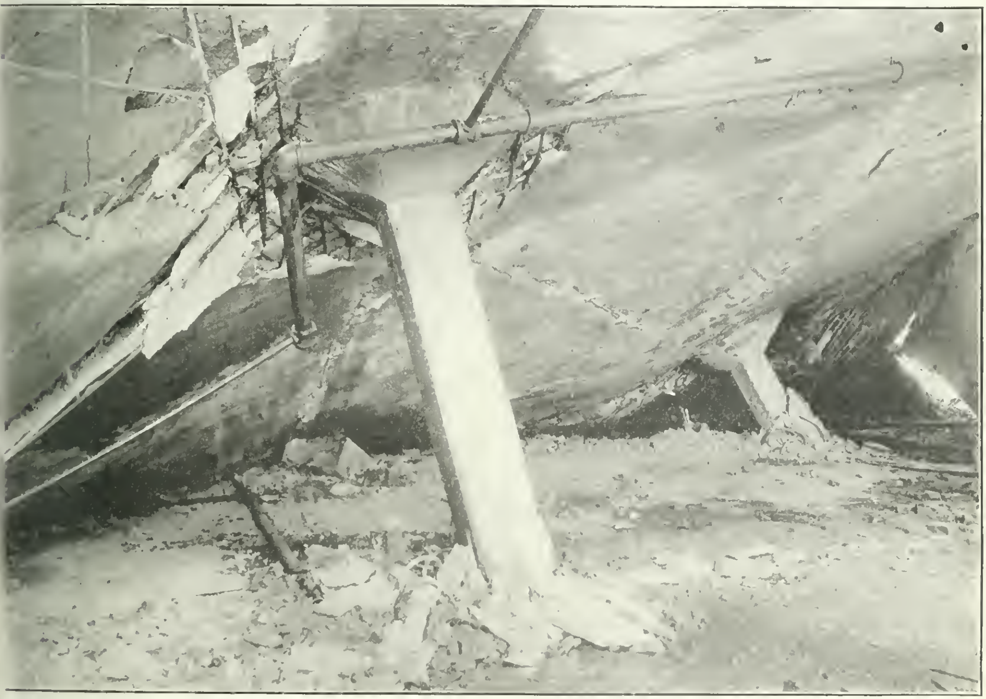


FIG. 3. FIRST FLOOR IN HIGH PART OF BUILDING AFTER FAILURE

The upper floor in this view is supporting the heavy load of the collapsed building good authorities at the time of the design of this building.

In considering the cause of the collapse, it must be noted that the structure consisted of concrete roof slab, concrete columns, concrete floor slabs, and brick walls, and the failure must have originated with one of these. Considering each one of these: (1) The upper roof was laid last, but I am advised that practically all the supports still remained in place, so that the concrete could not have caused the failure. (2) The columns under the upper roof were under no appreciable load because of the supports under the roof. (3) The columns under the second floor were shown by examination and test of the concrete to be unquestionably strong enough to sustain the loads that came upon them. (4) The second floor was partly supported by occasional 3x4-in. struts, which assisted in carrying the weight of the roof and cinder fill. The roof itself also, although the concrete was not thoroughly hardened, had considerable strength thereby relieving the slabs below of a part of the load.

In this case it is necessary not simply to consider theory, but experience. Case after case has been brought to my attention of flat slabs which have sagged up to 3 in. without failure. One of these cases was in a building in Boston from which the roof forms were removed while the concrete was green—as green, in fact, as the concrete in the present structure. Notwithstanding this sag, which came on gradually, the slab is standing at the present time. The great strength of the first-floor slab in the present building, which supported, although with very great deflection and cracking, the impact and weight of the slabs above for a number of days before failure, is an indication of the normal action of a flat slab under excessive load. If the struts under the second floor slab had deflected only ½ in., the struts would have buckled out several inches, and long before this would have been noticed by those in the building. In view of these facts, I conclude that the collapse did not originate by failure of the second-floor slab.

Turning now to the walls, we find a 12-in. thickness for the two upper stories (4 in. of this being face brick), a quality of construction very poor for the requirements and a mortar consisting largely of lime and sand. I am informed also that instead of slaking the lime in advance, it was slaked just before using. As evidence of this, I find at various places in the mortar small pieces of unslaked lime. The mortar materials I am advised were not heated. Computing the stresses, I find on account of the weight of the long span that the brickwork probably received a stress of more than 250 lb. per sq.in. whereas tests of a portion of one of the brick piers showed the beginning of failure at 167 lb. per sq.in.

In view of these conditions and as a result of examination, computations and tests, I am convinced that the failure of the building originated with the brick piers supporting the second floor. The conditions on Saturday, Mar. 24, the position of the columns, and the rest of the failed portions, indicate that the subsequent failure started at the junction with the ruins of the first failure. I am aware that a watchman who was at the rear of the building at the time of the second collapse states that the rear roof came down first. I believe that he is in error on this point, as it was impossible for him to tell from his position where the break started.

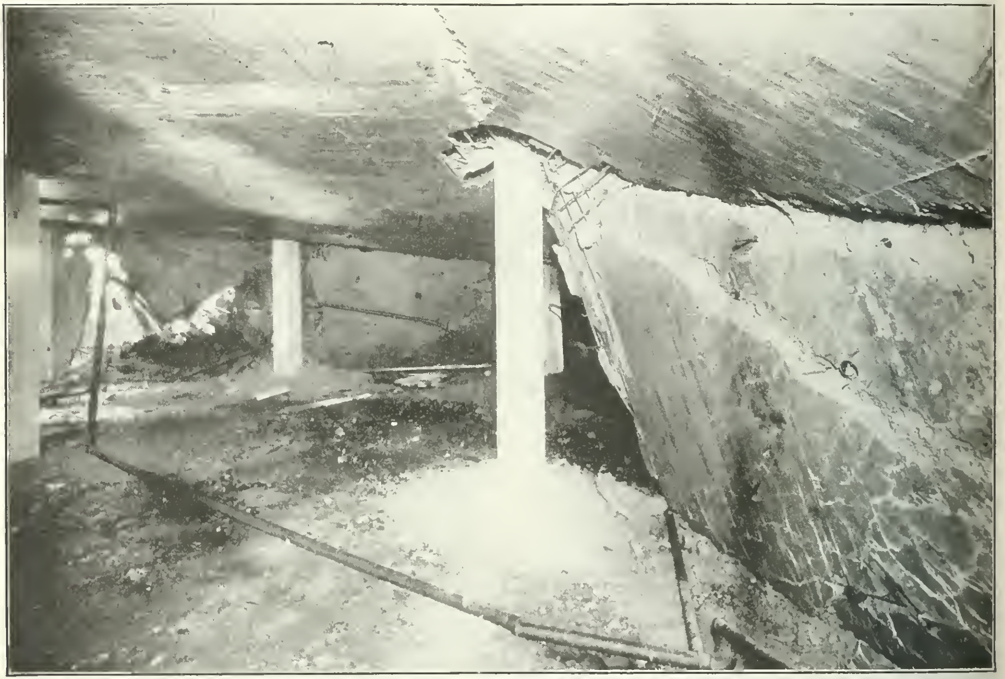


FIG. 4. BASEMENT UNDER LOW PART OF BUILDING AFTER FAILURE

Brick Mortar—Three samples of brick mortar taken by me from the job were analyzed chemically. The result of the chemist's analysis is as follows:

	Ratio Cementing Material to	Analysis of Cementing Material	
Sample	Sand	Cement, Per Cent.	High Magnesium Lime, Per Cent.
A	1 to 3.08	57.97	42.03
B	1 to 3.71	54.31	45.89
C	1 to 3.64	82.55	17.45

Sample A is mortar from the pier designated below is No. 1, which is pier on west face next to north corner ier. Sample B is from another pier in same section f building. Sample C is from a pier in rear end of uilding.

The specifications for piers require 1 part cement to 3 parts sand with not to exceed a shovelful of slaked ime to a bag of cement. Samples A and B, which are rom the wall where the failure first occurred, represent pproximately one barrel of lime to one barrel of cement. llowing for the expansion of lime in slaking, we find nstead of one shovelful of slaked lime per bag of cement the limit of the specifications), (A) 13 shovelfuls, (B) 5 shovelfuls, (C) 4 shovelfuls of slaked lime respectively.

Brickwork—Two pieces of brickwork from brick piers n the portion of building which collapsed were tested or compression. The first sample, No. 1 (taken from he pier on west side next to north corner pier between rst and second floors), showed a drop of the gage of he testing machine at 167 lb. per sq.in., or 12 tons per q.ft., showing that a constant application of this load ould have produced failure. The specimen actually roke at 550 lb. per sq.in., or 40 tons per sq.ft. The econd specimen showed initial failure at 240 lb. per q.ft., or 17 tons per sq.ft. with a breaking strength of 35 lb. per sq.in., or 45 tons per sq.ft. It is of course vident that the lower figures represent the actual value f brickwork in resisting the load.

Concrete—Chemical analysis of the concrete showed it) be in proportions 1 part cement to 6 parts of aggreate, or substantially 1 part cement to 2 parts sand to parts stone, as called for by the specifications.

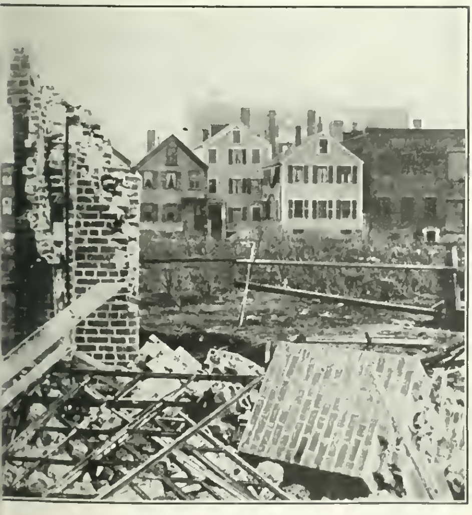


FIG. 5. CORNER PIER OF SHOP BUILDING, SHOWING VERTICAL JOINTS IN BRICKWORK

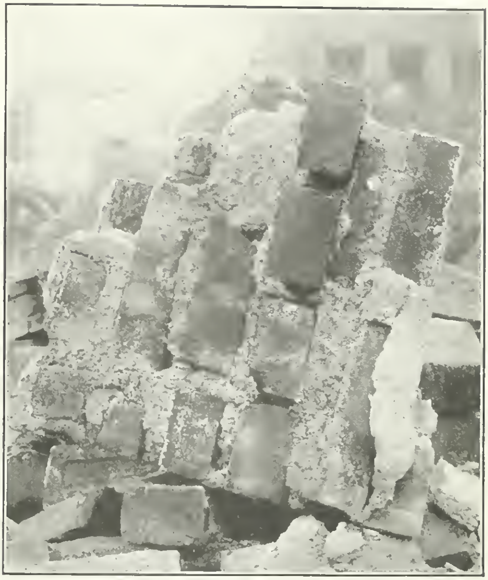


FIG. 6. NEAR VIEW OF PART OF BRICK PIER

A sample of this concrete hardened satisfactorily upon boiling, indicating its good quality and the fact that the low strength was due simply to the cold weather conditions.

A sample of the concrete, corresponding to the concrete in the columns between the first and second floors of the part of the building that failed first, showed a strength in compression of 1,350 lb. per sq.in., which is very much in excess of the stresses found by computation as caused by the loads.

No specimen of the slabs large enough to test could be obtained from the end of the building which first collapsed without endangering the men making the test. Inspection of the concrete, however, indicated it to be strong enough to carry the loads which came upon it.

CONCLUSION OF CAUSE OF COLLAPSE

The evidence points clearly to the brick piers between first and second floors as the place of initial failure. The cause of the failure of these piers we find to be due to (1) their improper design for carrying a long-span flat slab; (2) the quality of the brickwork, which was not adapted to sustain the normal loads of the long-span slabs; and (3) the use of lime and cement mortar, where the specifications called for cement mortar.

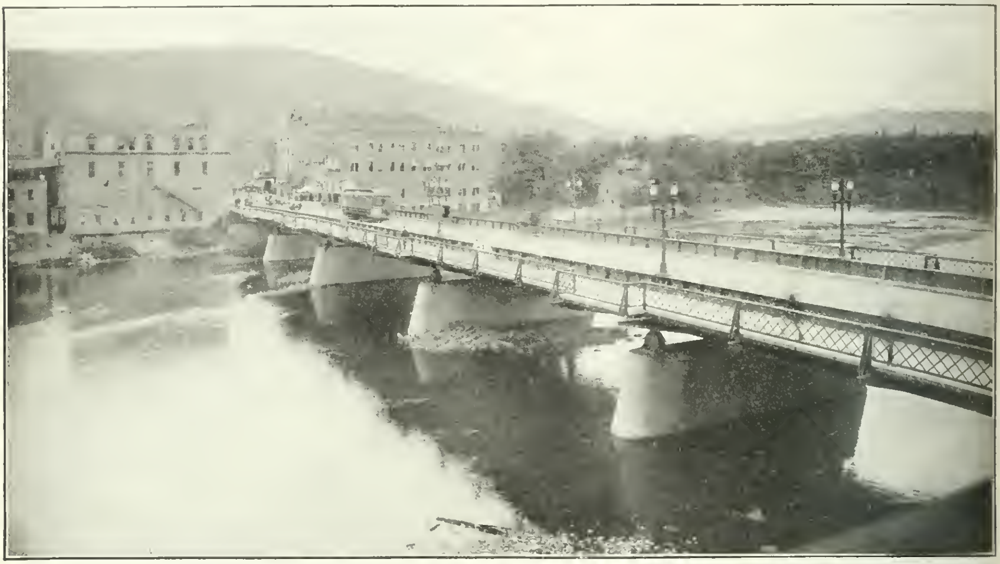
If the structure had been built with properly designed concrete wall columns, it undoubtedly would be standing today.

In reaching the above decision, due account is taken of the fact that the concrete in the floors and roof at time of collapse was not thoroughly hard, and in fact had not attained nearly the normal strength of concrete. I find, however, by actual test of the strength of the column concrete that the columns were amply strong to carry the load; also, from my knowledge of the action of flat slabs even of partly hardened concrete, I consider that such a sudden failure as wrecked the building could not have been produced by the failure of the slab.

Plate-Girder Cantilever Bridge

By Arthur G. Hayden*

A remarkably unusual form of construction was adopted recently for a bridge over the Allegheny River at Salamanca, N. Y. The total length of the crossing is only 400 ft.; and as the foundation question was not very difficult, short spans were practicable. In spite of these conditions favoring the usual type of a series of simple spans, it was found that short-span cantilever construction was cheaper.



FIGS. 1 AND 2. TWO VIEWS OF MAIN ST. BRIDGE, SALAMANCA, N. Y., A CANTILEVER STRUCTURE WITH 80-FT. SPANS

The objections sometimes raised against the cantilever bridge are lack of rigidity, and even lack of economy, as the writer has frequently heard maintained by engineering lecturers. Possibly the fact is sometimes overlooked that modern traffic requires heavier floor construction, which makes the dead-load stresses in the girders or trusses larger in proportion to the live-load stresses. This high dead-load ratio tends to nullify the objections as to lack of rigidity and favors economy in design, since the reversal stresses will be relatively smaller.

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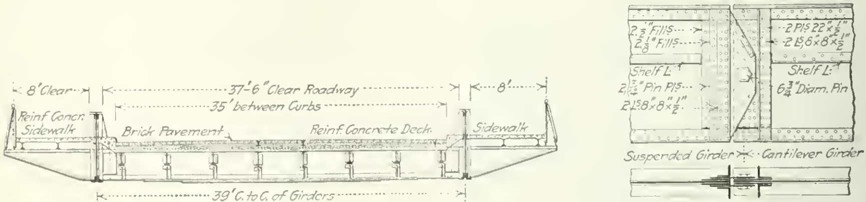
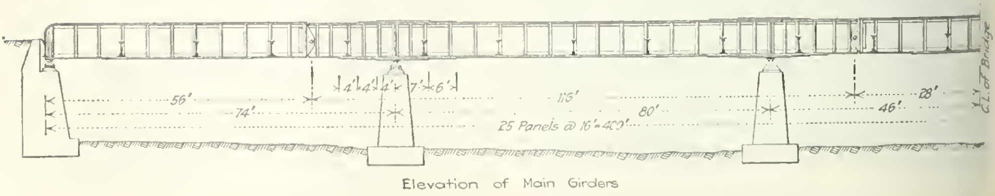
*Bridge Engineer, Barge Canal Office, Albany, N. Y.



Cross-Section

End Connection of Suspended Span



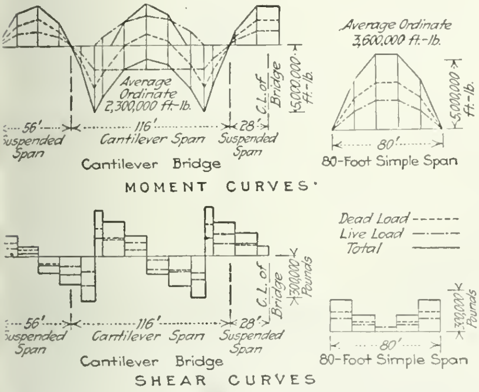
Elevation of Main Girders

FIG. 3. GENERAL DRAWINGS OF SALAMANCA CANTILEVER BRIDGE, AND HINGE DETAIL

In 1911 the State of New York made an appropriation for a bridge of specified general dimensions across the Allegheny River at Main St., Salamanca. Studies were made for a bridge of the usual simple-span girder style, and by use of the customary methods the most economical number of spans was determined.

The river bottom being practically level, the cost of ı pier was the same wherever located, about $3,800. The ost of two girders for one 80-ft. span was found to be $3,300, which approached more nearly the cost of one ier than the girders for one 100-ft. span or one 67-ft. pan. This is the criterion for the most economical span ength. The complete estimate for a bridge with five 0-ft. spans showed, however, that the cost would be bove the amount appropriated.

Studies were then made for a cantilever bridge. Since he cost of floor and abutments is the same for simple pans and cantilever, it was only necessary to compare nain girders and piers, the cost of the latter including he cost of excavation and pile foundations. The piers or the simple-span girders were required to be wider ian for the cantilever girders in order to accommodate ie bearings of the two adjacent spans. The comparison given by the following table:



IG. 4. MOMENT AND SHEAR CURVES FOR SALAMANCA CANTILEVER BRIDGE, AND EQUIVALENT SIMPLE SPAN

	Cantilever and Suspended Spans	Simple Spans
irders, 455,000 lb. @ 3¾c.	......	$17,100
irders, 355,000 lb. @ 3¾c.	$13,300	......
piers at $3,800	......	15,200
piers at $3,500	14,000	......
Total	$27,300	$32,300

It appears therefore that a saving of $5,000 is secured the use of cantilever construction, nearly $1,000 of hich is due to economy in the superstructure.

The data on which the designs were based and the com- rison made included the following items: Total length f crossing, 400 ft.; width of roadway, 37½ ft. clear; vo sidewalks, 8 ft. clear; floor, reinforced-concrete deck ith brick paving; loading, 30-ton electric cars on one ack occupying the middle of the roadway, 12-ton motor ucks on any part of the roadway and uniform live-load 100 lb. per sq.ft. on parts of roadway not occupied by ie concentrated load; impact, 50% for floor and string- s, 20% for floorbeams; unit stresses, 16,000 lb. per .in. in structural steel, 12,000 lb. in reinforcing steel, 00 lb. in concrete.

The foregoing comparison of cost is based on a rather low unit price. Ordinarily, the price bid for such work is higher and the economy of the cantilever structure would be greater. As to rigidity, to quote reports, the bridge is "solid as a rock" under fast-moving trolley traffic.

The accompanying drawings show the general construction of the bridge, and the kind of hinge used at the attachment of the suspended span, and also give a graphical comparison of the stress distributions in the simple and cantilever spans.

The entire cost of the new bridge, including substructure, superstructure, wiring and lighting system, laying rails and ties and the removal of the old bridge, was $77,681.10. This sum is itemized in the following table:

4,145 cu.yd. earth excavation @ 50c.	$2,072.50
973 cu.yd. rock excavation @ $1.50	1,459.50
511.5 cu.yd. first-class concrete @ $8	4,092.00
2,087.1 cu.yd. third-class concrete @ $7	14,609.70
857,837 lb. steel @ 3¾c.	32,168.89
0.79 ton cast-iron pipe @ $50	39.50
822 lin.ft. handrail @ $1.50	1,233.00
14,688 lin.ft. piles @ 40c.	5,875.20
1,886 sq.yd. brick pavement @ $1.50	2,829.00
127,277 lb. reinforcing @ 3c.	3,818.31
31,780 lb. cast steel and lead @ 7½c.	2,383.50
400 ft. laying rails and ties @ 50c.	200.00
Removing old structure, lump sum	1,350.00
Lighting system	3,500.00
Installing and wiring	2,050.00
Total	$77,681.10

The bridge was designed by the New York State Barge Canal Office, Albany, and was built by the Owego Bridge Co., of Owego, N. Y.

⁂

Baltimore Activated-Sludge Air Diffusers

Interesting experiences with filtros-plate air diffusers in the large activated-sludge tank at Baltimore, Md., were reported by Leslie C. Frank, Sanitary Engineer, United States Public Health Service, Washington, just too late for inclusion in the symposium on air diffusers published in *Engineering News* of July 13, 1916. In substance, Mr. Frank says:

> During May and June the umbrella-shaped diffuser grid was lifted out of the tank and 60 new filtros disks clamped into place, thus doubling the diffuser area. At the same time the old disks were carefully removed, washed and replaced. The old plates showed evidence of disintegration. Some of them were distinctly more crumbly than the new ones, and many of the old plates were cracked. The only explanation of this possible disintegration thus far offered is the alkalinity of the sewage. It should be noted that the old and the new disks represented two widely separated shipments and that the old disks may have been inferior to the new ones in manufacture.

Two views of the umbrella-shaped grid at Baltimore were printed on p. 800 of *Engineering News* of Apr. 27, 1916.

It may be added that owing to difficulties with the air blower at Baltimore the activated-sludge tank there had been out of commission for several weeks when Mr. Frank sent (July 14) the information given above.

⁂

The Garbage and Refuse Incinerator at Savannah, Ga., burned 27,661 tons of mixed refuse during 1915, at a total cost of $21,564. This sum was divided as follows: Incinerator operation, $17,084; weighing refuse and delivery of same to the hoppers, $1,556; maintenance, including outlays, $2,924. Deducting from the total cost the sum of $4,800 for steam furnished to the water-works pumping station leaves a net total cost of $16,764, or 59.7c. per ton. The destructor is of the high-temperature Heenan-Froude type and was completed in March, 1914, by the Destructor Co., New York City.

Field and Office

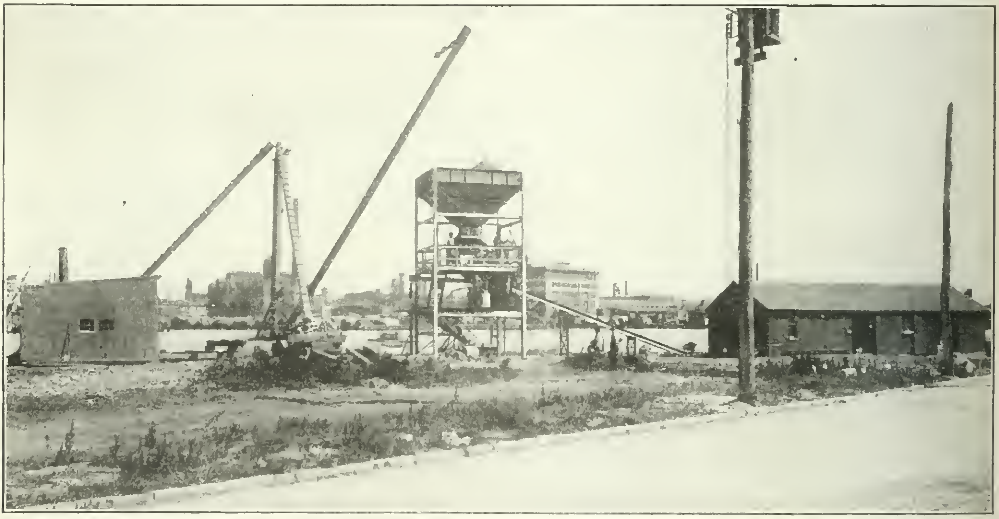
Central Concrete-Mixing Plant Tried at Baltimore

By G. Y. Carpenter*

A unique attempt to demonstrate the practicability of mixing concrete at a central plant and distributing it where required anywhere over a fairly large area was tried out in Baltimore, Md., last fall. In the opinion of the writer the feasibility of such a scheme was demonstrated, but certain limitations of capital prevented the construction of a working plant, or at least of the turning of the experimental plant into a working plant.

The company, incorporated in May, 1915, proposed to construct a plant that would supply wet mixed concrete of any proportion at a fixed price at the plant or delivered, at prices depending on the length of haul. It was necessary, before proceeding, to secure the approval of the city engineering department, inasmuch as it was expected that a great deal of the work would be on city jobs. The method later to be described was approved by that department. It was pointed out that by maintaining a system of inspection at the point of mixing, it would be unnecessary to place inspectors at all points of the city where concrete was being used, and further that the grade of concrete furnished would far surpass in every respect that secured by a hastily formed organization on the various jobs. In addition to this, there would be no litter in the streets, such as is inevitable where large or small quantities of raw materials are assembled for concrete work. The finished product passing from motor truck directly into the forms, where the elevation was sufficient, or to subgrade in the case of paving or sidewalk work, or quickly wheeled in barrows to the point of final deposition from a dumping board, would remove all the local evidences of concrete mixing.

The time agreed upon for transportation of the wet mixture was not to exceed in any case 30 min., a period ample for covering a very large area where motor trucks are used. In support of the safety of this time limit against deterioration of material due to initial set, some tests were carried out by the Richard K. Meade Laboratory in Baltimore, which showed that the jiggling of mortar for periods up to an hour and a half did not materially decrease the strength of the mortar so treated; in fact, a small amount of such shaking seemed beneficial.



CONCRETE PLANT AT FOOT OF HUGHES ST., BALTIMORE, FROM WHICH CONCRETE WAS DELIVERED FOR SALE

As a location as near as possible the center of the city was necessary in order to compete with delivered prices on raw materials, a site owned by the city on the waterfront was selected. This property is very near the actual center of Baltimore. As it had a short time before been equipped with a new dock, it was thought admirable for the point of distribution. Accordingly, a plant designed especially for this particular operation by the Ransome Concrete Machinery Co., of New Jersey, was erected. This entire plant, including that furnished by the above company, consisted of an office and cement-storage building, a steel-frame tower containing the equipment for mixing, an industrial railway for handling cement, a three-drum engine with stiff-leg derrick and half-yard clamshell bucket. The mixing tower contained a separated bin at the top for sand and gravel and on two platforms, one above the other and below the bin, the proportioning hoppers and the mixing drum of 1-yd. capacity. Gates operated by levers were provided at the bin bottoms and at the hoppers to accomplish quick movement of the materials downward. The complete plant, with the exception of the hoisting engine, was driven by electricity. It is shown in the accompanying view.

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*Estimating Engineer, Building Supplies Corporation, Norfolk, Va.

The aim of the company was to eliminate all handling of materials by manual labor and to perform the operations of charging the drum and discharging the mixed concrete into trucks entirely by gravity. A further advantage was that, being on the waterfront, sand, gravel and cement were bought in scow-load lots f.o.b. plant and were unloaded, with the exception of cement, which was trucked directly into the warehouse at a very low cost per barrel. Sack loss was unknown here, as the car returning from the mixing tower always brought back the empty sacks, which were unloaded in the warehouse a short time after they were emptied.

The first work undertaken after the plant was ready for operation was a number of sidewalk contracts. For the protection of the consumer an inspector was stationed at the plant, who approved the mixture and stamped with the hour and minute of departure of trucks a ticket carried by the driver and presented on arrival of his load to the receiving agent. As the time for transporting was set by the city at 30 min. maximum, all concrete arriving as shown by the delivery ticket within that time was accepted, and all exceeding that time was rejected. This was part of the agreement under which the material was sold. It is significant that during the entire time of operation not a single truckload of material supplied under the above conditions was rejected.

As it became known that concrete could be obtained in a wet mixed condition, a variety of uses developed. In one instance it was supplied in bags delivered to the job and elevated by means of a dumbwaiter to the third floor of a restaurant, where it was used to construct a concrete floor. In this case water was added on the job. Among the more important types of construction handled was a part of the Eastern pumping station for the city, involving a haul of five miles. In all cases the material was dumped directly into chutes leading to forms or was placed from a dumping board with barrows.

The organization of the company consisted of a manager at $100 per month, a hoisting engineer at $20 per week, three laborers at $12 per week, a fireman at $12 per week and a bookkeeper at $75 per month. The hauling equipment was made up of motor trucks of the regular contractors' hydraulic-dump-body type. They were found fast enough to handle all material easily within the limit of time. They also gave no trouble with concrete sticking to the body.

So far as the writer at this time knows, the work done was satisfactory in every way, and it is his opinion that such a plant, operated in strict accordance with the methods adopted from data gained after a few days' running, will in time come in all cities where concrete is used. On account of lack of capital, operation was not resumed this season, and it is thought by some that a certain antagonism on the part of the contractors prevented further financing.

The company operating the plant was the Baltimore Concrete Placing Co., of which the writer was vice-president.

Steam-Jacketed Forms for Winter Concreting

An unusual piece of winter concreting was done on the Baltimore & Ohio R.R., one mile east of Paw Paw station, W. Va. This job is a small element in building the Magnolia cutoff on the Cumberland, Md., division. Concreting was done by means of a large steel derrick traveler which was fully described in a comprehensive article by Francis Lee Stuart, the then Chief Engineer of the road, in *Engineering News* of June 29, p. 1218.

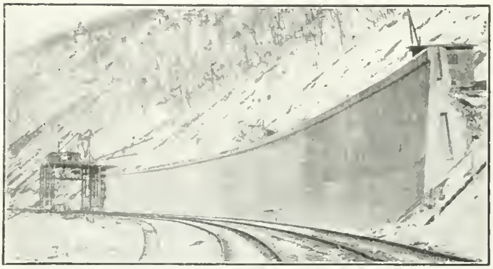
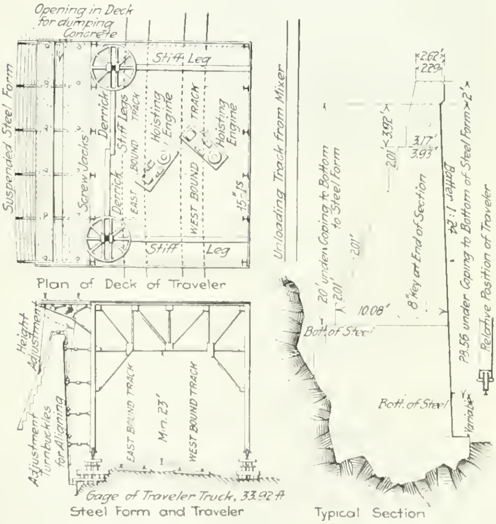


FIG. 1. VIEW OF PAW PAW RETAINING WALL, WITH STEEL TRAVELER AT WORK AT FAR END

The sand and crushed stone used in making the wall concrete were heated by diffusion of steam from perforations in a coil of 2-in. pipe placed at the bottom of the storage piles. The bottoms of the charging bins above the mixer also were fitted with perforated piping so that the heat might be retained in the materials.



FIGS. 2 TO 4. SKETCHES OF FORM-TRAVELER AND WALL
Fig. 2—Deck of traveler. Fig. 3—Steel form and traveler. Fig. 4—Cross-section of wall

The water used in mixing was maintained at about 100° F. by a live-steam jet discharging at the bottom of a 3,000-gal. tank or reservoir kept constantly full. The overflow from this tank discharged into a 50-gal. measuring barrel, being heated to scalding temperature by another jet of superheated steam.

The wall forms were insulated with straw and plank on the back and covered with tongue-and-grooved flooring on the face, retaining a 2-in. space between the steel and the wood through which low-pressure steam from one of the boilers on the deck of the traveler was diffused by a perforated 1-in. pipe. This pipe was at the bottom of the form and ran longitudinally the entire length, connecting with the boiler by a T-connection and vertical pipe at about the middle of the section.

A stationary mixing plant was installed adjacent to the main line of the railway, about a half-mile west of the wall site. The concrete was conveyed to the wall in buckets on cars drawn by a dinkey on narrow gage. A derrick on the traveler handled the buckets, dumping the concrete into the forms through the opening shown in the traveler floor in Fig. 2. The method of attaching the steel form is given in Fig. 3, while Fig. 4 shows a cross-section of traveler and wall.

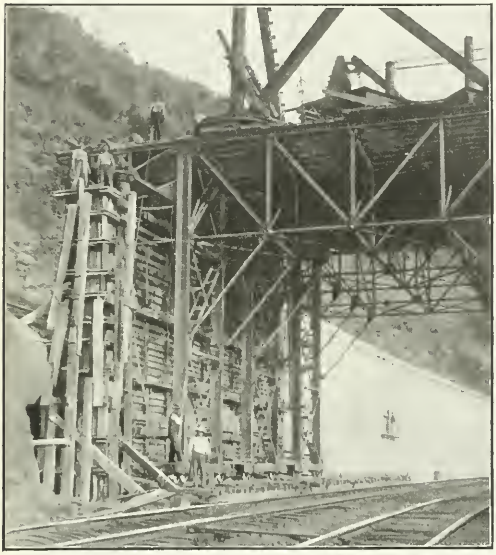


FIG. 5. VIEW OF TRAVELER AND STEAM-HEATED FORM

⁂

Cost of Piles vs. Increased Abutment Depth*

In designing abutments for bridges the question often arises as to whether wood piling should be used or the abutment carried down to a greater depth so as to eliminate the piling.

If the difference is more than 2 ft. it will be found that piling will prove cheaper in almost every case. In order to show this more clearly we will consider a typical case of a 30-ft. standard plan on reinforced-concrete abutments.

If piles are used the abutments will have to be 14 ft. high while if the piles are omitted and the concrete is carried down to solid bearing a height of 17 ft. will be required. The higher abutments contain 25 cu.yd. more concrete and 3,160 lb. more reinforcing than the 14-ft. abutments, which extras would cost about $470.

The cost of 32 wood piles 20 ft. long would be about $320.

This shows an estimated saving of $150 by the use of timber piling and in all probability the saving would be even greater. as no attention has been paid to the fact that the deeper excavation would be more expensive and therefore would increase the unit cost of the 17-ft. abutment.

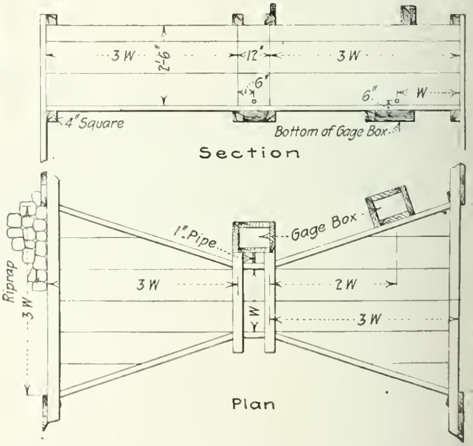
In addition to economy there remain to be considered the relative merits of the two structures. The abutment on wood piling should be better in every respect, as it is almost impossible for it to be washed out or in any way injured by high water. The abutment without piling would have to go to a considerable depth below water, which would make it difficult to properly place the steel in the footings and lower part of the wall.

Taking everything into consideration, the abutment with piling is in almost every way superior to the one resting merely on earth or gravel foundation.

⁂

New Measuring Flume

Experiments made in the hydraulic laboratory operated at Fort Collins, Colo., by the Office of Public Roads and Rural Engineering, United States Department of Agriculture, and the Colorado Experiment Station (see *Engineering News*, Oct. 2, 1913, for description of laboratory) have resulted in the development of a measuring flume which the experimenters believe promises to overcome the chief difficulties experienced in measuring water for irrigation purposes. The action of the device depends upon the adaptation of Venturi's principle to the flow of water in an open channel. The chief features of the device are shown in the accompanying sketch. The sides of the converging, throat, and diverging sections of the flume shown in the plan are vertical and the floor is level and at the same elevation as the bottom of the ditch. For smaller ditches a V-shaped throat having side slopes of 1 on ½, a top width of 1½ ft. and a length of 1 ft., is set between approach and outlet flumes 3 ft. long and



VENTURI FLUME DEVELOPED BY U. S. DEPARTMENT OF AGRICULTURE

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*From "Minnesota Highway Journal," July, 1916.

having bottom widths tapering from 2 ft. to zero. For large ditches there is a flume of trapezoidal cross-section with side slopes of 1 on 1½, bottom widths tapering from W (bottom throat width) to 3 W at a distance of 3 W. The throat is 1 ft. long.

The laboratory tests thus far made indicate that the device is quite accurate in its measurements. Additional laboratory tests are being made during the present season. Larger flumes have also been installed under field conditions and will be calibrated and tested.

The Venturi flume is inexpensive and easily constructed and maintained. It automatically takes care of the velocity of approach and requires but little loss of head in the ditch. The increased velocity in the throat greatly reduces the danger of trouble from silt, sand, aquatic growth or floating trash. The discharge through the flume is dependent upon the depth of water in the throat or the diverging section as well as upon the difference of depths. The depths are easily measured in the gage boxes and the discharges may be ascertained from tables or diagrams.

V. M. Cone, who has charge of the Fort Collins laboratory, and his assistants feel confident that the device which they have developed possesses sufficient merit to warrant making thorough tests.

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Long Distance Haulage with Motor Trucks

Experience with two 3½-ton motor trucks in mine haulage between Shultz and Tucson, Ariz. (47½ mi.), is given in a paper for the September meeting of the American Institute of Mining Engineers and now printed in the "Proceedings." One truck was fitted with a 1,075-gal. oil tank and used for carrying "tops." The other had a stake body and was used for hauling machinery, rails, pipe and miscellaneous supplies.

There were no excessive grades, but the roads were very bad for three months and never were good. The trucks were not run in wet weather—unless out on the road when rain started—for they were likely to stick in the mud. The lost time was about 5% of the total. Rubber tires were used throughout. Gasoline cost from 17 to 21c. per gal. Drivers got $4.50 to $5 per shift. The total cost of haulage was $12 per ton, compared with $15 as the best possible team price. The appended table covers the time from Aug. 21, 1913, to Aug. 15, 1914, when the trucks were in continuous service. From then to Mar. 30, 1916, the trucks were used only intermittently.

RESULTS OF MOTOR-TRUCK OPERATION BETWEEN TUCSON AND SHULTZ, ARIZ.; AUG. 21, 1913 TO AUG. 15, 1914

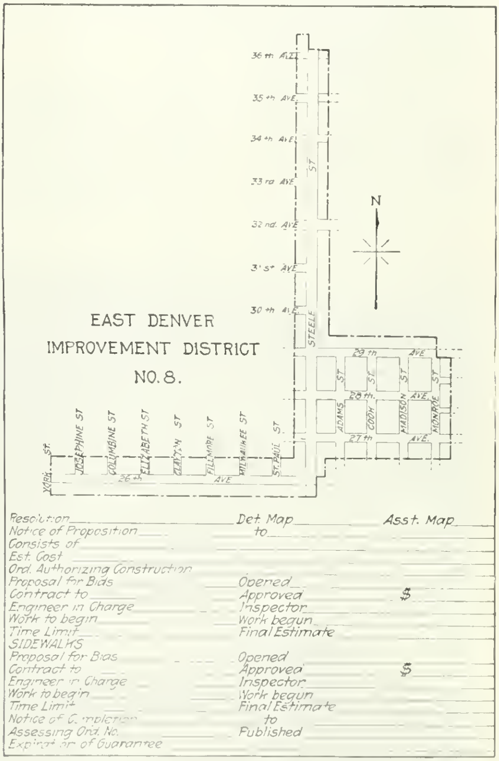
Total distance traveled, miles..	23 000
Total work done, ton-miles	42,700
Average distance per gallon of gasoline, miles.	4 5
Average distance per gallon of lubricating oil, miles	128
Average speed, loaded, miles per hour	7
Average speed, light, miles per hour	7 8

	Total Cost	% of Total	Per Truck-Mile	Per Ton-Mile
Wages of drivers	$2,623 32	23 91	$0.1141	$0 0614
Wages of helpers..	286 50	2 62	.0125	.0067
Repairs, labor	581.74	5.30	.0253	.0136
Repairs, lost time.	156 15	1 42	.0068	.0037
Oils, grease and waste. . .	379 17	3 46	.0165	0089
Gasoline	1,610 49	14 68	.0700	0377
Tires....	2,445 75	22 30	1063	0573
New parts.	515 08	4 69	0224	0121
Miscellaneous supplies....	348 82	3 18	0152	.0082
Incidental expense.....	226 21	2 06	.0098	0053
Depreciation.	1,796 80	16 38	.0781	0421
Total	$10,970 03	100 00	$0 4770	$0 2570

Pavement Construction Records at Denver, Colorado

The method of keeping records of pavement construction and incidental data in Denver, Colo., is as follows: A miniature map of the improvement district is plotted to such scale as to fit a 9x10½-in. sheet of tracing cloth. This and a standard form, as shown in the accompanying illustration, are printed simultaneously on a sheet of cloth-backed blueprint paper approximately 12x16 in. The blank spaces are then filled in consecutively as the work progresses.

The first line gives the date of the resolution of the council from which the work originates; the file number of the detail map or plan and the file number of the assessment map. The second line gives the dates when the resolution was published and the date of last protest. Printed clippings or copies of the resolution, authorizing ordinance and proposal for bids are kept in a bound scrap book, properly indexed so as to be readily accessible at all times.



Resolution Det. Map Asst. Map
Notice of Proposition to
Consists of
Est. Cost
Ord. Authorizing Construction
Proposal for Bids Opened
Contract to Approved $
Engineer in Charge Inspector
Work to begin Work begun
Time Limit Final Estimate
SIDEWALKS
Proposal for Bids Opened
Contract to Approved $
Engineer in Charge Inspector
Work to begin Work begun
Time Limit Final Estimate
Notice of Completion to
Assessing Ord. No. Published
Expiration of Guarantee

METHOD OF KEEPING CONSTRUCTION DATA ON PAVEMENTS, DENVER, COLO.

These cloth-backed blueprints are bound in books—one book for all work in progress, and a book for each year of completed work. Similar books are kept for sewer improvements. The page alone gives most of the data in general demand, and it serves also as an index to information filed in other places.

The city engineer of Denver is H. F. Meryweather

Cable System Handles Dump Wagons on Heavy Grades

By James Owen*

Old Dobbin, in these days of the efficient and fast-moving motor truck, is being rapidly crowded from urban grading jobs. Once in a while, however, through some mechanical aid he is enabled to cope with this modern mechanical wonder. This article has to do with just such a case. Briefly, the work performed was the hauling of rock in 2-yd. Troy wagons up a 16.5% grade, by means of an auxiliary cable—attached to the wagon—which made the load handled by the team almost negligible. Connecting this same arrangement of cable on another part of the work allowed the team to descend a 28.75% grade without setting the brakes and with comparative ease.

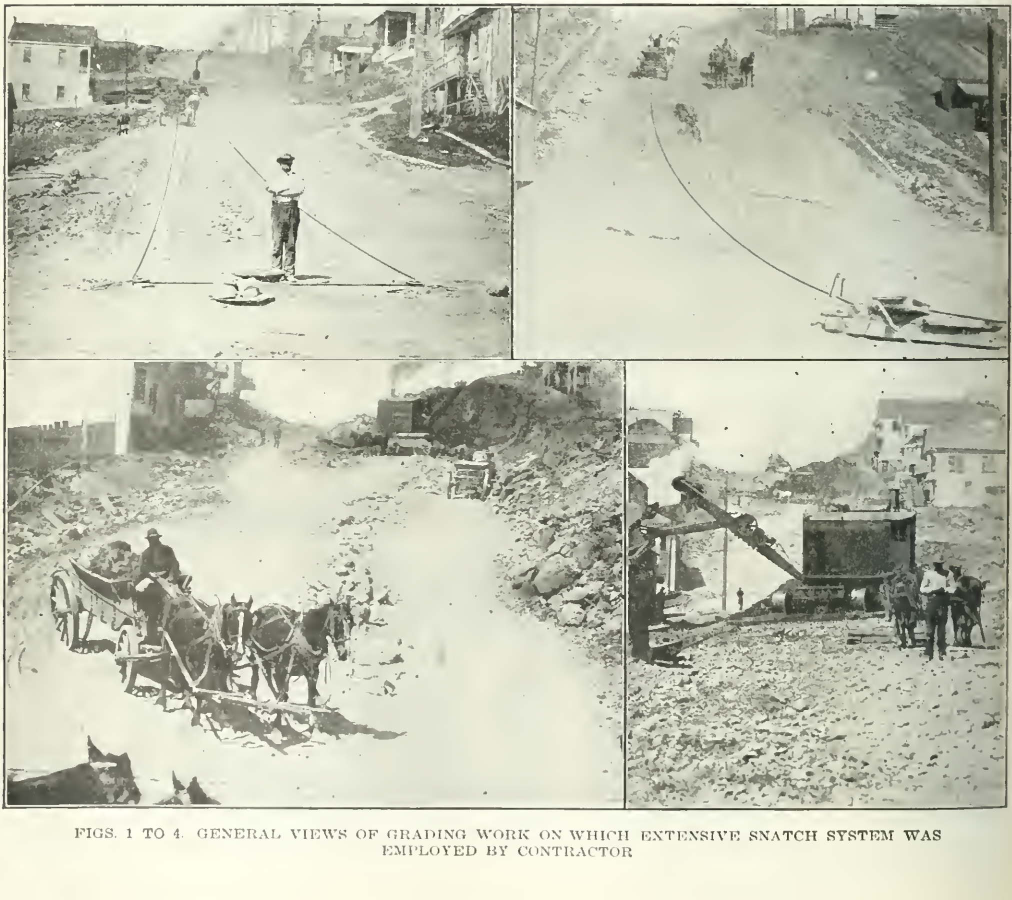
This ingenious method of handling the material was evolved by Al. Hennessy, the outside superintendent of the Federal Construction Co., and was used on a grading job that this firm had been awarded in San Francisco. The work was done under public contract under a two-year installment plan, at a total cost of $39,517.55, and involved moving 58,677 cu.yd. of material, of which 13,087 yd. was in slope. The contract was completed June 13, 1916.

Owing to the peculiar topography of this district (see views), some such method of handling the material as was adopted was necessary in order to show profit. Fortunately, a short haul was available, the contractors having made arrangements with the owners to fill some of the low land adjacent to the streets graded. On Vermont St., some very heavy fills were made, necessitating raising a number of houses to the new grade.

Using the method herein described, the contractors were enabled to make the fill at small expense to themselves. The sketch (Fig. 5) shows in detail how the material was handled.

A small donkey engine (with engineer and helper), a few hundred feet of ½-in. wire cable with hooks attached, and several deadmen and pulleys were all the extra equipment necessary.

Near-by, another grading job was in progress, under the supervision of the city, on which 5-yd. motor trucks were used. The haul, however, was much longer, and consequently the cost was much greater. It afforded a good opportunity to compare the two methods, as both jobs were in plain sight from the high ground. It was impracticable to use cars on account of the steepness of



FIGS. 1 TO 4. GENERAL VIEWS OF GRADING WORK ON WHICH EXTENSIVE SNATCH SYSTEM WAS EMPLOYED BY CONTRACTOR

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*Assistant City Engineer, San Francisco, Calif.

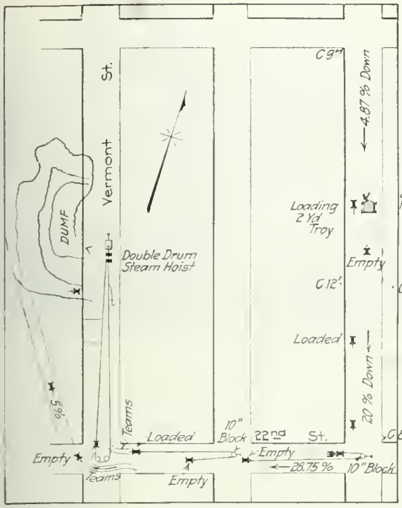

FIG. 5. LAYOUT OF CABLE SYSTEM DEVISED BY SAN FRANCISCO PAVING CONTRACTOR

the grades. The following cost data were supplied by Mr. Hennessy:

Shovel Crew:	Per Day
1 foreman	$4 50
1 engineer	6 75
2 firemen	7 70
2 pitmen	5 00
	$23 95
Estimated depreciation on steam shovel	10.00
20 sacks of coal @ 50c	10 00
3 flagmen @ $2.50	7 50
2 dumpmen @ $2.50	5 00
5 drillers @ $2.50	15.00
	$71 45
2 teams @ $6	72 00
	$143.45

0 teams, 24 loads each = 240 loads, or 480 cu.yd.
2 snap teams.

2 teams, averaging 20 loads each per day = 240 loads.
80 cu.yd.—$143.45—$0.2984 per yd.

Summary:	Per Cu.Yd.
uperintendent's rates, 480 cu.yd. @ $4.50 per day	$0 0094
oading shovel, 480 cu.yd. @ $39.45 per day	0 082
eaming, dumping, etc., 480 cu.yd. @ $84.50 per da	0 176
rilling, etc., 480 cu.yd. @ $15 per day	0 031
	$0 2984
owder	0 06
Average cost per cu. yd.	$0 3584

The four views illustrate particularly the handling of he material. Fig. 1, on Vermont St., shows a wagon eing assisted up a 16.5% grade to the side dump where nost of the fill was made. Fig. 2 shows 22nd St., south f Rhode Island St. The gradient on this block is 8.75%; the cleated walk at the west indicates the steepess of the grade. A cable block is illustrated. Fig. 3 s on Carolina St., looking east from 22nd, and shows he steam shovel at work. Notice the wagon with chain ttached to the rear axle—this chain was attached to a ook on the cable. Fig. 4 is on Carolina St., looking ast from a point south of 22nd, and shows a second team shovel at work.

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Sprinkling 294 Mi. of Streets in St. Paul, Minn., during the eason of 1915 took 254,248,000 gal. of water. This is equivaent to 9 in. of rainfall over the area sprinkled

Unit Stresses for Timber; Manufacturers' Table

The technical bureau of the National Lumber Manufacturers' Association, Chicago, has prepared a new table of recommended working stresses for structural timbers in dry locations. This table, reproduced herewith, is based on data furnished by the Forest Products Laboratory, Madison, Wis. The values given for "Dense" Douglas fir and yellow pine are subject to limitation of size and location of knots and other defects, as under most current specifications.

WORKING UNIT STRESSES FOR STRUCTURAL TIMBERS USED IN DRY LOCATIONS

	Bending		Compression	
Species of Timber	Stress in Extreme Fiber, Lb. per Sq.In.	Horizontal Shear Stress, Lb. per Sq.In.	Parallel to Grain "Short Columns," Lb. per Sq.In.	Perpendicular to Grain, Lb per Sq.In
Fir, Douglas:				
Dense grade	1,600	100	1,200	350
Sound grade	1,300	85	900	300
Hemlock, Eastern	1,000	70	700	300
Hemlock, Western	1,300	75	900	300
Oak	1,400	125	900	400
Pine, Eastern White	900	80	700	250
Pine, Norway	1,100	85	800	306
Pine, Southern Yellow:				
Dense grade	1,600	125	1,200	350
Sound grade	1,300	85	900	300
Spruce	900	70	600	200
Tamarack	1,200	95	900	350

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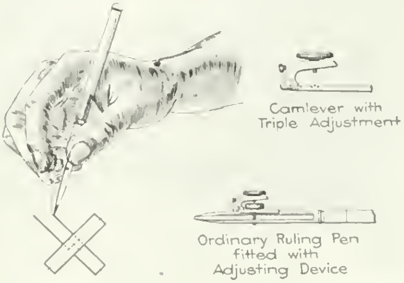
Ruling Pen Rapidly Adjustable for Heavy or Fine Lines

A practice quite general in tracing intricate drawings in drafting rooms is to trace in the heavy lines first and then insert the fine and dotted lines, or vice versa. By this method the draftsman must go over the entire drawing a number of times and must adjust the T-square and triangle twice before a line composed of heavy and fine parts can be completed. In inking in fine lines exclusively it frequently happens that the ink will not run freely, dries in the pen and forms a crust that can be removed only by cleaning. As a result of the two conditions stated, tracing is a slow and tedious process disliked by many draftsmen.

To overcome these disadvantages, A. E. Norman, of Portland, Maine, has developed what he calls an "automatic multiple adjusting" pen. As shown by the sketch, the new pen consists of a detachable adjusting device that can be attached easily to any standard drawing pen, thereby enabling an automatic adjustment of the pen for lines of three different thicknesses. The adjustments are accomplished by manipulating a small cam lever that acts on the upper blade, and the details of the de-

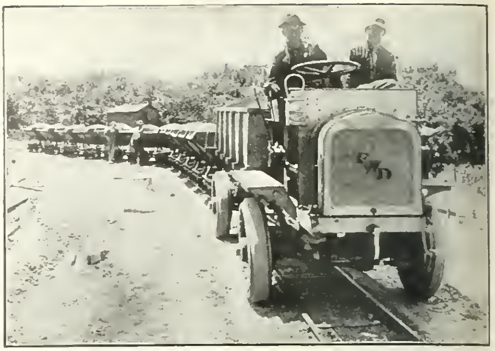

Camlever with Triple Adjustment
Ordinary Ruling Pen fitted with Adjusting Device

MULTIPLE ADJUSTABLE DRAFTING PEN INVENTED BY A. E. NORMAN vice are made so that the handling of the pen will become natural in the position of the pen for correct drafting. The inventor describes the action of the pen, which is not yet upon the market, as follows:

> With the adjusting device in its inoperative position the pen will draw a heavy line that can be adjusted as usual. If pressure is applied on the head of the large adjusting screw of the adjusting device, the pen will draw a fine line that can be adjusted by means of the large screw. As soon as the pressure is removed, the spring action of the blades of the pen will bring the pen back into the former adjustment again. If the cam lever is brought into a position where the small adjusting screw in the rear of the cam lever rests on the upper blade, the pen will also draw a fine line that can be adjusted by means of the small adjusting screw. This adjustment will be self-locked by the spring action of the blades, and the pen draws a fine line as long as the cam lever remains in said position.
>
> The combination of the self-releasing and the self-locking adjustment is a most valuable feature of the invention. It is desirable in drafting that the adjustment of the pen from heavy to fine and vice versa should be accomplished in minimum time, in order to draw lines that appear partly heavy and partly fine. In this case the self-releasing adjustment should be used, as it requires a motion of only some few hundredths of an inch for the adjustment. In drawing fine lines exclusively it is not always possible or convenient to exert the required pressure on the head of the large adjusting screw, and in this case the self-locking adjustment should be used, as it does not require any further effort on the part of the user.
>
> In using a multiple adjusting pen the draftsman can proceed systematically with his work. He can now, instead of searching all over the drawing for lines of the particular thickness for which his pen happens to be set, confine his attention to one part of the drawing, tracing in full lines, dotted lines and fine lines as he proceeds from one part of the drawing to the other.
>
> In constantly changing the automatic adjustments of the pen the crust that forms in the drying of the ink will be broken up, and actual experience has shown that the ink will run freely and the various lines be of the same uniform thicknesses whether the pen is full of ink or nearly empty.

NOTES

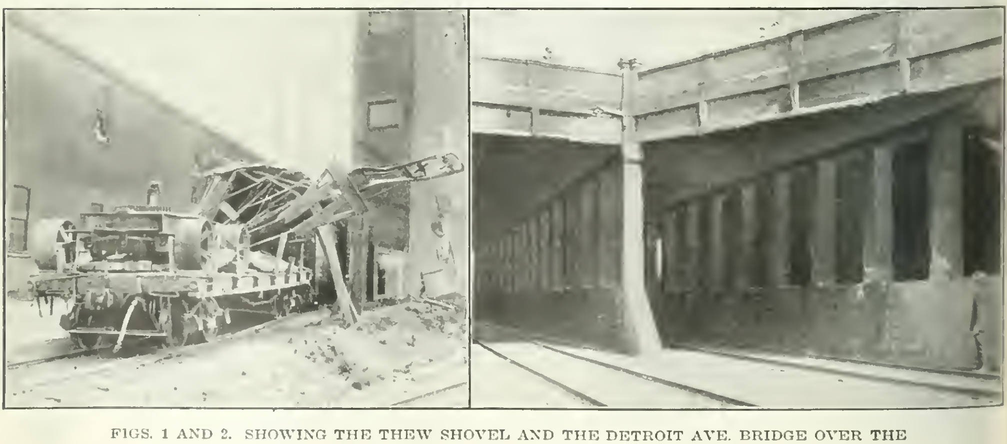
A 3-Ton Truck Hauls 26 Tons of Crushed Rock—A "Four-Wheel-Drive" truck is used in place of a dinkey to haul a string of 1½-yd. dump-cars running on narrow gage by the Hanlin & Oakes Co., contractor, of Sioux City, Iowa. The truck straddles the rails, as shown in the view, and according to a statement of the Four Wheel Drive Auto Co., of Clintonville, Wis., the train shown can go up a 5% grade, no load being carried on the body of the truck. The crushed rock, gravel and cement hauled by this outfit are being used in the construction of a 16-ft. concrete highway going north from Sioux City on what is known as the Perry Creek road. It is stated that from 500 to 600 lin.ft. of pavement is being laid daily. The material track is 4 mi. long, and 10 round trips are made daily. The truck pulls a load of 24 to 26 tons while running in high gear and travels at 12 to 15 mi. per hr. It is claimed that the daily cost of operating the truck and trailers in this service is $17.



A 3-TON TRUCK SERVING AS A DINKEY

Cost of Operating Motor Road Oiler—The City of St. Paul, Minn., has a 1,000-gal. "Good Roads" motor-truck road oiler. The machine is equipped with a kerosene heater and hot-water coils in the tank. The air pump is operated from the main drive shaft. The machine spreads oil to a width of 14 ft. As an average day's work under ordinary conditions the machine made the following record: Roadway oiled streets, 3,960 lin. ft. 24 ft. wide and 2,296 lin.ft. 16 ft. wide, in one 8-hr. day, or approximately 14,700 sq.yd.; 2,700 gal. of oil were spread, or 0.19 gal. per sq.yd.; 15 gal. of gasoline were used and the distance from the storage tanks to the streets oiled was 5 mi. Three trips were made. Two men, a chauffeur at $85 per mo. and an operator at $2.50 per day, were required. The machine cost $6,700 and does the work of five 600-gal. horse-drawn tanks. The weight of the machine empty is 7½ tons and loaded 11½ tons. The total unit cost of labor and material averages about 1c. per sq.yd. These statistics are from the city records.

Combat Between Steam Shovel and Bridge—The steam shovel as built today is expected to bear imperturbably a fall of rock following a blast. It is, in fact, one of the most rugged of contractors' machines. It is not, however, invulnerable—that fact was established recently in Cleveland, when a Thew automatic, loaded on a flat-car, worked loose and struck a concrete-incased steel bridge as the train passed under. Fig. 1 shows the remains of the shovel; Fig. 2, the scarcely damaged bridge.



FIGS. 1 AND 2. SHOWING THE THEW SHOVEL AND THE DETROIT AVE. BRIDGE OVER THE NICKEL PLATE R.R. IN CLEVELAND

Editorials

Safeguarding Large Cities from Explosion Disasters

The disastrous explosion of July 30 at New York City has brought forcibly to public attention the matter of safeguarding cities from disasters due to the accidental discharge of large quantities of explosives. This explosion was probably the most widespread disaster caused by the accidental discharge of explosives that has ever occurred in the United States. The loss of life was astonishingly small, only a half-dozen persons in all, owing to the fact that the explosion occurred at 2 a.m. on a Sunday morning, the time when working forces are at their minimum.

The property damage was very great, however, not only in the immediate vicinity of the explosion, but over a radius of nearly half a dozen miles. Besides the loss of life and property there was an unmeasurable nervous shock to millions of people awakened from a second sleep throughout greater New York, its suburbs and outlying districts for many miles in three states. Most of these people were filled with vague alarms and thousands were panic stricken. Were it possible to measure the waste of vital energy caused by the explosion it might prove to be the most serious aspect of the disaster.

It is evident that both the City and the State of New York are powerless to protect themselves against dangers that may be created across the state boundary in New Jersey. The authorities of Jersey City, however, promptly enacted an ordinance forbidding the transport of cars loaded with explosives on any railway entering the city and placed a force of 125 policemen at the municipal boundaries to stop all freight trains and prevent the entrance of any having explosive-laden cars. Perhaps the Federal courts will act to prevent this interference with interstate commerce; but the intent, at least, of the ordinance is sound—to stop the handling and storage of large quantities of explosive material in the vicinity of a densely populated city. The municipal ordinances in New Jersey previously prohibited the storage of explosives in any considerable quantity and required that explosives brought in by train during the day shall be transferred to lighters and taken away before nightfall, but there is always a chance that some interruption or other to traffic will cause an accumulation of freight. It is claimed that the explosive-laden lighter that caused the chief destruction should have gone down to Gravesend Bay before nightfall, but instead remained at the pier over night.

The operation of a large powder factory close to New York City would not be permitted, and neither should the transport and handling of great quantities of explosives in such a location be allowed. Explosives at the Port of New York, for example, could readily be handled from cars to boats at Perth Amboy, which is at the head of Raritan Bay and over 20 mi. distant from New York and the large cities across the Hudson in New Jersey. At other cities also where large quantities of explosives are handled the same principle of diverting the shipments to the outskirts should be applied. The carrying out of such a plan would probably have to be done through the Bureau of Explosives of the Interstate Commerce Commission. It is manifestly impossible for cities to exercise authority outside their own borders, and, as the New York situation shows, state action may be similarly hampered. Federal authority over interstate commerce is complete, however, and the splendid success attained by the Bureau of Explosives under Col. B. W. Dunn makes it probable that there would be general acquiescence in the proposal to extend the scope of his bureau to cover storage, transshipment and water transportation of explosives as well as handling on railway lines.

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How To Apply for a Job

The interesting paper by R. Fleming in *Engineering News* of June 8, giving hints to the engineer about what to do and what not to do when he writes a letter applying for a position, is followed in the present issue by a paper by C. A. Bock, Secretary of the Morgan Engineering Companies, summarizing his experience in examing some 3,000 applications for engineering positions.

It is unfortunate that the ability to write a first-rate letter of application for a position is very often lacking in engineers who have had a large amount of experience and are entirely competent in their special field. This is particularly apt to be the case with an engineer who has held one position for a long time and who, when some business change makes a search for a new position necessary, is at a loss how to go about it. The chances are that his letter of application to a prospective employer will be inferior to the one written by the happy-go-lucky chap who, because of something or other lacking in his makeup, seldom lasts longer than six months in a place, and as a result has a large experience in writing letters for a job.

Mr. Bock's suggestions, therefore, are likely to be found useful, not only by the large crop of June graduates of the present year, whom he mentions in his opening paragraph, but by many engineers of experience and high standing.

It occurs to us, in this connection, to add to those given by Mr. Bock, another useful hint that we happen to know has been found helpful by many engineers inexperienced in going about the task of seeking a position. Our suggestion is that the engineer who is seeking a position should prepare a letter setting forth in fairly complete form just what his professional experience has been, including in this, of course, a statement as to his education and personal characteristics, such as a prospective employer would desire to have. A list of references, stating in connection with each reference just what particular part of the applicant's experience or characteristics it treats of, should also accompany the letter.

This statement should be neatly typewritten on good paper of standard letter size, and a copy can then be inclosed with any letter of application or reply to an advertisement. In this way the letter of application itself can be made brief and businesslike, and can emphasize any special fitness which the writer may think he possesses for filling the particular position to which the letter relates. At the same time the employer is given all the facts concerning the applicant that he is likely to need, in a form where they are readily filed for examination.

There is another advantage in thus carefully preparing a statement of professional experience and personal qualifications and having copies on hand available for use when wanted. The engineer thus equipped is able to mail his application immediately for any position that may be open, whereas if he has not thus practiced preparedness, pressure of other duties may make it impossible to write promptly a good letter covering all the points, resulting in the sending of a poorly written missive in which he will not do himself justice.

Costly Maintenance Work

If anyone doubts that maintenance requires of the engineer more resource and judgment than does construction, let him consider the case of the Radebaugh tunnel. To maintain this tunnel in safe condition required, besides observation of settlement and other deterioration, the exercise of unusually keen judgment in interpreting the conditions existing at any given moment, and ingenuity in planning feasible and economical methods of repair. The reconstruction, a work of highly individual interest, is quite beyond comparison with the routine operation of driving a short rock tunnel on new construction.

But while thinking of maintenance it is important to distinguish those cases in which continuous and uninterrupted service is the imperative consideration. The responsibility of maintenance is multiplied under this condition, and judgment must be preëminently quick and unerring. Observation must be so close that failure is foreseen a long time, and planning for repairs must be generous both as to cost and as to time. Of two methods available, the more difficult and costly must be chosen if it reduces the hazards to the service. In short, we must apply a different scale of cost to problems of maintenance in continued service from that applicable to a service which may be discontinued. And in this light the costliness of an operation like the Radebaugh tunnel work appears natural and proper.

In this particular enterprise is found a common feature of difficult maintenance problems, namely a succession of attempts at minor repair before finally heroic measures are resorted to. But in this instance even the minor operations were of notable kind. Sinking a deep shaft, for example, merely to place a small patch of new lining is decidedly out of the ordinary run; and, by the way, some moral courage was required, no doubt, in recommending so elaborate an undertaking for a little local difficulty. Of course, the final step, enveloping the whole tunnel with lining in a new shell, is practically without precedent.

Relining, widening or other repair of tunnels in service is a frequent enough problem to direct attention to the first-cost question. It is far cheaper to do work at the time of original construction than to do it later on as a reconstruction job under traffic. Putting in permanent lining, for example, has often been regarded as a luxury to be indulged in only under stress of immediate necessity; and in so many a tunnel it has become necessary to do very expensive lining or relining work afterward. Not a few tunnels, where lining was omitted in "sound" rock, are the subjects of most anxious weekly or even daily inspection to discover sealing of roof, and even so rock falls happen from time to time. The costs and risks of such a condition should be fully appreciated before resorting to money-saving practices in first construction. There are similar cases in other fields, as in bridges. Bridges have so often been designed without overload capacity, and so often have been replaced at a young age because of obsolescence, that the disadvantages of skimping design are now better recognized than they have been in the past.

A City Built Upon a Hole

Scranton, Penn., presents the unusual spectacle of a large and prosperous city built on land that is steadily being undermined. Every once in a while the people of Scranton are reminded of this fact—reminded in a forceful way, such as by having a few buildings collapse or get so near the point of collapse as to be left standing only by the grace of the Almighty; or by having humps and hollows like a Coney Island scenic railway develop over night in some of the public streets.

The astonishing things are that there has been almost no loss of life and that people are apparently indifferent to the ever present danger of death and injury from falling buildings. Thus far, school buildings, an armory and other structures in which many people congregate have all but collapsed, and yet by happy chance these things have occurred at such times or in such a way as to have entailed no loss of life.

What rights have the public, if the coal operators own the anthracite that underlies the city? That question has not been satisfactorily answered by the courts or by other public authorities. So desperate have the householders in sections of the city become that anarchism—closing of some of the mines by mob law—is hinted at if the courts continue to refuse some kind of redress. The claim is made that not even the constitutional right to life and limb is respected.

Many coal operators have undoubtedly shown an arrogance and a disregard for the public welfare that are fortunately becoming less common with "captains of industry" than formerly. In most instances their legal right to the coal is unquestioned, but not always. They have sometimes been guilty of surreptitiously removing coal from under lands to which they had no right. They have browbeaten lot owners into disposing of their mineral rights for absurdly low sums, and they have asked huge sums of property owners who tried to purchase the coal in place to protect surface improvements. They have contended that lot owners who waived their right to the coal have no recourse, that any surface improvements are made at the lot owner's risk and that they, the operators, have the legal right to destroy all value in such property.

The courts have upheld this contention on the general principle that "he who builds a house over a volcano must take the consequences." Without questioning the legal precedent for such a ruling, the injustice of it is obvious. People have bought and paid large sums for lots that are valueless without the right to build on them and valueless if buildings on them are made uninhabitable. In plain words, the coal operators or lessors have sold something that they have reserved the right subsequently to destroy without compensation to the purchaser. Specific instances of injustice and the distressing results to small property owners are numerous. Many a laboring man has had his life's savings practically annihilated.

The problems from a humanistic point of view are pressing and complex. From an engineering point of view they are interesting and unusual, but not so difficult of solution. Subsidences like those described elsewhere in this issue show curious failures of building structures and still more curious instances where they do not fail. Changes in street grades are often radical and ultimately will mean reconstruction of both surface and subsurface street structures. There is often lateral movement enough to destroy alignment and cause strange shifts in property lines.

Left alone, the whole area would eventually readjust itself to new elevations and contours, but obviously the value of surface improvements and the danger to life and limb will not permit waiting for nature to take its course. It is no difficult engineering task to fill the old works or to replace the columns of coal with columns of masonry, but it is an expensive task, and many of the old workings would have to be reopened to make the work accessible. No one appears ready to assume the burden of expense for this undertaking.

A little refilling has been done, some by certain mine operators and some by the city, which in 1914 established a Mine Cave Bureau. Not until that time was it possible for the public to know how the mine operators were conducting their work, for they have been very careful to prevent outsiders from viewing underground conditions. Of course, the first thing to be done is what the Mine Cave Bureau is aiming to accomplish—namely, obtain an accurate survey of underground conditions. After that it will not be so easy for the operators to avoid responsibility.

In the past it has been customary to entangle matters as much as possible by a complication of leases and operating companies, so that in the case of a mine where several thousand tons of coal have been taken from under a public highway it may very likely be impossible to fix upon the mine operators responsible.

Whatever the solution of the problem of responsibility is, probably the anthracite consumers will ultimately foot the bill. The most popular proposal in Scranton is to put a tax on every ton of coal mined, the proceeds to go toward protection of the surface. Whether such a tax is established by law or the responsibility is placed on the mine operators, the result in the price of anthracite to the consumer will be practically the same.

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First Aid to Highway Travelers

For the convenience of automobilists, the Public Comfort Station Bureau of 261 Broadway, New York City, which is said to be backed by various national associaions, has started a campaign to provide one or more roadside waiting stations "in every city through which a main highway runs." These stations would have "saniary toilet accommodations for men and women, containng pure and wholesome drinking water," and in hard-water localities "there would be a small water-softening apparatus for supplying soft water for automobile radators." In addition, telephones and "other necessary electric equipment" (curling irons?) would be provided. It is comforting to know that these waiting rooms would be emergency hospitals and detective bureaus, perhaps also postal substations.

Besides caring for motorists the "comprehensive plan" of the bureau would include both landing places and parking places for aviators, with "land lights so that an aviator at night will know what state he is over, and the location above the state"—whatever the last clause may mean. City public comfort stations of the sort described are estimated to cost $10,000 each, but less expensive stations for small cities and towns are proposed. Cities would build the stations, it is said, and recover the whole cost in ten years by charging a use fee. The stations would therefore be, "not a charge upon the community, but a good paying investment in dollars, decency and health."

Although not so stated in the announcement, it is reasonable to expect that when automobilists and aviators have been provided for, attention will be given to the establishment of numerous buoyed way stations where submersibles can come up to aërate and do other things appropriate to undersea craft.

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Heavy Concrete Slabs Make Good Railway Bridges

Although heavy reinforced-concrete slab bridges for railway loadings have been fairly common for some years, it is doubtful if the engineering eye has yet become accustomed to their seemingly excessive thickness. The views in the first-page article this week well illustrate this. Used as we are to the comparatively thin slab supported on occasional girders, either of steel or concrete, the 20 to 40 in. concrete slab bridge seems unduly heavy to span an opening. It looks like a piece of pier footing strangely displaced from bottom to top of the structure and misapplied to the support of the light loads of traffic.

This uneasiness is of course entirely ocular, for the reinforced-concrete slab of a great depth is a most economical bridge span for heavy loads. Particularly when adapted to the unit system it has proved a valuable addition to the standard railway structures. In this form it possesses all of the known virtues of precast construction—that is, insured inspection and adaptability of time, working place and personnel—and at the same time it permits of great standardization of design for the many small crossings which railways require. In grade-crossing work it is of great value, because the abutments may be put in without interference with the street traffic and the slabs, cast anywhere convenient along the line, can be brought in and readily swung into place with a locomotive crane. When so placed its solidity permits of track work of the best type and its rigidity assures the permanence and the easy riding characteristic of main-line track.

A further advantage, which has been utilized on the Wabash work noted above and also on the Lackawanna grade crossings outside of New York City is the ease with which skew spans can be built. Form work for such skews is hardly more expensive than for a straight span and the piling up of one slab alongside or even on top of another is equally easy. This simplicity of form work, in fact, is the main factor in the economy of this useful structure.

Letters to the Editor

Standard Asphalt Specification Should Be Adopted

Sir—An editorial in *Engineering News* of July 27, under the caption "Repetitious Road Discussions," is very timely. You state that almost invariably the various papers presented at road conventions deal with elementary principles. This is quite so. In the future the subjects of discussion should deal with practical details rather than in glittering generalities.

For instance, the asphalt industry would probably feel grateful for some coherent effort toward specifications that would require a definite consistency of asphalt for the same type of construction. In the penetration method of road construction one locality demands an asphalt with a consistency showing a penetration of 100 to 110, and another locality in the same climate and for the same class of work requires an asphalt of a penetration of from 130 to 140.

Right here is a practical subject that might be developed at a road convention; that is, to determine what should be the proper consistency of asphalt for penetration road work. Of course, it would not be advisable to use an asphalt of the same penetration for Watertown, N. Y., as would be used at Columbia, S. C., but some uniformity could be arrived at that could be adopted for similar climatic conditions. Then again, this same disparity often occurs in defining the consistency of asphalt for sheet-asphalt and asphaltic-concrete pavements. It is true that streets for heavy traffic require a harder asphalt than those for light traffic; but there are many small cities where the traffic is relatively the same, for which some uniform or standard penetration specification for the asphalt could be developed.

The companies refining asphalt in these days are in the same position as the pickle factory—they have to produce 57 varieties. It makes it a very onerous proposition. If the consistency of asphalt for various types of pavement could be standardized, the asphalt refiner could give his customer better service in the way of shipment and could operate his refinery with much more smoothness.

It is time for road conventions to cast aside the old, hackneyed, worn-out topics and introduce subjects that really relate to the actual construction details of road building. J. R. DRANEY,

Sales Manager, United States Asphalt Refining Co.

New York City, July 28, 1916.

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Should Technical Societies Try To Influence Legislation?

Sir—There has been some active discussion in *Engineering News* and other technical publications recently as to whether engineering societies should take any action with reference to pending legislation that might affect the interest of engineers.

In the Philadelphia Engineers' Club the question has been brought to a head recently through the presentation of a paper by Past-President Henry Hess, at the close of which he offered a resolution to the effect that the club should not commit itself to any action with respect to any pending legislation. I quote the following extracts from his address:

> There has been growing for some time a conviction in the engineering world that engineers should and must take a place in the community in the shaping of public affairs—a place more in accord with the importance of engineering in the economic and social political affairs and life of the commonwealth.
>
> How best can engineering associations, including our Club of Philadelphia Engineers, best place their collective engineering knowledge, experience and training at the service of the community? Two ways are debatable: A stand in favor of or against direct legislation may be taken, or engineering matters affecting the community may be carefully considered and formulated to serve as a guide and basis for the formulation into laws by those more specifically fitted by experience and training in the framing of laws.
>
> Some, at least, of the great national engineering societies, some by practice and some by direct constitutional requirement, have decided to absolutely refrain from recommending or formulating laws and to limit themselves to specific engineering advice and recommendation. In so restricting themselves they have actually broadened and deepened their influence on actual legislation. They have not sought, nor do they seek, to influence legislation, and in so refraining they have actually gained a deep and beneficial influence in and for the community.
>
> A case in point that most of you are familiar with may here be cited: A number of engineers, members of the American Society of Mechanical Engineers, largely interested in steam boilers and their safe construction and use, got together a number of years ago and were constituted a special committee of that society. A code for boiler construction was evolved that, while restraining no maker of any particular type of boiler, made certain that any boiler built and used under the code was as safe as the combined experience and skill of the designing, manufacturing and operating engineers of the country could evolve.
>
> Did the engineering association that participated in this work recommend the adoption of the code as the law of the land? Many members of the committee most earnestly demanded that that should be done. Wiser counsel prevailed. The code was published simply as what it was—the crystallization of the best knowledge of the engineering profession.
>
> And what was the legislative result? Various legislatures in various states secured copies; some had the code reprinted in toto, and many used it as the basis for a revision of their boiler laws. Nowhere was the code objected to, as must inevitably have been the case had its framers worked for the adoption into law. No point was raised of a selfish motive or a selfish end to be gained for any maker of a boiler or of a boiler accessory.
>
> A number of legislatures have incorporated the code in whole or in part into organic law. Even those members who advocated the engineering societies putting themselves behind the enactment of the code into law are now agreed that what they hoped for in the interest of the public and community actually came about much sooner and more readily as a result of their confining themselves to their special domain.

It is exceedingly interesting to compare Mr. Hess' statement that the A. S. M. E. boiler code "gets itself adopted" by state legislatures, etc., without any action by the American Society of Mechanical Engineers, with Bulletin 5, just issued by the American Uniform Boiler Law Society, an organization which was formed to secure the legal adoption of the A. S. M. E. boiler code and which represents ten different groups of commercial organizations engaged in boiler manufacture and use:

Your chairman begs to report that on July 11 a meeting of he Administrative Council was held in New York; the afairs of our society were generally discussed and a camaign planned for the continuance of the work. It was deided to put in our strongest effort on the States of Conecticut, Michigan, Illinois, Minnesota, Texas, Missouri, Tenessee and Louisiana and continue our effort in New York.

The financial report showed that all bills had been paid nd approximately $2,000 on hand.

The Administrative Council was continued and the request iade that each section provide at least the amount of funds hat were provided last year.

In our work during the past year we have given our soiety and the A. S. M. E. code very broad publicity and have iade known our desires throughout the United States. We o not believe we are wrong in stating that there is probbly not a section in the United States that has not had the iler code placed before them and its advantages outlined to iem.

From the above quotation it is evident on its face iat Mr. Hess' example cited to demonstrate that an ugineering society can influence legislation by merely lopting something and refraining from all publicity oncerning it really proves the exact contrary.

The rapid adoption of the excellent boiler code formuated by the A. S. M. E. is due to the fact that a strong rganization, backed with the funds necessary to carry n hard, steady and effective work over a broad area, as got behind the code and is making its merits known they deserve to be known. Had nothing of the sort en done, there is no reason to doubt that the A. S. I. E. code would have been comfortably buried in the ociety's transactions, to remain in dust-covered repose n library shelves, and its effect on state legislation d municipal ordinances would have been nil.

The principle at stake is a broad one and ought to clearly understood. If the members of an engineering ociety decide that they want to do anything concerning iblic questions such as legislation affecting matters in hich engineers are interested, they should understand iat they will be practically wasting their time if they erely deal with abstract technicalities and adopt formal solutions. If they really want to have any vital inuence on such matters in this busy world, they must t be afraid to give all possible publicity to what they y and do, and they must be willing to do the necesry work to bring their action to the notice of those who e in authority. Q. E. D.

New York, July 29, 1916.

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Ir. Godfrey Defines "Unbiased"

Sir—Referring to Arthur R. Lord's letter in your sue of July 13, Mr. Lord says that I have repeatedly iblished statements to the effect that wall panels are ver loaded. He then recites tests made that refute is: Let us see. In Transactions of the American ociety of Civil Engineers, Vol. LXXVII, p. 1701, I id, "There are no recorded tests of isolated panels with e load in the square inclosed by the columns, and none exterior panels, except where the outer edge was suprted by a girder or a wall. Furthermore, there are tests of flat-slab construction where load was placed all panels across a building." On page 1392 of the me volume I said practically the same thing.

The Larkin building, the test of which Mr. Lord ndly invited me to witness, had deep girders in the ter walls on the floor tested. I was impressed with e care and thoroughness with which this test was made, and if Mr. Lord, or anyone else, thinks that my remarks concerning disinterested tests refer to bias in the matter of conducting the tests, he is simply mistaken. The "interested" feature of practically all of the tests made consists in the selection *by the patent owners* of the portion of the floor to be tested. They do not select, for test, an isolated panel. They do not select a row of exterior bays where there is a simple rib support on the exterior edge, and leave the next row of bays unloaded. They do not select a row of bays completely across a building and thus counteract the dishing effect that aids greatly to support loads on single bays. They do not select an upper floor where the columns are small. They do not, therefore, make a real test of their construction. The testing engineers may do their work never so carefully and conscientiously, but so long as the selection of the portion tested is along the lines just indicated, the test cannot be said to be disinterested.

To give a little history to illustrate the point. I once tested a building. The first test was made to satisfy the builder. It was on one interior bay. The result was excellent. If I had stopped there, the report would have been lovely, and I should have resented any implication that the test was biased. But in the interest of truth and the owner I went on and tested the three bays across the building. The result was failure. The first test was unbiased but it was "interested." The second test was also unbiased, but it was disinterested. The aim was purely to find out what the floor would do under legitimate loading and use. EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Pa.,
July 24, 1916.

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Another Electric Battleship—Contracts have recently been let for electric propulsion machinery for the U. S. S. "Tennessee," a superdreadnaught now under construction. This action may be regarded as a result of success with the U. S. collier "Jupiter" and the battleship "California." There will be in the "Tennessee" two steam-turbine electric generating units aggregating 33,000 hp. and feeding four 6,700-hp. motors, each connected to a propeller. Smaller turbine sets will drive the auxiliaries and furnish light and power throughout the ship. There will be several hundred motors, doing all work from anchor raising to steering. Electricity will be used for cooking, ice making, etc.

Legislation and Ethics in Relation to Engineering in Minnesota are included in resolutions adopted at the recent annual meeting of the Minnesota Surveyors' and Engineers' Society. It was voted that the society should coöperato in three movements to secure improved legislation: 1, Drainage—No drainage ditches should be ordered constructed under the state laws unless it is definitely shown by the engineer's survey and report that they will be of sufficient capacity to drain effectively all low, wet or marshy lands in the watershed, together with all lands from which the water is likely to be diverted thereto. 2. Water-Supply and Sewage Disposal—There should be better laws defining the powers and duties of the State Board of Health, as the present laws are inadequate to control properly water-supply and sewage disposal. The lack of competent supervision and advice is leading to practices and conditions that are liable to endanger public health and cause the wasteful expenditure of public moneys. 3. Land Surveying—The limiting of the compensation of county surveyors, under the present laws, has resulted in keeping competent men from accepting this office. This society therefore will petition the legislature to abolish such parts of the statutes as refer to this compensation and to prices to be paid for surveys, allowing the work to be paid for on its merits. 4. Free Engineering Services—It appears that several manufacturers of materials are offering the free services of their engineering forces to furnish detail plans of reinforced-concrete steel structures, tile-drainage systems and other engineering works. The society protests against this practice, as it is sometimes misleading to the public, is not conducive to fair and impartial commercial consideration and is demoralizing to the engineering profession.

More Mine Cave-Ins Threaten Parts of Scranton

Recent serious subsidences from mine caves in the City of Scranton, Penn., along North Main Ave. and vicinity, again make pressing some solution of a perplexing problem—the protection of surface and surface improvements when the anthracite coal that underlies the city is removed. The accompanying views, taken July 22, look like distorted photographs, but they do not by any means adequately show the actual conditions of things—a street with a surface like a roller coaster and buildings leaning against each other like inebriated companions.

This particular subsidence is alleged to have been caused by the mining operations of the People's Coal Co. and happened a few weeks ago, but numerous similar subsidences have occurred in the past in other parts of the city. The most valuable surface structure thus far injured is the 13th Regiment armory at Adams Ave. and Myrtle St., within a few minutes' walk of the business center of the city. A corner of the armory is shown in the lower right-hand view. This building cost over a quarter of a million dollars.

The City of Scranton is in the heart of the Pennsylvania anthracite field. Its beginning as a town dates from an iron manufactory, which assumed quite large proportions before anthracite mining became important. It was not until the '60's that anthracite mining was conducted on an extensive scale. The existence of the anthracite was of course known for many years before it came into extensive demand, and therefore the greater part of the land on which the City of Scranton now stands was acquired long ago by farsighted individuals because of its mineral wealth. The general practice has been for these owners and their heirs to lease the mining privilege to companies that carry on the mining operations and pay the owner a royalty.

As the city grew, the surface as well as the coal underneath became valuable. In a large part of the downtown business section the land was sold outright, with the coal under it, but there are large sections where the original owner in selling surface rights expressly reserved all mineral rights. In some instances, of course, the original owners were the coal operators themselves.

At the time most of these sales and leases were made it was the current practice of the mine operators to leave one-third of the coal in place as pillars to support the roof and prevent surface subsidence. Some few of the old leases specify this condition and guarantee the surface owner from damage caused by subsidences; other deeds and leases distinctly disclaim liability for any surface damage whatsoever.

Probably most of those who bought city lots did so on the supposition that past methods of mining would be continued and that the danger of subsidence (based on past experience) was negligible. At all events they went ahead and made surface improvements, in many instances of more value than the coal under them.

Today, increasing evidence points to the conclusion that not all coal operators, past or present, have been conscientious about leaving one-third of the richer and more easily worked coal seams—in other words, they have been guilty of "robbing the pillars." Subsidences over large areas of from 1 or 2 ft. to 8 or 10 ft. have occurred without warning. Sometimes such large areas have been involved as not to damage seriously ordinary frame dwellings on land that subsided. In most cases, however, the damage has been alarming and extensive.

The surface cover of the upper coal veins varies from nothing where the coal outcrops to 150 ft. or more. The immediate danger from subsidence is generally more serious where the cover is shallow, as under North Main Ave., in the views shown, where the mine workings are only 70 ft. below the surface. An examination of underground conditions, however, shows that the subsidence of large areas over old workings is imminent; in fact, is slowly but surely taking place.

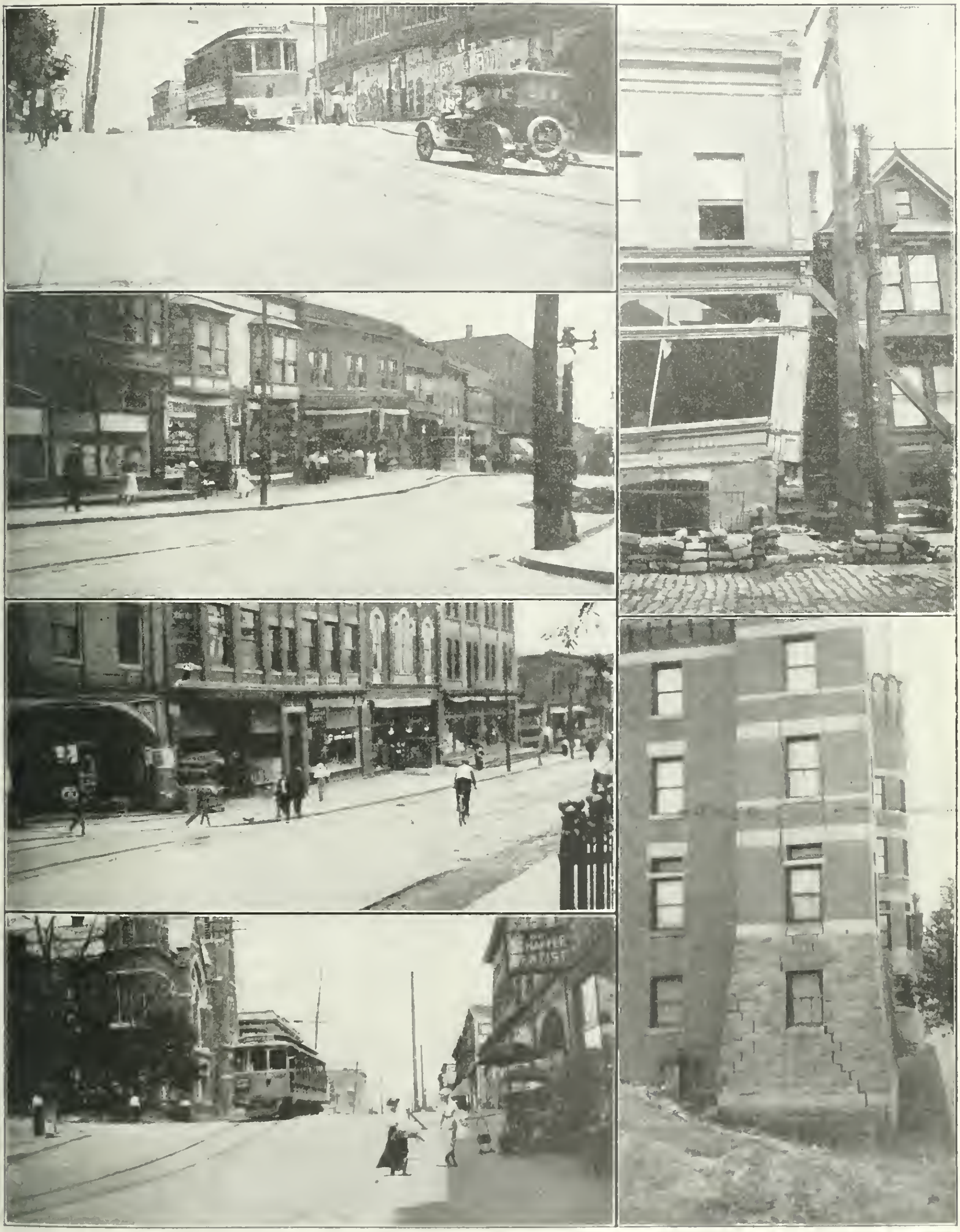
The number of veins under the city which have been worked varies from five to seven. Until recent years this mining was carried on without governmental supervision, with inadequate surveying methods and with no system whereby the pillars in the different veins or levels were columnized—that is, placed vertically over one another. The present condition of many acres of these old workings is impossible of determination, for large areas have been closed by squeezes, and other large areas have been purposely walled off by the mine operators.

The danger of extensive subsidences has long been recognized and has been the subject of more or less elaborate engineering investigations. An abstract of the report of the first of these will be found in *Engineering News*, Sept. 21, 1911, which describes in detail the mining methods that have been in vogue and the methods that were then recommended for preventing further subsidences. Such protection is essentially a simple matter: it means only the replacing of the coal with columns of masonry or else filling the old workings with culm or dirt.

It must be remembered, however, that about 250,000,000 cu.yd. of coal and refuse has been taken from under the city (about as much as the total excavation for the Panama Canal), and to replace all of this vast volume would be impossible, as well as unnecessary. Very little systematic filling, however, has been done, because no agreement can be reached as to who shall pay for it.

The courts have refused to hold the coal operators liable except in specific instances where they assumed liability through the original leases or deeds. Except in a few cases, like the armory above mentioned and two or three public-school buildings, a great part of the damage has been done to small dwelling houses and places of business, the owners of which have neither the means nor the heart to fight long drawn-out legal contests. Matters have now reached a crisis, however, and an organization known as the Scranton Surface Protective Association has been formed with several thousand members, which intends to fight out collectively the points of law involved.

Aside from the buildings mentioned there has been extensive damage to public property, as well as to private property. The illustrations give some idea of the present contour of the street surface, and any engineer can imagine what happens to subsurface structures—sewers, water and gas mains, etc.—under such conditions. The gas and water mains are owned by private interests, and it is



VIEWS OF SCRANTON, PENN., MINE-CAVE DAMAGE

The left-hand column shows views of North Main Ave. after a recent mine-cave, or general subsidence. The humps in the street mark places where the property owner attempted to protect his property by buying the coal under it, or where pillars of coal were left. The lower right-hand view is a corner of the 13th Regiment Armory alleged that damages to these properties are paid for by the coal operators, but the city has collected damages for broken sewers only in rare instances. The courts have held in each instance that the city must show by deed or lease that it has absolute control of the coal under the streets. A case is now before the Supreme Court of the state involving damage done to North Main Ave., which was a public thoroughfare in the eighteenth century, or long before anthracite coal came into use.

In spite of the roller-coaster surface of the street the vitrified-pipe sewer has been kept in service, but because of the sags and low places, flushing out is frequently required. In some instances, however, it has been necessary to take up and relay sections of sewers on new grades. Fortunately, Scranton is a side-hill city, and drainage problems have so far been successfully solved.

From the foregoing it will be evident that the damage which has occurred is not a circumstance to what may occur. No one can predict what may happen. There are known to be large areas where one-third of the coal was not left for pillars—where less than half of that was left. It is known that anthracite disintegrates on contact with the atmosphere and that the pillars of coal which were left are gradually crumbling away. Subsidences may be gradual and uniform, but they seem certain to continue, unless extensive areas are underpinned or refilled.

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Improving the Appearance of Chicago River Bridges

Improvement of the appearance of the numerous bridges over the Chicago River in the City of Chicago has been agitated for some years and is now being studied with reference to the new bridges to be built under the $5,000,000 bond issue recently authorized.

Most of the Chicago River bridges are of the through or half-through truss type, with two or three trusses rising above the floor level. The swing bridges are obsolete (those now remaining are to be removed), and some of the bascule bridges, while doubtless structurally unimpeachable, are not of attractive appearance. One of the fundamental ideas in improving the appearance of future bridges is to keep all the structural work below the deck, or at least beneath the parapet level. This will give the bridge an appearance of width and lightness from the approaches.

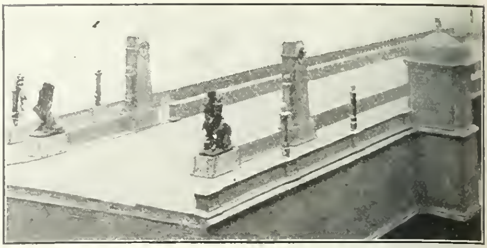


FIG. 2. PROPOSED ENTRANCE TREATMENT OF APPROACHES TO THE MADISON ST. BRIDGE AT CHICAGO

Not much can be done in the way of architectural treatment of the approaches, for the streets are of moderate width and are generally flanked by commercial buildings extending to the river bank. Hence, there is no opportunity for creating wide open spaces at the approaches. The most that can be done is to adopt some pleasing treatment for the masonry abutments and parapets, the operating cabins, electric-light posts and similar accessories, and place some decorative features on the approaches at the curb lines to form a distinctive entrance to the structure.

In the accompanying views is shown a model of a proposed ornamental treatment of the new bascule bridge at Madison St. The limitations of headway prevent the use of a curved bottom chord and necessitate extending the trusses above the floor to parapet height. The lower part of the steel work, therefore, has a girder effect, and the upper part (at the curb lines) is masked with ornamental ironwork of similar design to that of the outside parapets or hand rails. Fig. 1 is a general view, and Fig. 2 shows in more detail the treatment at the approaches.

The abutments are designed to be of granite, and the Pennsylvania R.R. has agreed that, if this is decided upon by the city, it will use granite for the river-front wall built in connection with the new Union Station. The operating cabins are to be of vitrified tile, with mat, glaze finish, imitating granite.

The architectural entrance treatment at each approach is to consist of a pylon and bronze statuary group on either side, with a low parapet wall extending between them, on the line of the curb. The pylons would be about 26 ft. high and narrow enough to avoid obstruction.

This model was prepared at the direction of the Municipal Art Committee of the Illinois Chapter of the American Institute of Architects. The committee is working in coöperation with the Chicago Plan Commission and the Department of Public Works.

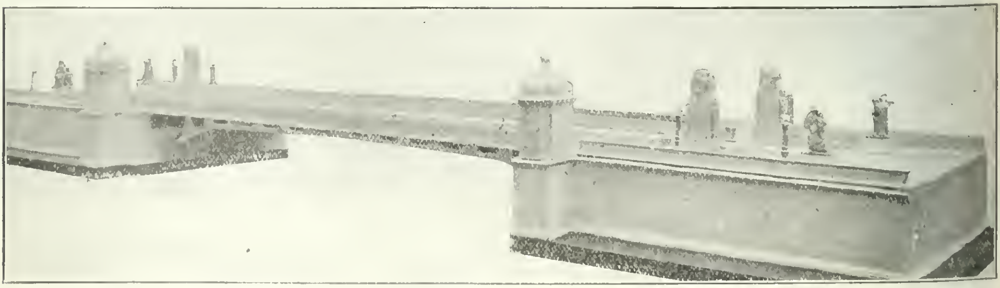


FIG. 1. MODEL OF PROPOSED DESIGN FOR MADISON ST. BRIDGE AND APPROACHES AT CHICAGO

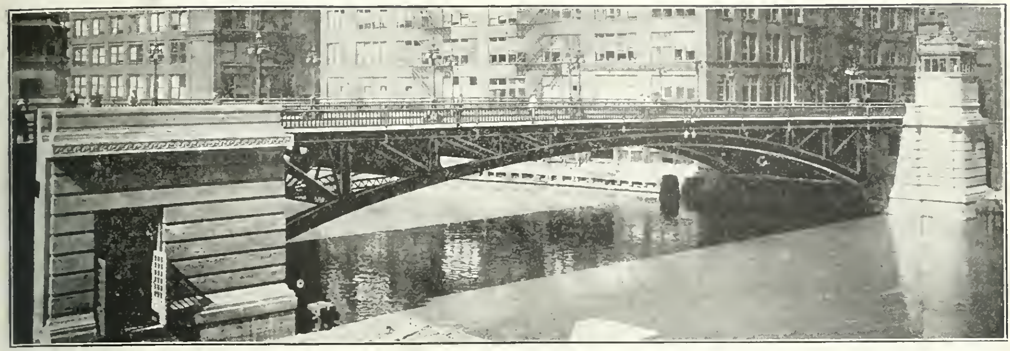


FIG. 3. BASCULE BRIDGE OVER THE CHICAGO RIVER AT JACKSON ST.

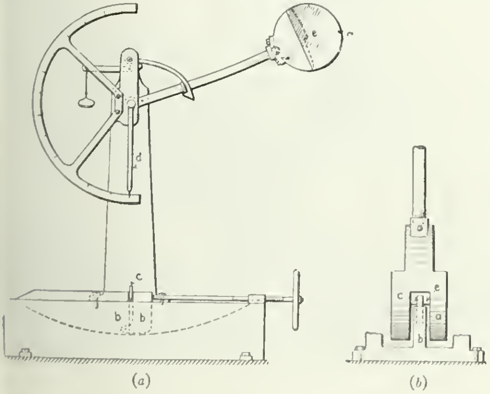
The excellent appearance of a deck bridge as part of a public street, as compared with a bridge having the roadway broken by projecting trusses, is shown strikingly by the new Jackson St. bascule bridge, built by the Strauss Bascule Bridge Co. and opened a few months ago. A view of it is given in Fig. 3. A slightly greater headway here permitted the use of curved bottom chords, and it enabled all structural work to be kept below the deck, so that there are no parapets between the sidewalks and roadway, as in the Madison St. design. This gives a fine open appearance to the bridge.

The abutments at Jackson St. are of reinforced concrete, housing the operating machinery, and upon each is an operator's tower, with concrete lower portion surmounted by a cabin of steel, copper and glass. A simple decorative treatment is given to the concrete work, and the tower is paneled with inserted lines of tile. The design of the abutments and operating towers at this bridge was the result of coöperation between the engineers and the Chicago Plan Commission.

* * *

Torsional Endurance and Impact Machines

A machine for endurance experiments using alternating torsion in a peculiar way has been built at the Naval Engineering Experiment Station at Annapolis. It was described by D. J. McAdam, Jr., in a paper "Endurance and Impact Tests of Metals." Arm *b* (see Fig. 1) grips one end of the specimen (Fig. 2), which is journaled in two bearings in the frame. The other end is held by arm *e*, whose outer extremity engages the opposed springs *f* and registers on the drum *h*. The throw of the crank disk *a* can be varied. With a given throw, the torsional load on the specimen is less when the specimen yields than when its deformation is small. Tests have been run with various steels at loads producing rupture at several thousand cycles. Such tests have been applied to the problem of choosing between half a dozen different heat-treatments for chrome-nickel steel.



(*a*) (*b*)

FIG. 1. MACHINE FOR ALTERNATING TORSION TEST

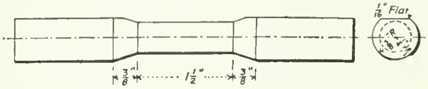


FIG. 2. SPECIMEN FOR ALTERNATING TORSION TEST

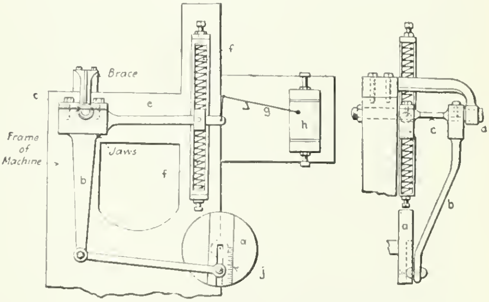


FIG. 3. IMPACT-SHEAR TEST MACHINE

An impact-shear testing machine was also built, and tests are being run on it for comparison with the torsion-endurance tests. This is shown in Fig. 3. The specimen *c*, 3/8 in. wide and 1/4 in. thick in the direction of the blow, is held by the vise *bb*, and its projecting end is sheared off by the punch *e* in the pendulum *a*. After the break, the pendulum carries the dead pointer *d* with it, and thus the residual energy is measured, giving by subtraction the foot-pounds absorbed by the break. After breaking a piece, it can be moved up in the vise and repeated breaks made. The average rupture work for tough metal is about 15 to 50 ft.-lb.

News of the Engineering World

Bascule Bridge Replaces Old Swing Bridge

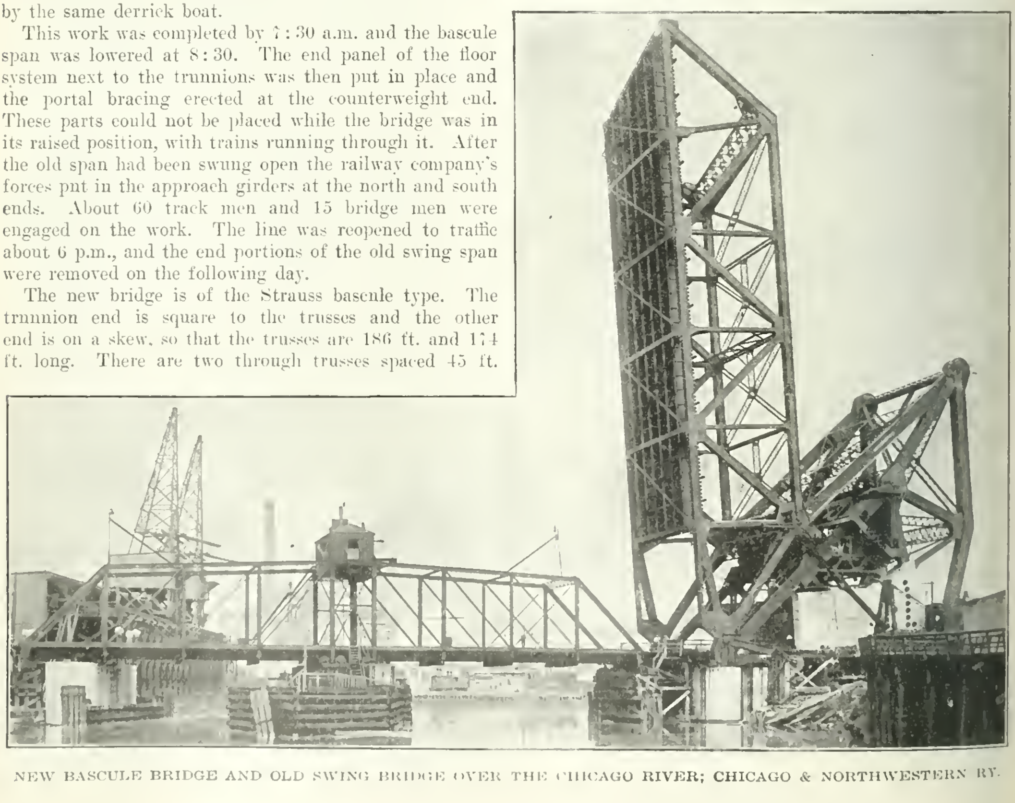
The new 186-ft. three-track single-leaf bascule bridge of the Chicago & Northwestern Ry. over the Chicago River near Fullerton Ave., Chicago, was put in service July 30 (Sunday). It takes the place of an old double-track center-pier swing bridge. The new structure was erected in the open or raised position, the end floor panel being left incomplete to allow trains to pass through while the work was in progress. The accompanying view affords an interesting comparison of the old and new structures.

Traffic was suspended soon after midnight, and work was commenced at 12:30 a.m. The old bridge was swung into the open position and blocked up on the protection pier, and the operating machinery was removed by a derrick boat. The middle portion, for a width sufficient to enable the bascule span to be lowered, was then cut away by means of oxyacetylene torches and the parts were loaded upon a scow by the derrick boat. These parts were afterward cut up by the torches and loaded on cars by the same derrick boat.

This work was completed by 7:30 a.m. and the bascule span was lowered at 8:30. The end panel of the floor system next to the trunnions was then put in place and the portal bracing erected at the counterweight end. These parts could not be placed while the bridge was in its raised position, with trains running through it. After the old span had been swung open the railway company's forces put in the approach girders at the north and south ends. About 60 track men and 15 bridge men were engaged on the work. The line was reopened to traffic about 6 p.m., and the end portions of the old swing span were removed on the following day.

The new bridge is of the Strauss bascule type. The trunnion end is square to the trusses and the other end is on a skew, so that the trusses are 186 ft. and 174 ft. long. There are two through trusses spaced 45 ft. c. to c. for the three tracks. The clear width of channel is 145 ft. (on the square), and the headway above the water is 18 ft. 3 in. The total weight of structural steel (including trunnions, pins, sleeves, bearings, stairs, platforms, anchorage and grillage) is 1,250 tons; the operating and lock machinery weighs 92,840 lb. The concrete counterweights are a new design, placed only at the sides (instead of extending across the tracks), so that they could be erected without blocking traffic. They contain 522 cu.yd. of concrete (4,536 lb. per yd.) and 12,300 lb. of reinforcing bars. Holes are left in the concrete for adding pig iron or bars to adjust the weight. The bridge is operated by two 150-hp. electric motors which can open or close it in one minute. An auxiliary 50-hp. gasoline engine is provided in case of failure of current or accident to the electrical machinery.

The bridge was designed by the Strauss Bascule Bridge Co., of Chicago. The substructure was built by the Great Lakes Dredge and Dock Co., of Chicago, which also cut apart the old span. The steel for the superstructure was furnished by the American Bridge Co. and was erected



NEW BASCULE BRIDGE AND OLD SWING BRIDGE OVER THE CHICAGO RIVER; CHICAGO & NORTHWESTERN RY.

by the Kelly-Atkinson Construction Co., of Chicago. The design and construction of the bridge, and the work of changing from the old to the new structure, were all under the direction of W. H. Finley, Chief Engineer, Chicago & Northwestern Ry.

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Report on Boston Edison Tunnel Accident

The fatal accident of June 24, 1916, in the shaft and tunnel under construction for the Edison Electric Illuminating Co., at Summer St., Boston, by the Hugh Nawn Contracting Co., has just been reported on by Edwin Mulready, State Commissioner of Labor. The report suggests that the shaft shell tore apart and "blew up," presumably because the shaft was not strong enough for the tension due to the high air pressure. The report says:

> About 7:47 a.m. on June 24, 1916, the vertical airlock and shaft blew up. The four men who were working in the tunnel itself were killed, and three men who were in the airlock were uninjured.
>
> This work is being done under about 31 lb. pressure. The haft is about 80 ft. in depth, with a 10-ft. heading at the ottom. The tunnel itself is about 7 ft. in diameter. The irlock is also about 7 ft. in diameter and held about eight men at the time of the accident.
>
> The probable explanation of the accident as learned from nvestigation is that the air chamber at the point where heading started snapped off and blew up. At the broken point in the shaft sand and water rushed in. The manhole rrangement of the vertical shaft is now only 3 ft. above ground, but after the accident it was pushed up about 5½ t. upon the ground and canted at an angle of about 45°. This haft is situated at the bridge at Summer St. at the beginning of L St. There were three colored men and one white man killed.

*

Standard Warnings for Grade-Crossing Protection

Committees of the National Association of Railway Commissioners and the American Railway Association ave coöperated in planning standard warning signals for rade crossings of railways and highways. The principal eature of the new standard is the placing of a cautionary ign beside the highway at least 300 ft. back from the ailway track. This warning sign is to be a circular disk 4 in. in diameter, painted white with a black border nd a black cross, with the letters R.R. above the horiontal arm of the cross. This disk is to be placed beside he road on top of a pole of sufficient height to be seen t some distance; and on much traveled roads it is recommended that these warning signs be lighted at night. The dditional signs now in use or required by law, which are laced directly at the crossing, are to be continued.

In place of the white flag now generally used by guards at crossings to warn back approaching traffic, hich has sometimes been misinterpreted by drivers of ehicles as meaning safety, the committee recommends hat crossing guards shall display a white disk 16 in. n diameter with a black border, with the word "Stop" ainted across the center in 5-in. black letters.

A further recommendation of the committee is that rossing gates should be painted white with alternate iagonal stripes of black. Experiments have shown that ates so painted are more striking to the eye than when ainted one solid color. The railways are also required o grade the highway approachings at crossings so that here will not be a sharp grade close to the crossing, to educe the liability of teams or motors being stalled just s they reach the crossing.

The action of these committees is to be reported to the National Association of Railway Commissioners at its meeting in Washington next November, and if approved a movement will be started, with the coöperation of the American Automobile Association, to secure uniform legislation in the various states to cover the protective measures above outlined.

*

The Pennsylvania R.R. Changes Signal-Color Scheme

A complete change in the color scheme of signal indications will be made on the entire Pennsylvania R.R. system just as soon as the necessary materials can be obtained, orders already having been placed. White lights are to be eliminated altogether as a signal, being replaced by green, indicating "clear" or "proceed." This step is taken on account of the increasing use of white lights of various kinds in buildings, driveways, roads and streets close to or adjacent to the right-of-way.

The railroad states that it was unwilling to proceed with this change until a yellow glass could be obtained for the caution signals, which would give a bright light at long distances and still would not be liable to be mistaken for white. Not only will alterations have to be made in all semaphores, but the following devices also will be effected: Marker lights on the rear of passenger and freight trains, switch lamps and targets, markers for track tanks, "slow" signs, "resume-speed" signs, hand lamps, and the light displayed to the public at crossing gates. Lights for the last-named purpose will be red instead of green.

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A Falling Boom cut through the roofs of three houses in Los Angeles, Calif., on the afternoon of July 31. A large steel derrick was used to erect an elevated-railway structure being constructed to San Pedro St.; a cable slipped and the boom fell, cutting through the roofs of three houses to the first floors. There were no casualties.

A Broken Reclamation Dike near San Francisco caused floods which stopped all traffic between Oakland and Alameda, over Webster St., on July 25. The first floor of the Panama Hotel was covered with mud, while the plant of the Bay Wrecking Co. and several industrial plants were threatened. The dikes are part of a plan to reclaim the Alameda marshes and convert them into industrial sites. Fill is made by suction dredges pumping against the 10-ft. dikes built along Webster St.

Hypochlorite Treatment of Oysters from Polluted Waters appears to be safe and practicable, according to William F. Wells, sanitary chemist, United States Public Health Service ("Public Health Reports," July 14, 1916, pp. 1848-52). Acting on the knowledge obtained by Prof. E. B. Phelps and others that oysters from polluted layings are rapidly freed from B. coli on being placed in clean water, tests were made with oysters placed in galvanized wire baskets and suspended in water treated with calcium hypochlorite. From 0.25 to 0.63 p.p.m. of available chlorine were used, the periods of immersion ranging from 4 to 29 hr., with a second period of 12 to 24 hr. in some cases. The conclusion reached in the report is that:

> The experiments are believed to prove that oysters which have laid in polluted water can be artificially purified to such a degree as to pass a most rigid standard by exposure for a short period in water containing calcium hypochlorite, and they appear also to demonstrate the feasibility of such a process.

An Excursion Boat Equipped with Diesel Engines began running on the Hudson River at New York City on July 17. The boat can accommodate 300 passengers and is driven by a pair of four cylinder Diesel marine engines of 240 hp. each, giving it a speed of about 12 knots. The engines were built by the Southwark Foundry and Machine Co., of Philadelphia, under the Harris patents. They have stepped pistons and in starting the engine the compressed air acts upon the annular piston and does not enter the cylinder in which combustion takes place. Thus is avoided the sudden changes of temperature which occurs in other Diesel engines when compressed air expanded to a temperature of far below zero is admitted into a cylinder which has an instant before had combustion going on within it at a temperature of several thousand degrees. In normal working, the annular piston compresses the scavenging air and is of sufficient area so that the volume of the scavenging air is about 75% in excess of the volume of the main working cylinder, thus insuring thorough scavenging. The boat has been built for George W. Perkins, President of the Palisades Interstate Park Commission, to carry excursionists from a pier at 129th St. to the piers which have been built along the waterfront at various points under the Palisades for the benefit of campers, canoeists and picnic parties.

A Subway for Sydney, N. S. W., has just been commenced, according to a statement in "The Indian and Eastern Engineer." Work is to be prosecuted from four or five places and will take about five years to complete.

On the Australian Transcontinental Ry., according to the "Commonwealth Engineer" for June, track laying has progressed 770 mi., leaving 283 mi. still to be laid. The estimated total expenditure on the line to June 30, 1916, is $25,000,000.

Mill Creek Flood Channel at Erie Started—On the anniversary of last year's destructive flood at Erie, Penn., work on improvement of Mill Creek channel was formally inaugurated Aug. 3. The creek is to be converted into a concrete-lined conduit.

The Pikes Peak Motor Highway, described in "Engineering News," Dec. 23, 1916, was opened Sunday, July 23. The road is from 20 to 50 ft. wide, the maximum grade is 10½%. The elevation of the summit is 14,109 ft. above sea level, which is claimed to be the highest altitude accessible to motor vehicles. The road is to be used for hill-climbing contests.

Ratings in the Examination for Senior Civil Engineer in the Valuation Department by the Interstate Commerce Commission, held Nov. 2, 1915, have been announced by the Civil Service Commission as follows: There were 438 competitors in the examination. The number of eligibles who obtained an average percentage between 90 and 100 was 55; between 80 and 90, 129; and between 70 and 80, 70.

Douglas County, Nebraska, Highway Paving will probably be held up until another season. The legality of the bond issue is now in question before the courts. The amount of the bonds voted was $1,700,000, but no more than $500,000 is to be spent in any one year. It was specifically provided in the law that all the new pavements were to be brick on a concrete base. The law was also unusual in specifying exactly what county roads were to be improved. There is much preliminary engineering work to be done, which cannot be undertaken until the legality of the bond issue is established.

Exportation of Natural Gas from Alberta has been prohibited by the Provincial Government, thereby blocking projects which had been mooted for piping supplies to points in Saskatchewan and Manitoba. The act ratifying an agreement between the City of Edmonton and the Northern Alberta Natural Gas Development Co., Ltd., was amended so as to prevent the company from piping gas beyond the boundaries of the province. It is the intention of the Government to embody a similar clause in any charters that may hereafter be granted empowering companies to supply natural gas.

Operations of the Portland Cement Industry for the first half of 1916 are reviewed in a bulletin of the Geological Survey. Two new cement plants have been opened in this period; one at New Duluth, Minn., and the other at Houston, Tex. The one at New Duluth belongs to the Universal Portland Cement Co. and uses as raw material slag from the blast furnaces of the Minnesota Steel Co. and limestone from Alpena, Mich. The plant at Houston is mill No. 2 of the Texas Portland Cement Co. and uses oyster shells dredged from a reef in Galveston Bay and clay from Harrisburg, Tex. The bulletin notes the rise in the price of cement and remarks that this does not represent wholly increased profits to manufacturers as there has been a large increase in the cost of explosives for blasting, of labor and of fuel.

Comparing Tension and Transverse Tests of Cast Iron—For a series of comparisons of the tension test and the transverse test of cast iron a device for use in the transverse test was designed to H. L. Morse, of Watertown Arsenal, who also described it in a paper before the American Society for Testing Materials entitled, "An Apparatus for Testing the Standard Cast-Iron Arbitration Bar." The device was designed for use in a horizontal Emery machine; the support or anvil is screwed to the weighing piston, while a loading block containing a pin which applies the load is screwed to the loading piston. Pins in the anvil furnish a seat for the test bar. A little plunger under the middle of the bar receives the deflecting movement and transmits it by way of a bell crank to the push rod of an Ames dial. This dial rod moves outward for deflection of the bar and is not subject to injury when the bar breaks.

A Large Deep-Water Dock has been under construction in London since August, 1912. This undertaking includes the creation of an inclosed deep-water area accessible to large ships. The site is for the most part low-lying land, but a total of some 3,500,000 cu.yd. of material had to be removed to secure the desired depth of 38 ft. below the level of the impounded water. Excavation is practically completed. The dock tapers in width from 700 ft. to 500 ft., and will have a quayage of 10,000 lin.ft. Seven jetties run parallel with the south quay. It will be possible for barges to lie between the jetties and the quay, so that steamers can deliver cargoes into craft on either side of them as well as on to the quay by crane. The entrance lock from the Thames is 800x100 ft. in plan and has a depth below high-water mark of 45 ft. There are three sets of steel gates, dividing the lock into compartments. The lock can be extended 100 ft., by placing a caisson at the inner end. The walls of the lock have been constructed and the bottom is being put in. The new dock will be connected with the Albert and Victoria docks by means of a passage 100 ft. in width, the walls of which are now under construction. A large dry dock is an important part of the enterprise, and is to be 750 ft. long by 100 ft. wide, which width is claimed to be greater by 20 ft. than that of any other drydock available in the port of London.

PERSONALS

F. X. Bode has been appointed Deputy City Engineer of Troy, N. Y., to succeed J. C. Watts, resigned, as noted elsewhere.

G. B. Arthur has been appointed District Engineer of the Portland Cement Association, with headquarters at Parkersburg, W. Va.

J. C. Watts, Deputy City Engineer, of Troy, N. Y., has resigned to become Engineer of the Harbor and Dock Commission of the same city.

H. E. Merrell, Civil and Mining Engineer of St. Petersburg, Fla., has been made Superintendent and Engineer of a large dredging project at Boca Grande, Fla.

J. Harold Rapp, formerly Vice-President and General Manager of the W. N. Kratzer Co., Pittsburgh, Penn., has resigned to open an office in the Fulton Bldg., Pittsburgh, as a consulting structural engineer.

George W. Nichols, recently Engineer with John Eichleay, Jr., Co., Pittsburgh, Penn., is now in charge of structural steel designing and construction for the S. C. Webb Engineering Co., also of Pittsburgh.

Ambrose Swasey, President of the Warner & Swasey Co., Cleveland, Ohio, has been made an honorary member of the American Society of Mechanical Engineers. He was a founder member of the society in 1880.

D. V. Swaty, Assoc. M. Am. Soc. C. E., formerly Construction Engineer of the Great Lakes Dredge and Dock Co., Cleveland, Ohio, has been made Vice-President of the Cleveland Engineering Construction Co.

P. H. Waldio, formerly Assistant Engineer of the Florida East Coast Ry., has been appointed Sales Manager for the Virginia territory of the Monroe Calculating Machine Co., with headquarters at Richmond.

John C. Johnson, Assoc. Am. Inst. E. E., formerly Engineer of Electrical Construction of the Cleveland Municipal Electric Light Plant, is now a member of the F. W. Ballard Co., Swetland Bldg., Cleveland, Ohio.

L. G. Wallis, recently Resident Engineer of the Southern Ry. at Spartanburg, S. C., has been appointed Engineer of Construction of the Jacksonville Terminal Co., Jacksonville, Fla., and will have charge of the erection of the new union station.

R. H. Dare, M. Inst. C. E., of Roseville, New South Wales, Australia, has been appointed a member of the Water Conservation and Irrigation Commission of New South Wales. Other members of the commission are W. C. Grahame, Minister of Agriculture, and W. Neville Sendall.

John V. W. Reynders, M. Am. Soc. C. E., recently Vice-President of the Pennsylvania Steel Co., in charge of the Steelton plant, has opened offices in the Equitable Bldg., New York City, as a consulting engineer. He is a graduate of Rensselaer Polytechnic Institute and has made structural engineering his life work.

Ralph G. Kirk has resigned as Superintendent of Construction at the Steelton plant of the Bethlehem Steel Co.

Charles J. Gadd, former Engineer in charge of construction of the American Iron and Steel Manufacturing Co., Lebanon, Penn., has been promoted to be Chief Engineer.

Robert W. Hunt, M. Am. Soc. C. E., of Chicago, Ill., was awarded the honorary degree of Doctor of Engineering at the recent commencement at Rensselaer Polytechnic Institute.

F. O. Hale, Chief Engineer of the Southwestern Bell Telephone System, has been promoted to be General Manager of the Southwestern Telephone and Telegraph Co., with headquarters at St. Louis, Mo.

W. O. Pennell, Assoc. Am. Inst. E. E., of the engineering department of the Southwestern Bell Telephone System, has been promoted to be Acting Chief Engineer, to succeed F. O. Hale, promoted, as noted elsewhere.

W. S. Dale, for three years Chief Engineer and General Superintendent of the Santa Monica Water Co., Santa Monica, Calif., has been appointed Superintendent of the municipal water-works, which has purchased the Santa Monica Water Co.

OBITUARY

Robert McCallum, former City Architect, of Toronto, Ont., died Aug. 2. He was 65 years old. He was at one time a civil engineer with the Ontario Provincial Government.

William H. Upton, a civil engineer of San Francisco, Calif., died July 30. He was a native of San Francisco, and was 59 years of age. He had charge of construction of the Argentine Building at the Panama-Pacific Exposition.

Robert Safford Towne, M. Am. Inst. M. E., President of the Metalurgia Mexicana, a mining engineer of long experience in Mexico, died Aug. 3, at his apartment in the Engineers Club, New York City. He was born in Portsmouth, Ohio, 58 years ago. He graduated from Ohio State University in 1879. He was an officer in many Mexican corporations, including the Mexican Northern Ry., of which he was President and Treasurer, the Alvarez Land and Timber Co., the Mexican Lead Co. and others.

A. M. Valz, a prominent contractor of Staunton, Va., died July 22, at the Union Protestant Infirmary at Baltimore, Md. He was born in Italy in 1848, and was graduated at the University of Turin as a civil engineer. He came to America in 1866. In attempting to return to his native country in 1871 he narrowly missed being executed at Paris during the French revolutionary troubles. Escaping to this country he began work as a contractor on the construction of a stone bridge on the Valley R.R. Subsequently he became one of the most important contractors in that part of the South. He is survived by a widow, four sons and two daughters. One son, Arthur M. Valz, has been associated with his father under the firm name of A. M. Valz & Son.

Arthur Hider, M. Am. Soc. C. E., Principal Assistant Engineer, Mississippi River Commission, Third District, died at Greenville, Miss., July 28, 1916. He had been connected with the Mississippi River improvement work since 1879, giving the best years of his life to the development and perfection of plans for the control and improvement of the river, and a large share of credit for successful work is due to his faithful, untiring, and patient attention to the duties of his position. For the past 25 years of his life he was the Assistant in charge of all the bank revetment work in the Third Mississippi River District, and also in charge of the design and construction of towboats, tugs, hydraulic graders, and all the various items of plant that are required for the work of river improvement. He was unquestionably an authority on Mississippi River work. In addition to his work with the Mississippi River Commission, Mr. Hider while on vacations and during spare time served as Consulting Engineer, passing on the plans for many large undertakings, some of which are as follows: Design and installation of water-works systems at Greenville and Hollandale, Miss., Lake Providence, La., and other places; he was expert member of Valuation Committeee to determine value of the Memphis, Tenn., water-works system when this was taken over by the City of Memphis. Before his connection with the Mississippi River Commission, he was in the City Engineer's department at Louisville, Ky., and was in charge of considerable municipal engineering work. He had been a member of the American Society of Civil Engineers since 1881, and contributed many papers and discussions to the "Proceedings." Mr. Hider is survived by a wife, three sons and two daughters.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The American Electric Railway Association and its affiliated associations, will hold an annual convention at Atlantic City, Oct. 9 to 13.

The National Smoke Prevention Association will hold its 11th annual meeting in St. Louis, Sept. 26, with headquarters at the Planters Hotel. Among the papers to be presented are the following: "Smoke of Heating Plants," "Feeding Boilers and Furnaces," "Chimney Drafts," "Powdered Coal as Fuel." The third day of the session will be "Railroad Day." The officers of the association are: President, Wm. H. Hoffman, vice-president, Charles W. Heath, secretary, Frank A. Chambers, of the Chicago Smoke Department. The Joint Smoke Prevention Committees of St. Louis, recently organized, will provide for the entertainment of the delegates. The Chairman of this joint committee, A. P. Greensfelder, is a past-president of the Engineers Club of St. Louis.

The American Institute of Mining Engineers for the first time will hold its annual meeting in Arizona, Sept. 18 to 25. A special train will leave New York City (Grand Central Terminal) at 5:30 p.m., Thursday, Sept. 14. At 4 p.m. Friday, the train will arrive at Chicago, and the party will be taken by automobile for a two hours' drive, returning to the La Salle Hotel for dinner. On Monday, Sept. 18, the party will reach Santa Rita, and from that point will visit the mines of the Chino Copper Co. and the mill of the Empire Zinc Co. The next day the reduction works of the Copper Queen Consolidated Mining Co. and of the Calumet and Arizona Mining Co. will be visited, while in the afternoon a technical session will be held on "Smelting," and another after dinner on "Leaching." On Sept 21, the mine and reduction works of the

Old Dominion Copper Co. will be inspected and in the afternoon a session will be held on "Concentration and Flotation." On Sept. 22, the works of the International Smelting and Refining Co., and the mills of the Inspiration Consolidated Copper Co. will be visited. Returning, the special train will arrive at Grand Central Terminal, New York City, at 9:40 a.m., Thursday, Sept. 28. The total mileage of the trip will amount to 6,473.

Appliances and Materials

Anti-Corrosion Steel Fittings

Since the development by the Research Laboratory of the General Electric Co. of "calorized" metals—surface alloys of aluminum—which are resistant to destruction by high temperatures or by ordinary corrosion, license for use of this material in soot-blower fittings has been secured by the Diamond Power Specialty Co., of Detroit. This company has a device for cleaning the outside of water-tube boiler tubes; difficulty has been experienced from the short life of tips and pipes exposed to the furnace gases in the hotter passages. The trade name "Insuluminum" has been attached to these products.

* * *

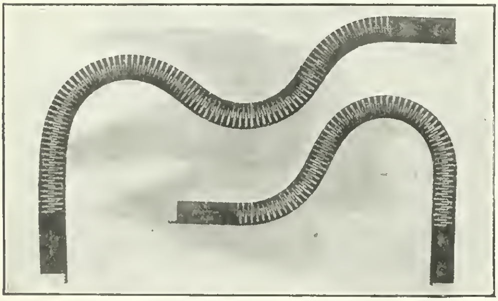
Flexible Sewer-Pipe Joint Compound

A new pipe-joint compound, called the "Superior," for sewer lines has been recently put out by the Superior Chemical Co., Chemical Building, St. Louis, Mo. It is melted and poured into place. It adheres to both tile and iron and after hardening it is claimed to remain pliable and tight.

* * *

New Flexible Curve Rule

A new type of flexible curve rule for drafting offices has been devised by Keuffel and Esser Co., of Hoboken, N. J. The aim has been to secure the flexibility of older rules but with extreme lightness. The body is a strip of black xylonite with overlapping alternate notches from opposite edges. Along one edge is a ruling strip of the same material, and along the other edge is a metal wire holding the rule in any curve into which it is bent. Each extremity ends in a tangent.



NEW FLEXIBLE CURVE RULE

* * *

New Comparison Pyrometer

A new pocket pyrometer, bearing the trade name "Irite," is being made by the Gibb Instrument Co., Highland Building, Pittsburgh, for measuring the temperature of furnaces, heated pieces, ingots, soaking pits, etc. It is of the comparison type and has a color wedge, showing the different shades (calibrated) of color taken on by a heated body, and diffusely illuminated by a small incandescent lamp supplied with current from a dry cell in the pyrometer tube. The color wedge is shifted until a match is secured with that of the piece under study and the temperature is read off. The pyrometer sells for $25.

* * *

Tool for Roughing Concrete Walks

A special tool has been devised by the Gardner Governor Co., of Quincy, Ill., for roughing slippery sidewalks. It is intended for use with an air-driven plug drill, and consists of a shank with a square case on the end carrying 16 hard steel points. The case also has a bail handle to help in guiding.

A complete sidewalk dressing plant consists of small air-cooled compressor driven by a gasoline engine, both mounted on a little steel hand truck.

* * *

Motor-Driven Sewage Ejector

A new design of sewage receiver and ejector for office buildings has been made by the Yeomans Brothers Co., Institute Place, Chicago, Ill. There is a cast-iron tank to be placed in a concrete-lined dry pit, and to this are connected all sewers that will not drain into the street sewers. On either side of this and drawing from the bottom are two vertical-shaft centrifugal pumps. The top of the receiver supports a platform on which are mounted the two pump motors and the automatic-control switchboard. The pump casing can be opened up for cleaning without disturbing the shafts and bearings. The control float is in an 8-in. housing pipe. The ejector is regularly built in sizes ranging in capacity from 200 to 1,000 gal. per min.

* * *

Oxygas Lead-Burning Outfit

An outfit for greater convenience in fusing together lead sheets, etc., has been developed by the Safety Car Heating and Lighting Co., of New York City, American maker of Pintsch gas and equipment. The oxyhydrogen flame has previously been generally used, but this has been expensive and sometimes hazardous. In railway battery houses, shops, etc., low-pressure (12 atmospheres) Pintsch gas is available from car tanks; for other places high-pressure (100 atmospheres) flasks are provided, to be carried about as needed and the torches supplied direct through reducing and regulating valves. An outfit comprises a high-pressure or low-pressure regulator, oxygen flask with regulator, 25 ft. of hose, mixing valve, torch and wrench. Burner tips are furnished with different-sized orifices for various work.

* * *

"Unaflow" Engines for Rolling Mills

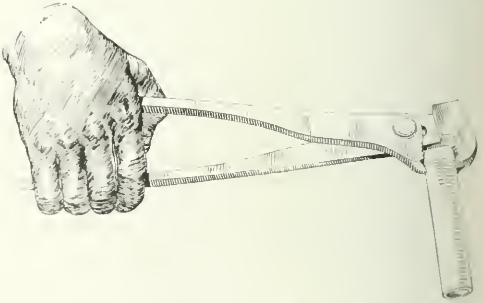
Two engines of the Stumpf "Unaflow" design (exhausting from ports in the center of the cylinder instead of at the ends) are being made by the Nordberg Manufacturing Co., of Milwaukee, Wis., for the Youngstown (Ohio) Sheet and Tube Co. The larger unit (44x50 in., 110 r.p.m., 700—4,000 hp. 480,000 lb.) will drive a 12-in. rod mill, and the smaller one (37x48 in., 110 r.p.m., 360,000 lb.) a 9-in. mill. These are reported to be the first American machines for this service, though similar engines up to 6,300-hp. continuous capacity have been so used in Germany. High economy under severe overloads is claimed to fit them particularly for this field.

The cylinder is a plain casting; all valve chambers and inlet passages are in bolted-on head castings. The valves are double-beat balanced poppets, with stems in lapped bushings, operated from a layshaft. Near the head bottoms are poppet reliefs which, on loss of vacuum and over-compression, automatically connect the clearance space with the steam space.

* * *

New Handy Wrench

The "Eagle-claw" wrench shown in the accompanying sketch is being made by the Mechanical Specialties Co., Peoples Gas Building, Chicago, as a general-utility tool for holding pieces of any regular or odd shape. The wrench consists of two pieces and a bolt and nut. The under jaw has a single prong and the upper jaw two prongs in addition to gas-pipe grips, which hold for turning both ways. For getting into difficult places one model is made with jaws at 45° to the handles. Three sizes are made; 7-, 10- and 13-in. The 7-in. holds pieces from 0 to 1 in., the 10-in. from 0 to 1¼, and the 13-in. from 0 to 1½ in. Prices range from 75c. to $1.25.



"EAGLE-CLAW" TURTLE-MOUTH WRENCH

Engineering News

VOLUME 76 AUGUST 17, 1916 NUMBER 7

Cylinder Pier Foundations Laid Inside Sheetpile Wells

By C. S. Boardman*

SYNOPSIS—In new power house for Buffalo General Electric Co., heavy foundations in low-lying ground were rapidly built by driving cylinder piers of steel sheetpiling, excavating by jet pump and filling with concrete.

With the present prosperous business condition arose the necessity for a greater production of electric power in the Buffalo and Niagara Falls territory. The Buffalo General Electric Co. to meet this demand gave a contract to the Stone & Webster Construction Co. for a steam-generating electric plant to cost more than $3,000,000 and to be erected on a site selected on the Niagara River in the town of Tonawanda, about midway between Buffalo's north city line and the south city line of Tonawanda. This plant will occupy a plot having a frontage on the Niagara River of 1,010 ft. and a depth of 600 ft., and will have railway connection with the New York Central & Hudson River R.R. (Buffalo Industrial Line). In the design and construction of this plant the conditions were: First, the contract called for starting this work in midwinter on ground overflowed with every high southerly wind, the ground level of the property being less than 12 in. higher than the normal flow of the river. The materials lying below the surface of the ground were about 5 to 7 ft. of soft mud and silt, then 25 to 28 ft. of sand or quicksand thoroughly saturated with water from the river; the remaining 3 ft. overlying bedrock was a clay containing quantities of glacial drift composed of large gravel and small boulders. Time of completion was also an essential feature. It was proposed to have this plant under cover and in operation some time during the fall of 1916. With all these conditions imposed, the contractor realized that only a small part of this time could be given to the construction of the foundations, at the same time realizing the loads which would be imposed upon the foundations required that they all be carried to bedrock. The building is approximately 210x223 ft. in plan, with a floor level about 40 ft. above bedrock and about 5 ft. above river level. The roof is about 100 ft. above floor level, and the top of two sheet-steel stacks is about 111 ft. higher. These stacks are supported by the structural-steel framework of the building.

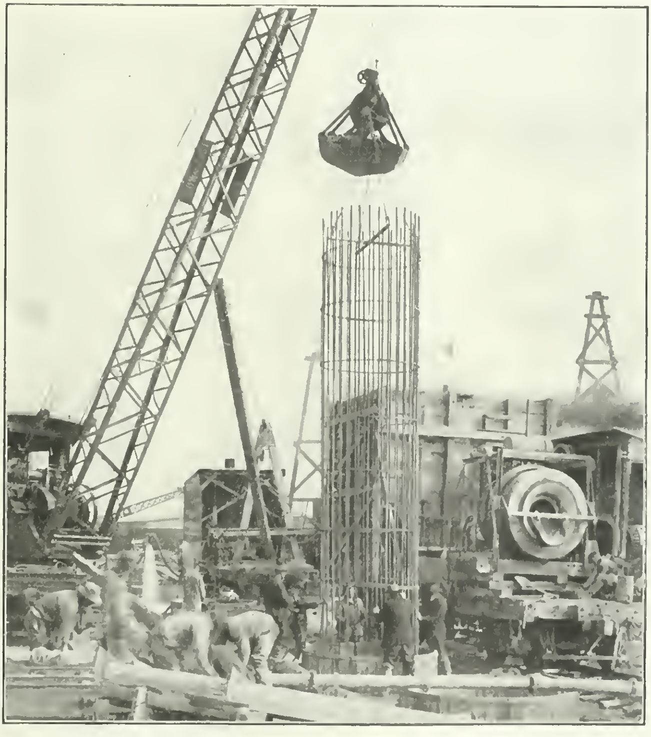


FIG. 1. PLACING THE REINFORCEMENT CAGE IN THE CYLINDER WELL

A series of bore holes developed that bedrock lay almost horizontal and about 35 ft. below the surface of the ground, the materials, as stated, being general over the entire site.

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*Chief Engineer, Sheetpiling Department, Lackawanna Steel Co., Buffalo, N. Y.

It was decided to carry all loads upon 157 cylinder piers varying in diameter from 33 to 81 in. The maximum compressive stress allowed anywhere on the reinforced concrete was 500 lb. per sq.in. The larger piers carry as high as 874 tons per pier.

Operations were started almost immediately after the contract had been awarded, and materials were purchased even before the plans could be perfected. It must be remembered that the past winter was a very severe and trying one, even for Buffalo territory. The condition of the market for purchase of materials, the delay in the delivery of most of them, and the freight congestion during this period, caused many inconveniences and delays at first.

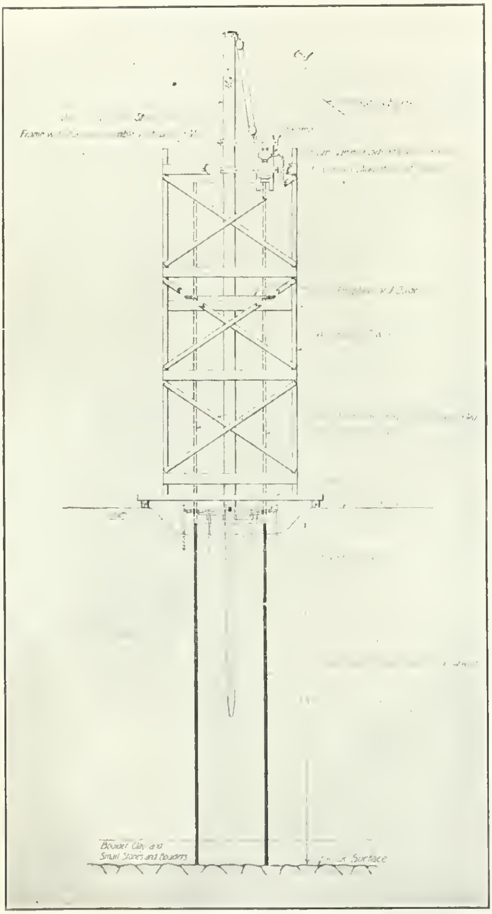


FIG. 2. DIAGRAM SHOWING METHOD OF DRIVING CYLINDERS OF SHEETPILES

It was decided to construct these foundations in open cylinder caissons of steel sheetpiling, Lackawanna 12¼x⅜-in. straight-web and bent-web sections being selected. The first order for piling was placed Dec. 27, 1915, and the material was on the ground about the middle of January, 1916. The cylinder diameters were adopted from a table of bent-web piling (compiled by the steel company) as follows:

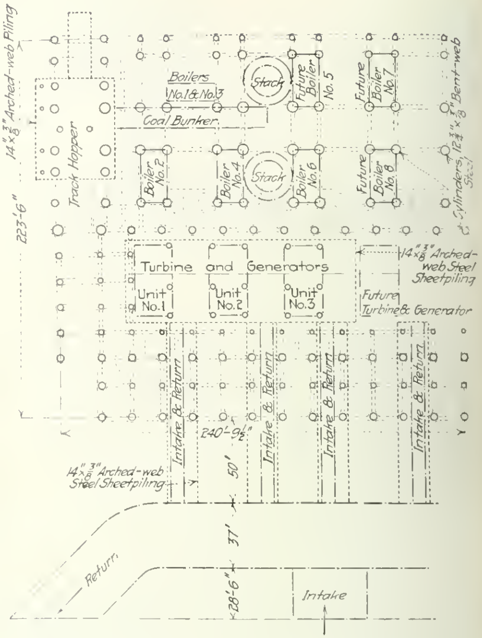


FIG. 3. FOUNDATION PLAN OF BUFFALO GENERAL ELECTRIC CO. ON NIAGARA RIVER

Number of Piles	Angle of Bend in Web of Sheetpile	Diameter
18	0° straight web (Required no bending)	73 in.
16	4° bent web	5 ft. 4 15/16 in.
14	7° bent web	4 ft. 8 11/16 in.
12	11° bent web	4 ft. 11/16 in.
10	17° bent web	3 ft. 4 9/16 in.
8	26° bent web	2 ft. 8 7/16 in.
6	21° bent web	2 ft. ⅜ in.
4	90° bent web	Four 90° bends

Cylinders of 8, 12 and 14 piles of bent-web piling and cylinders of 18 and 20 piles of straight-web piling were used. In these cylinders 1,296 tons of sheetpiling in 33-ft. lengths were used. The piling is to remain permanently in position as part of the structure. The accompanying plan shows the general arrangement and size of the piers, as well as the location of intake and discharge condensing-water tunnels constructed from the Niagara River to each turbine.

The construction of these tunnels required coffer-dams and these were built using 344 tons of Lackawanna 14x⅜-in. arch-web section in 35-ft. lengths. This piling has been driven and redrawn—by inverted steam hammer—several times during construction of this part of the work, and will be used in extensive coffer-dams required for constructing the intake, etc.

The pier foundation work consisted essentially in driving closed cylinders of sheetpiles, excavating the inclosed material by jetting it out, and filling the opening so left with reinforced concrete.

The construction of these cylindrical piers is novel and original, both in design and execution. Two cableways with two timber portable towers 70 ft. in height built on skids were placed over the center lines of two rows of piers and were used to handle the steel sheetpiling, timber mast, steam piledriving hammers, wooden assembling towers, etc., as described in detail later. Reference to Fig. 7 will show a general view of this contract on Mar. 25, 1916.

To sustain the loads imposed it was of utmost importance that the cylinder piers should be vertical and located accurately. A timber pile was first driven on the exact center of each pier. These piles were later dressed at the top and a hole bored in the center. Excavation proceeded around this pile to a point near the water level, when the lower templet was set in position and secured to the center pile.

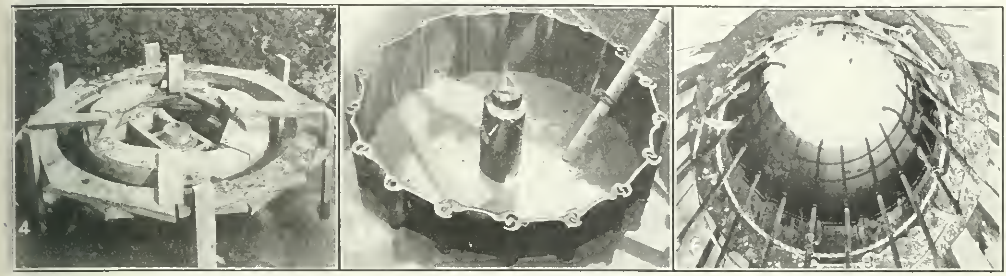
The timber assembling tower (Figs. 2 and 7) was now placed over the lower templet, and the upper templet and guide ring were centered in this tower in correct position over the lower templet.

The steel sheetpiling was now handled by the cableways and assembled one piece at a time around these templets, the cableway being of sufficient height to raise he pieces above the 33-ft. sheeting already assembled, so that the piles could be interlocked at the top. The position of the cableways also permitted all of the piles n one cylinder, or all the cylinders in the row, to be assembled. The greater portion of the assembling was done at night; while the cylinders were driven by day.

This method of assembling allowed the entire cylinder to be set and held vertical, and the closure pile assembled for its entire length. A 14x14-in. wood mast 42 ft. long was then mounted and held in position on top of the wooden pile by a 2-in. steel pin, and guyed at the top by four ⅝-in. wire cables, the mast being free to move within the top templet.

A No. 7 McKiernan-Terry steam piledriving hammer weighing 5,000 lb. was lifted by the cableway and supported from the mast by a steel A-frame so designed as to allow the hammer and frame to slide freely upon the mast. The mast was free to revolve, and the hammer was offset from the mast the required distance to bring it central over the pile walls. The steam piledriving hammer was lowered or raised by a set of double blocks provided on the side of the mast above the hammer, the power line passing over a sheave in the top of the mast to the stationary hoisting engine.

Two sheetpiles were then driven by this steam hammer about 3 or 4 ft. when the hammer was raised and placed upon two adjacent piles, driving them about the same distance. This operation was repeated until the entire circle was driven into bedrock. The average time of driving was about 6 hr. for each cylinder. A greater portion of this time, however, was required to drive the



FIGS. 4 TO 6. SUCCESSIVE STEPS IN THE DRIVING OF THE CYLINDERS
Fig. 4—Guide frame in place. Fig. 5—Sheetpiles driven. Fig. 6—Reinforcement and upper casing in place

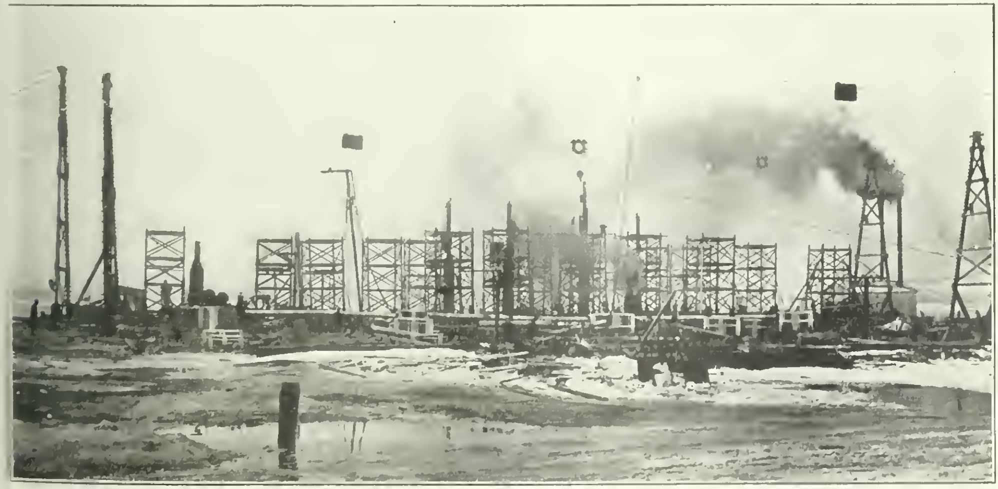


FIG. 7. GENERAL VIEW OF WORK DURING DRIVING OF PIERS

piles through the glacial drift and into the disintegrated top of bedrock. Penetration into rock—as closely as can be determined from original borings—was from 6 to 18 in. Six No. 7 hammers were used in this driving.

The work of assembling and driving the cylinders was commenced on Jan. 15 and, notwithstanding the delays caused by severe weather, flooding of the site, and the exposed location, the driving was entirely complete by Apr. 6, or in a total of about 70 working days.

Excavating Materials from Cylinders

A multiple-stage centrifugal pump with a capacity of 1,500 gal. per min. against a pressure of 125 lb. per sq.in. was installed on a timber-pile trestle on the shore of the river. An 8-in. main with a 6-in. distributing pipe carried the water close to the cylinders. A sand jet pump constructed with a 6-in. pipe about 40 ft. long, having an elbow at the top, and a right-angle pipe 10 ft. long (with two water jets fastened to opposite sides of this pipe) was used as a water jet pump. The two pipe jets had reducers at the lower end—one of 2½-in. being turned upward and toward the center of the bottom of the 6-in. pipe, the other being straight, 1½ in. in diameter and extending about 12 in. below the end of the larger pipe. These jets had the effect of stirring the sand and forcing it upward through this larger pipe. To complete this pump a 2-in. pipe connection was made in the elbow, directly opposite the horizontal piece of 8-in. pipe. These three jets were connected to the pump by fire hose.

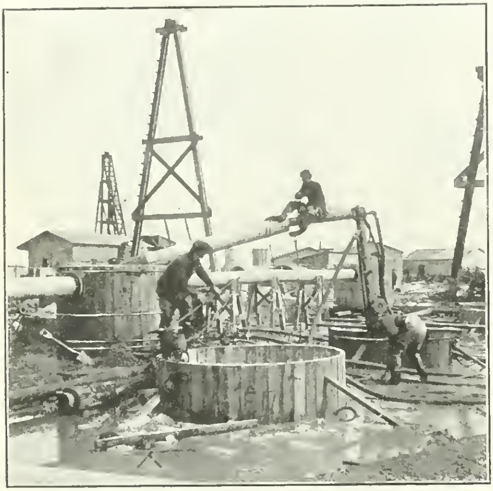


FIG. 8. GETTING OUT THE CONTENTS OF THE CYLINDERS

The pump thus assembled was raised by the cableway and stood vertically on the material within the cylinder, the upper end of the 6-in. tube being closed by a gate valve. The water was then turned into the jets, and as the only avenue of escape was through the bottom the pump rapidly settled under its own weight to the bottom of the cylinder. The gate at the top of the pump was then opened and the pressure from the jets caused a large stream of sand and water to be discharged. This method of excavation proved to be so rapid that only 2 hr. was required to remove all the sand and loose material from a cylinder. An independent jet was used to clean the sand and material from near the walls of the cylinder.

Circular wooden forms were bolted to the top of the steel cylinders to permit the spoil to be used to raise the general ground level.

Excavating Overlying Materials and Cleaning Bedrock

To remove hard clay conglomerate or heavy gravel and boulders remaining in the cylinder after the finer material had been removed, a 14-in. arch web sheetpile 35 ft. long, weighing 1,425 lb., was hung inside and used as a vertical battering ram until the hard formation was broken up so that it could be removed by a small orange-peel bucket. The final operation in cleaning bedrock inside the cylinders was to replace the large jet pump and to carefully wash the rock by means of 2-in. jets—one operating vertically, the other horizontally. The degree of cleanliness of the bottom was tested carefully with a sounding rod.

Concreting the Foundations

After inspection had proved that the rock was clean and ready for concrete, the jet pump was removed and a cage of reinforcing steel, previously assembled, was lowered (Fig. 1) into the cylinder. These steel cages were provided with stub guides which held them in proper position relative to the sheetpiling forming the cylinder shelves.

A portable concreting plant was employed, traveling on railway tracks. This plant, consisting of a flat-car equipped with a wooden hopper and a 1½-yd. mixer with loader, was placed at a point convenient to the cylinder to be concreted. Concrete was chuted to the hopper of an ordinary tremie pipe which deposited it on the bottom. The tremie was hoisted and sections of it removed as the level of the concrete rose. The lower end of the tremie was maintained from 1 to 2 ft. below the surface

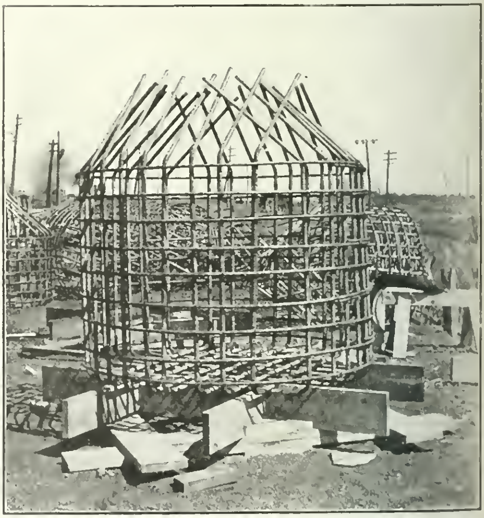


FIG. 9. NEAR VIEW OF A REINFORCEMENT CAGE FOR THE TOP OF PIER

of the concrete. This tremie was operated with extreme care so as never to lose its seal in the concrete nor its charge of concrete.

By this method each cylinder was filled with concrete to a point 2 to 3 ft. below the top of the sheetpiling and after allowing sufficient time for the concrete to set, water was pumped out of the top to the level of the concrete, and the laitance (usually 2 to 3 in. deep) was removed.

The wooden forms were now placed upon the form for the cap of the pier and the reinforcing bars required for the floor-beams were placed in position and all concrete for top and caps was placed at one pouring.

This work was designed by the Stone & Webster Engineering Corporation, Boston, Mass., and executed by the Stone & Webster Construction Co.; George O. Muhlfeld, Construction Engineer, S. L. Shuffleton, Western Manager, in charge, and E. C. Macy, General Superintendent. H. G. Stott was Consulting Engineer for the Buffalo General Electric Co.

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Venturi Meters Inaccurate on Lively Lines

By Allen Hazen[*]

When there is a steady, uniform flow through a venturi meter, the coefficient of discharge—that is, the ratio which the actual quantity of water bears to the theoretical quantity—is very high and for practical purposes may be taken as 0.99, with a small variation either way. But venturi meters are often used on pipe lines where he flow is not uniform. If the variations are gradual from hour to hour, or even from minute to minute, the apparatus that is ordinarily used will sum up the total low with accuracy. If, however, the variations in flow are rapid, so that there are substantial changes in rate in a single second, an error may be introduced. This error may be one of considerable importance on lines carrying water directly discharged from reciprocating pumps or from a reservoir into a system where wide and sudden luctuations in rate of draft are taking place.

A number of circumstances tend to increase this fluctuation. Among them may be mentioned a relatively short discharge line, air chambers that are too small or not adequately connected with the pipes and a high degree of elasticity in the material of the pipe. Steel pipes are more elastic than iron pipes, and there is apt o be more jump or vibration with changes in rate hrough them. A lively line, for which considerable errors may be anticipated, may be defined as one on which a pressure gage connected to the line wide open will show considerable and rapid fluctuations.

The theoretical reason for the error is that the venturi recorders in reality sum up the squares of the flows. In other words, the flow is averaged by squares instead of directly. The height of the mercury column that is the starting point in the registration is proportional to the square of the velocity.

To take an extreme case, suppose that for half a second the velocity is nothing and for half a second it is 2 ft. per sec. For the whole second the average velocity will be 1 ft. per sec.; but the height of the mercury columns will tend to be for the first phase 0 and for the result corresponding to the average height of the mercury column, which is 2, and the quantity indicated will be the square root of 2, or 1.41, in place of the true quantity, which is 1. In this case the error of over-registration will be 41%.

This merely illustrates the way in which the error is produced. An actual error as large as 41% is not to be anticipated in any case. However, with very lively lines errors of 2% or 5% or even 10% or more may be anticipated, depending upon the liveliness of the line. The error will always be in the same direction—namely, the registration will be above the truth.

In *Engineering News*, July 31, 1913, there was a discussion in regard to the coefficients of venturi meters, in which the writer took the stand that the coefficient of 0.99 should be used in place of the lower coefficients that had frequently been used by makers of venturi apparatus. The thought now occurs to him that in reality the use of these lower coefficients was the outgrowth of practical experience with venturi meters placed beyond reciprocating pumps where over-registration had actually taken place, and the logical result of this condition was for the maker of the meter to use a lower coefficient, which would give more nearly correct results for those particular conditions. The writer now believes that the best procedure is to use the coefficient 0.99 for all cases of steady flow, which is the standard condition. For lively lines the coefficient will be less and will be variable, depending upon the degree of liveliness.

It may be doubted if any data can ever be secured to make possible strictly accurate measurements on very lively lines. In many cases the errors on such lines will be within such limits that the meter will remain an invaluable instrument. In such instances a correction, to be ascertained as accurately as possible to meet local conditions, may be used.

So far as the writer's experience goes, the percentage error with lively lines is very much greater at low flows than at higher flows; the source of error was first brought to his attention in using the venturi meter as a means of checking up the minimum rates of flow into a completely metered system in the early morning hours, when there would normally be little use. The meter was found to over-register for these conditions as compared with the strokes of a pump to an extent that could not be accounted for, although the meter was known to register with approximate accuracy for the higher rates of flow that occur during the day.

It may be pointed out that the errors in the venturi measurements resulting from rapid fluctuation in velocity also occur with the pitometer or standard orifice or any other method of measuring water which depends upon the effect of velocities upon pressures. These studies indicate the need of some new and better apparatus for integrating flows of venturi meters, pitometers and other instruments on lively lines.

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The Total Lumber Cut in the United States in 1915, according to statistics published by the United States Forest Service, was 37,013,294 M ft. More than one-third of this was yellow pine, the total cut of which was 14,700,000 M ft. The cut of Douglas fir was 4,131,000 M ft. Of oak, white pine and hemlock, a cut of between 2,000,000 and 3,000,000 M ft. was reported for each. Of spruce, Western yellow pine and cypress, the cut was between 1,000,000 and 2,000,000 M ft. The cut of all other varieties of timber was below 1,000,000 M ft.

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[*] Of Hazen, Whipple & Fuller, Consulting Engineers, 30 East 42nd St., New York City.

Analytical Study of Garbage, Rubbish and Ashes

The report of Irwin S. Osborn, consulting engineer, Cleveland, Ohio, to the Commissioners of the District of Columbia, on the result of his investigation of the collection and disposal of municipal wastes in the District, contains a mine of valuable information. From this report the following abstract has been made for the purpose of showing the scope of the investigation, an outline of the data necessary and the methods of accumulating these data; this being a field of engineering investigation which as yet has received scanty attention from municipal officials and engineers.

PURPOSE OF THE INVESTIGATION

The studies were made in order to arrive at definite conclusions as to what would be the most feasible plan or method to be adopted, from sanitary and economical standpoints, for the collection and disposal of municipal wastes in the District of Columbia. The following were the principal points embraced:

1. Inspections of all sections of the District with reference to topography and plan, and their influence on collection.
2. Population studies with reference to past growth, sectional growth and estimated future growth.
3. Studies of the present method of collection, with reference to improvement in methods, from the standpoint of sanitation and economy.
4. Time studies of present methods of collection with reference to time required for the several functions of collection.
5. Inspection and studies of quantities produced during the time of investigation.
6. Preparation of maps and tables showing the population in small unit areas.
7. Preparation of tables showing the estimated production of several classes of waste in each unit area.
8. Tables giving the length of haul for each class of waste to assumed points of disposal; from which the estimated cost of collection for any year could be computed for each class of refuse by any method of collection or disposal.
9. Mechanical analysis of rubbish and ashes, to determine the component parts and the proportion of each.
10. Laboratory tests of the component parts of ashes and rubbish from samples taken at the time of mechanical analysis, to determine the calorific value.
11. Chemical and calorific tests of representative garbage samples to determine the percentage of fertilizing elements, fats, solids, combustibles, moisture, calorific value and percentage of ash.
12. Chemical and calorific tests of sectional garbage samples, to determine seasonal variations, the influence of the character of population, etc., on the percentage of fertilizing elements, fats, etc.
13. Inspection and studies with reference to suitable locations for disposal plants and transfer stations.
14. Inspection of all plants operated by contractors for the transfer or disposal of wastes, with reference to their adaptability to the work and to improvements.
15. Inspection of equipment used by the various contractors and investigations into the practicability of improved equipment with District conditions.
16. Comparison of available data with that of other cities, with allowance for variation in local conditions.
17. The applications of the studies made to a large number of projects, assuming certain points for disposal or transfer stations which might become available for the purpose. These data were classified under the following subheads:
    - a. The territory or collection district which would be the most economically served by various assumed disposal or transfer stations.
    - b. The population to be served in each established collection district.
    - c. The estimated quantities of each class of waste produced from each collection district.
    - d. The estimated maximum quantity of each class of waste produced during the season of maximum production in each collection district, in order to determine the various plant capacities.
    - e. The final capacities of disposal plants for each district, based on the estimated maximum production for the year 1925.
    - f. The ton-miles haul for each class of waste, based on the estimated production for the year 1925.
    - g. The estimated cost of collection for each collection district and for various methods of collection, based on the estimated production for the year 1925.
    - h. The estimated capital costs for each project.
    - i. The estimated operating cost for each disposal plant based on the production for the year 1925.
    - j. The estimated annual revenues for various methods of disposal, based on the production for the year 1925.
    - k. The estimated fixed charge for interest and depreciation.
    - l. The net annual cost for each project.
    - m. The estimated annual per capita cost.

DIVISION OF DISTRICT INTO UNIT AREAS

In making the studies and investigations, the entire District was divided into unit areas, which were used as a basis in making all collection and production computations. The various items pertaining to the collection and production of refuse for the several projects were deduced from each unit area. The totals for each unit area in all cases were reconciled with authoritative records for the entire District covering the item under study.

The unit areas were based on the present garbage routes, as accurate data were available covering the production in each unit area for past years. In assuming unit areas for future collections, only the natural and topographical areas which would receive service were taken. Tables were made showing the actual amount of garbage collected each day from each unit area, which were used in estimating the future production of garbage in the various sections of the city.

The population of each unit area was taken and the production per 1,000 population determined. This production per 1,000 population was taken as a factor to be multiplied by the population for the different periods.

The estimate of future production of garbage was figured in five-year periods up to 1940, in order to provide plant capacities and estimates for the various years during the anticipated life of the disposal works.

STUDIES OF COLLECTION METHODS

In connection with the collection of garbage, sixty complete time studies were made in order to determine the time required for the various steps entering into collection, as well as to determine the time required for each step under varying conditions.

The time studies also take into account the number of houses visited, and, at the same time, the number of houses from which collections were made, so as to determine the percentage of houses receiving service, as well as the average number of receptacles handled. Determinations were also made as to the amount of time required in loading and the time required in hauling after the load was placed on the wagon, so as to estimate the cost of service from the standpoint of loading as well as haul.

SAMPLING THE GARBAGE

During the year in which investigations were made, general samples were taken periodically every fifteen days, and the garbage submitted to the Department of Agriculture, Bureau of Soils, for making mechanical and chemical analyses.

All samples were taken from the wagon as they arrived at the transfer station. In drawing samples from the garbage tanks, a sample was taken from each tank on a specified wagon, the samples being drawn from approximately one-third of the wagons in service on each day a sample was taken. The wagons were specified in order that the samples would be drawn from different sections of the city, so as to insure a representative sample.

Each wagon tank was inspected to determine whether the material in all parts of the tank was of the same general character before drawing a sample from any part, and when the sample was drawn it was taken from such sections as would give the average of the full tank. Approximately 1 cu.ft. of garbage was taken from each tank.

The total amount removed from all the wagons was placed on a water-tight platform in a transfer station yard, where it was thoroughly mixed and chopped fine. The total was then divided into quarters, three-quarters being discarded, and the remaining quarter being thoroughly mixed and chopped in quarters. This procedure was repeated until the resultant sample was reduced sufficiently to fill three 2-qt. jars. The jars after being filled were sealed and sent to the Bureau of Soils for analysis. The material from each jar was analyzed so that three analyses were made of the same general sample, in order to check results.

The garbage was analyzed for the percentages of moisture, combustibles, ash, ether extract, potash, phosphoric acid and nitrogen, as well as for its calorific value.

SAMPLES FOR SECTIONAL CLASSIFICATION OF GARBAGE

In addition to the regular samples which were taken as an average of an entire day's collection, the District was divided into sixteen sections as nearly as possible, according to the classification of people, such as the wealthier, intermediate and poorer classes. From these sections, samples were drawn in a similar manner to that described in drawing the regular samples, and these were analyzed.

All told, 131 sectional samples were taken, the samples being drawn each week so that a sample from each section was analyzed every month. In making up the sectional samples, a part was taken from each load collected in that section from which the sample was to be taken, so as to eliminate any local variations. At the same time, special places such as hotels, the War College, Navy Yard, etc., were omitted in order to get a representative sample from the residences.

The object of taking the sectional samples was to determine, if possible, the variation in the quality of the garbage produced by the different classes of people, as pertains to the value of fats or fertilizing elements contained in it. From the elaborate tests and studies made, curves were plotted and the various elements determined by analyses, and the analyses studied.

STUDY OF RUBBISH AND ASHES

Tables were made giving the results of the weight and volume studies covering a considerable period of time. At regular intervals mechanical analyses were made of the rubbish for the purpose of obtaining the quantities of the different constituents making up this class of municipal waste, as well as the products which have a commercial value. Special wagons were sent out for collecting the samples, taking a number of houses out of each collection route, so as to get a representative sample of the day's collection.

A representative sample of each component part of the rubbish which contained combustible material was sent to the Bureau of Mines in order to determine the calorific values. The results of the tests constitute the first data available in regard to the calorific values of the various constituents of rubbish.

During the investigation forty-four time studies were made on the rubbish wagons. These were carried on to the same detail as those described in the collection of garbage, and the time required for each function of the work in connection with the collection of rubbish taken into account. The results were used in checking up the costs for the various steps in making the collections and delivery of material.

The estimated future production of rubbish was computed in the same way as for estimating garbage production. The quantities produced per capita in the various sections of the city were applied to the unit areas, so as to determine as nearly as possible the quantities produced in each unit area.

STUDY AND TESTS OF ASHES

The records of the amount of ashes collected by the contractor were furnished by the District Street Cleaning Division. At regular intervals mechanical analyses were made of typical loads of ashes collected from the several districts and the results plotted.

Samples for calorific tests were made at regular intervals from the various collection routes for the purpose of obtaining the fuel value of the ash in connection with the incineration of other classes of waste collected in the District. Samples were taken by screening the load as it arrived at the point of disposal, using a ⅜-in. mesh screen.

The material collected by the screen was classified as cinders, and that which passed through the screen as dust. A representative sample of the cinders and dust was then sealed and sent to the Bureau of Mines for analysis, where the following factors were determined: Moisture; volatile matter; fixed carbon; ash; B.t.u. in material as received; B.t.u. in material on dry basis.

At regular intervals twenty-eight time studies were made on the ash-collection wagons. The time studies for ashes were carried out in the same manner as described for the collection of garbage. The time required for each function of the work was taken into account and the results used for checking up the costs of the various steps in making the collections and delivery of the material.

STUDIES OF COMBINED REFUSE

From the results and quantities obtained for the separate collection of garbage, ashes and rubbish, tables were developed giving the total estimated pounds of refuse collected per capita per annum, of all three classes of waste. Tables were made giving the estimated future quantities of combined waste to be collected and disposed of, as well as tables giving the quantities of combined waste by volume and weight, as collected during the maximum and minimum months. From these tables estimates were made of collection equipment and plant cost, considering all three classes of waste combined. A second article will give the results of these studies.

Sewage-Treatment Plant, Cook County Institutions

By Burton J. Ashley[*]

When the Poor Farm for Cook County, Illinois, was moved to Oak Forest in 1911, a sewage-treatment plant was built consisting of two tanks 10x80 ft. in plan by an average water depth of 7 ft., followed by four contact beds 10x10x4 ft., operated by four 5-in. Miller siphons. Five feet from the inlet end of each tank was a baffle wall, extending from the floor upward to a line 12 in. below the water line. At the floor line of each baffle wall were two 12-in. square openings. Within 5 ft. of the outlet end of each tank was a baffle that extended from the floor of the tank to the top with openings at the flow line.

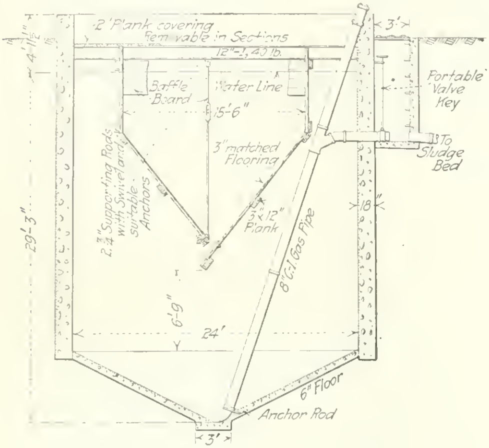

FIG. 1. SECTION OF COOK COUNTY IMHOFF TANK

The duty required of this plant was to serve from 1,800 to 2,800 persons. Storm water from the new buildings was supposed to be excluded from the sanitary sewers, but connections had been made to such an extent as to cause the plant to be deluged during heavy storms. Judging from observation and hearsay evidence, these tanks never became positively septic.

The effluent from the old plant became so serious a nuisance and menace to the farmers below the Poor Farm, through whose farms the effluent flowed, that legal action was taken by the farmers to compel the County Commissioners to abate the nuisance.

About this time, the County Commissioners concluded to build a $1,000,000 County Tuberculosis Sanitarium on the Poor Farm. Consequently it became necessary to rebuild and enlarge the sewage-treatment plant.

The ultimate occupancy of both institutions, including employees, was estimated to be 5,000 persons. The plant designed and built to meet the present and future demands includes: A screening and detritus chamber; Imhoff tank; hypochlorite plant; doubling the area and capacity of the old contact beds, using eight 5-in. Miller siphons in two control chambers, and a sludge-drying bed.

The screening chamber was of the ordinary box type, 2x10 ft. in plan, with a water depth of 1 ft., and provided with ⅜x1-in. bar screens set ½ in. apart.

The Imhoff tank (Fig. 1) is circular in main plan, with a rectilinear flow chamber 15½ ft. wide. The cover was depressed as shown to afford more ready access to the scum chambers when cleaning them.

An attempt was made to complete the excavation for the Imhoff tank and then to build the walls within the excavation, but this plan was a failure. The "dig and sink" principle was then successfully adopted by using a circular T-bar heavily anchored in the concrete wall as the cutting edge and by reinforcing the walls themselves. The reinforcement consisted of ¾-in. rods set diagonally 12 in. apart.

The hypochlorite plant was built directly above and upon the inlet ends of the two old tanks and receives the Imhoff effluent, it being the intention to use the south tank as a sedimentation chamber after introducing the hypochlorite into it by means of an orifice box and mixing channel. The inlet end of the old south tank was reconstructed and made into a mixing channel by introducing baffles projecting into the tank from each side wall, thus causing the Imhoff effluent to pass in a sinuous course for the distance of 20 to 25 ft. before being discharged into the sedimentation tank (the old south tank). The hypochlorite is introduced at the inlet end of this channel.

A bypass has been provided so that the discharge of the hypochlorite from the orifice box can be made directly to the outlet sewer from the contact beds by merely opening a valve in the hypochlorite house.

The four old contact beds were duplicated, thus doubling the nitrifying capacity. The material in the old beds, consisting of a 2-ft. layer of 2-in. stone covered with a 2-ft. layer of ¾-in. size (Fig. 2), was wheeled out and washed by passing it through a flooded concrete mixer. This method proved a most unqualified success. The cost of washing and replacing this material was about 45c. per cu.yd. The material was automatically rescreened as it was dumped from the mixer and wheeled back to place.

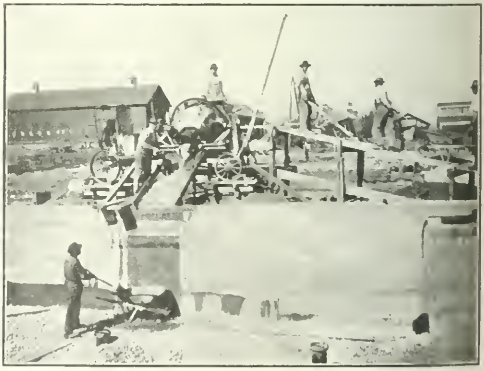

FIG. 2. CLEANING CONTACT-BED STONE IN CONCRETE MIXER, COOK COUNTY, ILLINOIS

The fluid chambers of the control houses being approximately 80 ft. apart were connected by a 12-in. cast-iron water main and the siphon-control pipes in the two houses by 1½-in. air pipes running from one control house to the other on the top of a concrete dividing wall which separates the contact beds.

Each control house was built of concrete and provided with a roof ventilator and a small window. The doors were made practically frostproof after the character of refrigerator doors.

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[*]Engineer, Morgan Park, Chicago, Ill.

The filling of one unit of the beds at the time of starting the plant occupied about 50 min. on the average. The siphon mechanism was timed for holding the beds full 1 hr., empty 1 hr., resting empty about 3 hr.

The sludge bed has an area of 2,000 sq.ft., a 1-ft. filtering depth, and consists of cinders with agricultural tile underdrainage.

The nuisance along the farms spoken of was abated immediately on beginning use of the plant in October, 1914.

The plant was designed by the writer, and its construction was supervised by G. A. Freeburg. The contractor was J. J. Croake & Co., Chicago. The contract price was $25,000.

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Earth-Road Maintenance in Irrigated Lands

By C. N. Perry*

A method of earth-road maintenance by turning irrigation water upon the roadbed is in vogue in Imperial County, Calif., which could perhaps be used to advantage in other irrigated sections of the arid West. The roadbed is constructed with a center ridge or dike and with a dike on each side forming two distinct roadways. These dikes are usually made about 6 to 8 in. in height, and the center one should be 8 ft. in width, so that a wagon can travel on it should occasion require.

The irrigated section of the Imperial Valley where such roads are maintained is very level, and the only construction work necessary in most cases has been to give the roadbed a light plowing and then, with a fresno scraper, move the soil thus loosened to the line of the central and outside dikes. This done, the two roadways are leveled by dragging and are ready for irrigation. The most convenient irrigating ditch is tapped, and a stream of water from 3 to 4 in. deep is turned on one of the roadways.

By practice the roadman learns just when to turn off the water, gaging it so as to cover the entire distance without ponding the water at the lower end of the stretch. Practice in handling the road after that varies with the ideas of the roadman. Some wait until the road is very nearly dry and then drag it again; others appear to consider their work done when the water has been turned on and shut off again.

The Imperial Valley soil varies from a fairly heavy clay, a silt loam and sandy loam to a sand which when wet is practically a quicksand. The heavier soils respond to this flooding treatment, but the sand, having absolutely no binder in it, soon dries out and is as bad as ever. The soil that does respond is encountered much more often than is the sandy soil, but sandy spots occur even in the heavier soils.

There is no law against traveling the flooded side, except that which good sense dictates. The soil, when wet, is so soft and sticky that no one will willingly turn in on the wet side. However, a bunch of cattle being driven along the road is not so particular, and as a result of their wanderings a road which might be within two days of being ready again for travel is made worse than it was before the water was turned on. Just when the half of the road that has been flooded is ready for the resumption of traffic is left to the discretion of the traveling public, and each man decides for himself which side he will take. As a result a road may be cut into deep ruts before it is thoroughly dry.

The expense of maintenance by this method simply means the cost of three trips of a wooden float pulled by a four-horse team, which would probably drag a mile of road (one side only) in 1½ hr. After that it is merely a question of turning on the water and leaving a man on the job with a shovel, to see that no high places have been left, which might escape flooding. How much this should cost depends so entirely on the amount of judgment employed that I can give no figure. The flow of water along most of our roads is at the rate of about 1 mi. in 2 hr. If the irrigator planned his work, he could either attend to flooding two roads in the same locality at once or could so arrange his work that he could do something else while waiting for the water to travel to the other end. This brings in the personal equation, and I imagine the cost per mile varies widely.

The county is divided into five road districts, each with a supervisor in charge. The supervisor selects his own road foremen, and they in turn select their own workmen. The foremen and workmen may be farmers living near the road to be constructed or improved. The county engineer has nothing to do with either the first construction or subsequent maintenance of the roads. He is called in when the construction of the road necessitates a bridge or when there is some unusual feature on which his opinion is desired. Otherwise, all the details are handled by the supervisor through his road foremen. I know of no other method we could have employed which would have given us passable roads; but at the same time the roads are, and always will be, only makeshifts.

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*County Surveyor, Imperial County, El Centro, Calif.

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Use of Injunctions Limited in Labor Suits

A statute limiting the use of court injunctions in labor disputes is declared unconstitutional in Massachusetts. The Massachusetts Legislature in 1914 passed a law limiting the use of injunctions in labor disputes on the ground that the right to labor and to contract for labor was a personal and not a property right. The Massachusetts Supreme Court, in deciding a case where two trade unions were in litigation with each other, recently ruled that this law is unconstitutional because it deprives the lawful owner of property of equal protection under the law and thereby subjects it to confiscation. The court in its decision said:

> The statute provides that the property rights of labor of any individual or number of individuals associated together shall not be recognized in equity as property . . . That a man cannot resort to equity respecting his property right to work simply because he is a laboring man, and that he cannot have the benefit of an injunction, when such remedies are open freely to owners of other kinds of property needs scarcely more than a mere statement to demonstrate that such a man is not guarded in his property rights under the law to the same extent as others. It is beyond the power of the Legislature to declare that without any process at all, a well-recognized kind of property shall no longer be property. Lawful property cannot be confiscated under the disguise of a statute.

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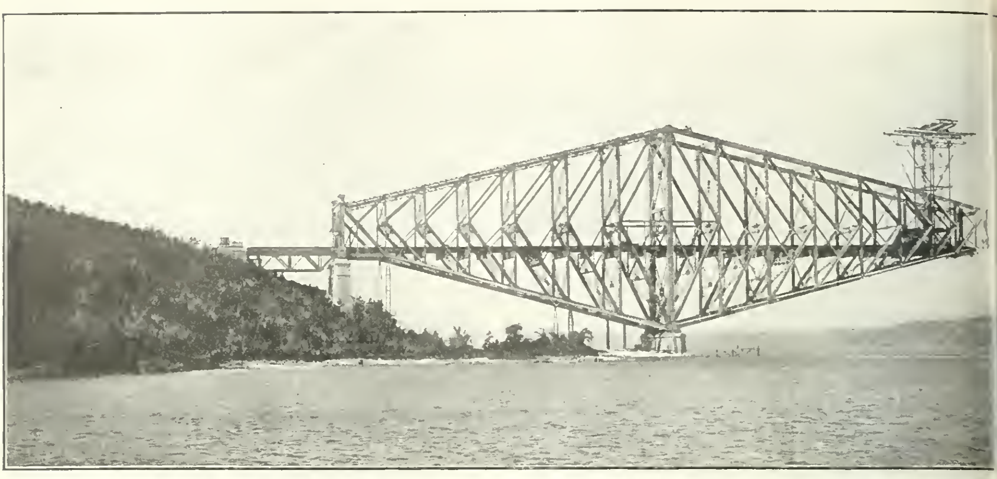
Dry Farming and Irrigation in New Zealand are receiving increasing attention. There are large areas where the rainfall is scant and farming by the ancient method is not profitable. The soil is fertile if moisture can be secured, and it is claimed that there are many satisfactory sites for irrigation plants



South Cantilever Arm of Quebec Bridge Completed

By A. J. Meyers*

SYNOPSIS—The south cantilever arm of the new Quebec Bridge was completed on July 28. About 13,000 tons of steel was placed in 92 working days—over a month ahead of schedule. Description of erection work and equipment.

During the season of 1915 the material of the new Quebec Bridge erected on the south shore of the St. Lawrence River consisted of the inside falsework carrying the anchor-arm floor and traveler tracks, the outside staging carrying the anchor-arm truss material and bracing, and all material of the south anchor arm complete, including the main post and the links at the top of the main post connecting the top chords of the cantilever and anchor arms. The total weight of steel erected by the one traveler on the south shore during the season of 1915 amounted to approximately 20,000 tons, including the weight of the falsework. At the close of the working period the traveler was standing over the south main pier, prepared to begin the erection of the south cantilever arm as soon as the working season for 1916 opened.

The erection of the 13,000 tons of steel in the south cantilever arm was started about Apr. 1, 1916, by which time the traveler machinery and tackle had been thoroughly overhauled. The members of the cantilever arm placed by the traveler while standing over the main pier are shown in heavy lines in Fig. 2.

Use of Flying Bridge

The first half of the flying erection bridge which was used, panel after panel, to support the bottom chords and laterals, as well as the main tension verticals, until these members were properly aligned, their splices riveted completely and the final connections to the upper truss members made, was first placed in position, connected up to its bearings on the main shoes and the front end tied back by yoking girders and links to the main post.

This erection bridge is illustrated in Fig. 5. It was made up of four plate girders of a length equal, approximately, to the longest main panel of the cantilever arms. These girders were placed in pairs under the chords of the trusses on each side of the bridge. The two girders forming a pair were spaced far enough apart to allow ample working space for the men on each side of the bottom-chord members as they were temporarily supported on the bridge. The girders of each pair were braced together by cross-girders which transferred the load of the truss members to the girders and also provided seats for the hydraulic jacks which were used for aligning and connecting these truss members. Each pair of girders had a complete bottom lateral system and a wooden floor supported along the bottom flange. This wooden floor between the girders completed a commodious working apartment for the assemblers and riveters who were working on the chords. The pairs of girders were braced together by two transverse plate girders which had a separate lateral system of their own. These transverse girders had to support the bottom-chord laterals until the end connections were made.

The erection bridge was thus a complete erection unit and was handled as such. It was supported, while in use, at the end nearest to the main pier by pins connecting to brackets which were bolted to the bottom flanges of the chord members already placed. The other end was held up by links at the center and end of the erection bridge. These links were attached to yoking girders which straddled the compression diagonals already erected overhead and in the panel to the rear.

The method of handling by the traveler cranes of the erection bridge while being moved forward into a new position is illustrated in Fig. 6. The links to the

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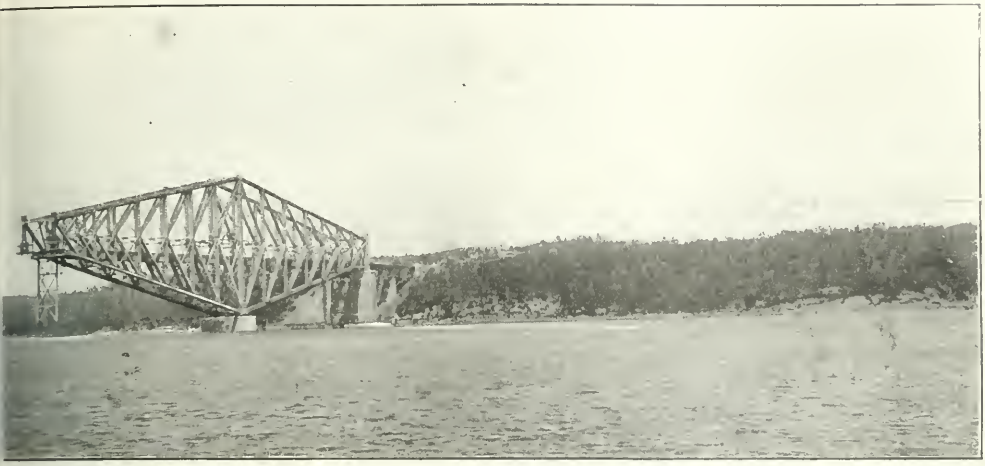
*Chief Draftsman, Board of Engineers, Quebec Bridge, Montreal, P. Q.



THE QUEBEC BRIDGE ON JULY 31, 1916, WITH BOTH LEVERS COMPLETED. ON THE SOUTH ARM, TO THE T, THE ERECTION TRAVELER IS IN ITS LAST POSI-ON. THE NORTH ARM, TO RIGHT, ALREADY HAS IN PLACE HANGING TRUSS, FOR GUIDING THE SUSPENDED SPAN DURING ITS MOORING

rward end were first disconnected. The load of the ction bridge was then taken by the rear cranes, links were disconnected, and the pins connecting the bridge the chord brackets were removed. The bridge was n lowered and moved forward until stopped by the ttom laterals of the chord panel just completed. At s point the bridge was connected up and the load nsferred to the hoisting tackle of the front cranes. e bridge was then moved forward and lifted up into new position.

Cantilever Bottom Chords

In the first main panel CL16-CL14, as soon as the t section of the erection bridge was in position, the ir of 30-in. pins, with their 45-in. semicircular sleeves, the cantilever arm bottom chords, and the 20-in. s, with 30-in. sleeves, for the main compression diagal CL16-CM14, were first placed on the shoes at CL16. The first sections, CL16-CL15, of the cantilevern bottom chord were then placed on the erection dge and carefully centered and aligned from the shoe. ese members, built entirely of nickel steel, having a ss-sectional area of 1,630 sq.in., with outside dimenns of cross-section 84 in. deep by 124 in. wide, are heaviest pieces in the cantilever arms. Each mainnel chord, made up of four vertical webs laced longilinally in three horizontal planes, was divided into half-panel sections, the members being fully spliced this half-panel point in material and rivets, as well as ng accurately faced to as nearly a perfect bearing modern equipment and machinery could make possible. ch half-panel section was again divided vertically along longitudinal center line. The member was shipped d handled in these sections, the heaviest of the sections ighing 160,000 lb. Each section was handled by means specially designed and tested hitches bolted to the flanges, two sets of hitches to each section. The sections were lifted from the cars in pairs, at the same time, one section for the east truss and the corresponding section for the west truss, all four of the 55-ton hoists of the two traveling cranes at the top of the traveler being used, one hoist of each crane to a section. The sections after leaving the cars were "fleeted" apart until they hung vertically over their positions on the erection bridge, when they were lowered into place.

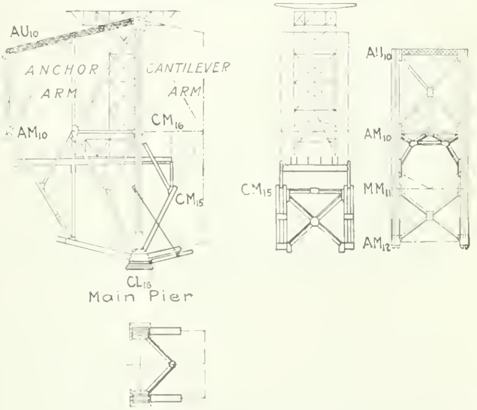
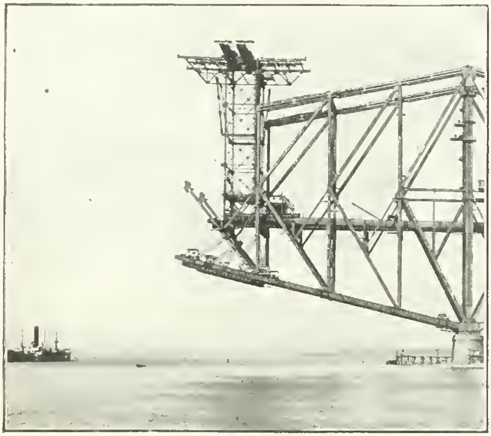
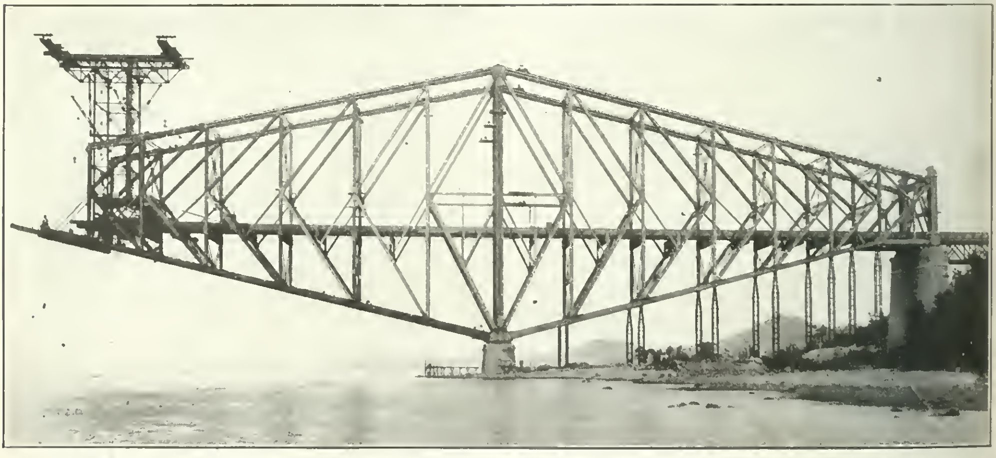


FIG. 2. CANTILEVER MEMBERS PLACED BY TRAVELER OVER MAIN PIER

The erection of the half-panel of the bottom chords was followed by the placing of a half-panel of bottom laterals, panel CL16-CL15, from the shoes to the middle intersection plate. The middle intersection plate and the lateral members themselves rested on the transverse girders of the erection bridge. The bottom lateral system is a double intersection system with a strut at each main-panel point. Each of the diagonals in a panel of the system is designed to take compression as well a tension. The lateral members are of nickel steel, the largest cross-sectional area being 98.7 sq.in., made up o eight 8x8x$\frac{13}{16}$-in. angles, built into a box section with a depth equal to that of the bottom chord and latticed in the horizontal and vertical planes.

The small subtension diagonals, CM16-CM15, were next hung from the main post by driving the pin at the upper end, CM16. These members were followed by the placing and careful centering on the shoe pins of the lower section, CL16-CM15, of the main compression diagonals.





FIGS. 3 AND 4. PROGRESS OF ERECTION OF SOUTH CANTILEVER

Fig. 3 (Above)—South cantilever on June 15, 1916. Fig. 4—The south cantilever on July 11, 1916. Erecting three panels in less than three weeks is a fair sample of the speed of progress on the work. In Fig. 3 the bottom chords, temporarily supported by the erection bridge, are tied back by links and yoking girders to the compression diagonals

As shown in Fig. 7, the upper ends of the sections were tied back and held in position temporarily by tackle to the main post. As soon as the two halves of the lower sections were placed, the pins connecting the subtension diagonal, CM16-CM15, to the main compression diagonal at CM15, were driven, and the sway bracing for these lower sections was placed in position. These compression diagonals are built members with an arrangement of cross-section similar to that of the bottom chord, but of much smaller area. They are spliced, shipped and handled in a manner similar to the bottom-chord members. The diagonals in the panel next to the main pier, where the weight of the member itself has practically no influence on the remainder of the bridge, were made of carbon steel. All of the remaining main compression diagonals in the cantilever arm were built of nickel steel.

Bridge Floor-Beams

The subposts CM15-CF15, and the single-web floor-beams at CF15 were next erected, and the steel for the bridge floor from CF16 to CF15 was laid. The traveler was then advanced until the front legs rested on the floor-beam at CF15. The floor-beams of the bridge, built of carbon steel, are 88 ft. c. to c. of pins, and 10 ft. back to back of flange angles, the heaviest weighing approximately 120,000 lb. In the majority of cases for the cantilever arm they had additional material in the web and flange to take care of the shears and moments from the dead weight of the traveler and the lifted loads.

To lift these floor-beams from the cars and place them in their position in the bridge necessitated the design of a special lifting connection shown in Fig. 8. This lifting connection had two sets of cast vanadium-steel hooks which engaged the top flanges of the floor-beams. These hooks were pin-connected to hanger plates that were in turn riveted to a crosshead composed of two 10-in. 25-lb. channels. A specially designed swivel pin, with an eye at the upper end and threaded at the lower end to engage a cast-steel bearing nut, was used to transfer the load from the hoisting cables to the channel crosshead. A short cast-steel guide pin was bolted to the top of the floor-beams and served the purpose of insuring that the floor-beam would rotate about a vertical axis. The floor-beams were lifted from the cars by the two hoists of the front traveler crane, carried out until they cleared the steelwork of the traveler, then rotated through an angle of 90°, and lowered into position.

At each of these subpanel points, temporary bracing was put in from the floor-beam to the subpanel point, to transfer the wind load on the traveler to the bracing planes of the trusses.

The traveler, standing with its front legs resting on floor-beam CF15 (see Fig. 9), first erected the completing section of the erection bridge. The bottom-chord half-panel sections CL15-CL14 were then placed on the erection bridge, jacked into line, and the splice at CL15 made. Throughout the work all splices and riveted connections in the truss members were practically completely riveted panel by panel as the traveler advanced.

Erection of Main Diagonals

The upper sections, CM15-CM14, of the main compression diagonals, were next erected and the splices at CM15 riveted up, the CM14 end of the member being tied back by tackle to the main posts, as illustrated in Fig. 7. The erection of the sway bracing below the bridge floor for the upper sections of these diagonals, the upper portions, CF15-N15, of the subposts and the subchord member CM16-CM14, followed immediately, ie pins at CM16 and CM14 connecting the subchord at iese points being driven.

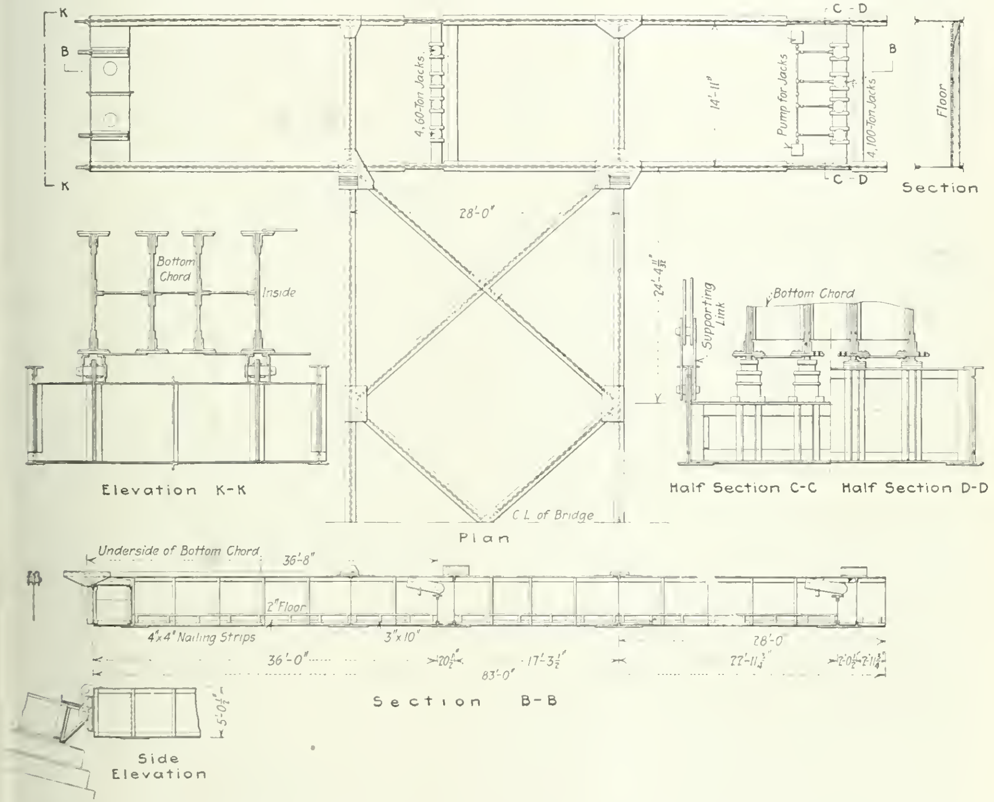


FIG. 5. ERECTION BRIDGE FOR QUEBEC BOTTOM CHORDS, LATERALS AND TENSION VERTICALS

The main-panel point CM14 is typical of all the mainanel middle points or "K" joints of the cantilever arm, xcept that it has an extra connection for the subchord ember CM16-CM14, which appears only in the first ain panel of the cantilever arm. Generally there are ur main truss members and one subtension diagonal onnecting at these joints, all of them being pin-concted with the exception of the main compression agonals. The main compression diagonals have the ght large main gussets riveted into their ends. These eight gusset plates are cut so that each and every gusset engages the pins of all the other main members connecting at the joint.

The main tension diagonals, CU16-CM14, are 150 ft. 6⅛ in. c. to c. of end connecting pins. They are built up of four webs, the webs being connected and riveted together in pairs by means of lattice bars and tie-plates. The pairs are then connected by means of spacer tie-plates. Each pair of webs was shipped to the bridge site in three sections, making up the total length of the completed member.

Before erection, these sections were assembled on the floor of the bridge between the traveler and the bridge trusses, and their field splices completely riveted up. Each pair of webs was then hoisted into position separately by the traveler. The inner pair was first placed and the pins at CU16 and CM14 driven. Any adjustment necessary to center the pin holes was made by means of tackle leading from the panel point CM14 to the main post. Immediately after placing the inner section, the outer section of the member was erected and its pins driven. The pin holes at the lower end of the member were slotted ¼ in. on the side remote from the bearing surface in order to facilitate the driving of the pins. The main tension diagonals in the first main panel of the cantilever arm are of carbon steel; in all the other panels they are of nickel steel. The pins throughout the bridge for each main-member connection are in half lengths, each half engaging two webs of the member and two gussets of the connection. This method of pin connection enabled the pins to be driven in all cases with remarkable ease.

Tension Verticals and Top Chords

The splice of the bottom chord at CL15 being completely riveted, the inside halves of the tension verticals, CM14-CL14, were next erected and the pins at CL14 driven. The bottom chords were then jacked up from the erection bridge until the pin holes at CM14 were in true line. The pins were then driven. The operation was then repeated with the inner halves of the tension verticals. These tension verticals are similar in built-up construction to the main tension diagonals previously described, and are shipped and handled in a similar manner. The upper pin holes were also slotted to allow the last driven pins to be easily entered.

The half-panel of bottom laterals, CL15-CL14, together with the bottom lateral strut at CL14, was next placed and the sway bracing from the floor-beam at CF14 to the bottom-chord panel point CL14 for the tension vertical CL14-CM14, was erected. The erection of the floor-beam at CF14 and the laying of the track floor from CF15 to CF14 followed immediately. The sway bracing for the tension verticals throughout the cantilever and anchor arms transfers a main-panel load of wind shear, due to wind on the floor and train, from the plane of the floor bracing to the plane of the bottom lateral bracing; also the cross-wind reaction on the front of the traveler during erection travels to the bottom laterals by the same path.

The compression verticals, CM14-CU14, which were the next truss members to be placed into position, were spliced transversely and longitudinally in a manner similar to the bottom chords and main compression diagonals, and the same methods were used for shipping, handling and hoisting into position in the bridge. All these compression verticals in the cantilever and anchor arms were of similar construction. They were built up of four plate-girder webs, spaced the same distance center to center of webs as the compression diagonals and bottom chords. They were similarly latticed in three longitudinal planes, and rested on pins in half pin holes at the main middle or "K" joints of the trusses. At this joint they were temporarily supported, as shown in Fig. 7, during erection by means of tension anchor bolts on the one side of the connection. These anchor bolts engaged brackets on the compression verticals and reaction brackets on the gusset plates of the main "K" joint. The anchor bolts were thrown into tension by means of the tackle which, as shown in Fig. 7, attached to the upper end of the member, and by means of which the member was tied back to and supported by the truss material already erected.

The erection of the truss material for the first main panel, C16-C15, was completed by the placing of the top chord eye-bars, CU16-CU14, with their supporting trusses (see Fig. 9), and driving the eight pins at CU16, connecting the eye-bars to the link at the top of the main post.

Each main-panel top chord in the cantilever and anchor arms is composed of two lines of eye-bars, spaced 3 ft. 6 in. c. to c. vertically, the one line above the other.

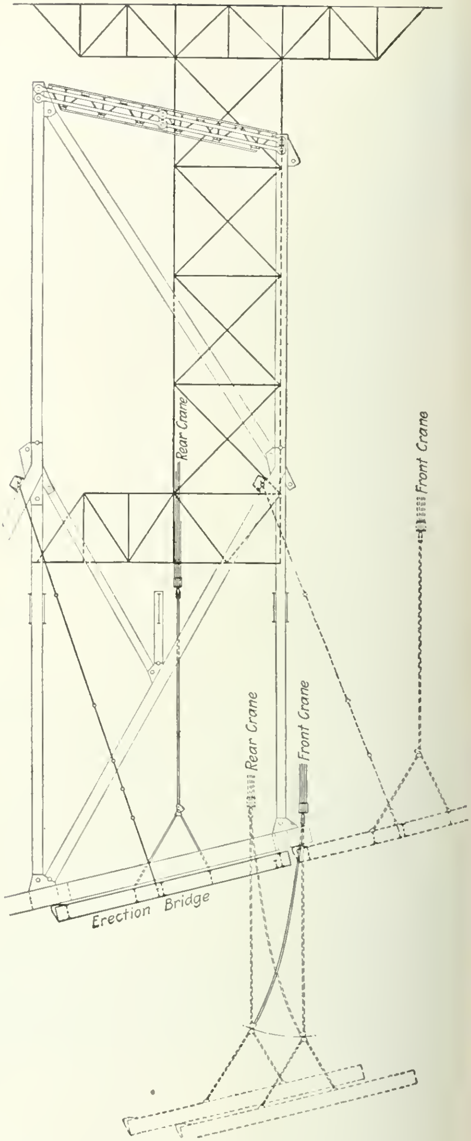


FIG. 6. TRAVELER CRANES HANDLING ERECTION BRIDGE

Each line of eye-bars in all panels over 50 ft. in length is made up of two lengths of eye-bars per panel, pin-connected to each other at the middle point of each panel, where the weight of the pins and one-half the weight of the eye-bars is taken by supporting trusses. Each supporting truss for one panel of eye-bars is made up of four single-intersection Warren trusses connected together in pairs by cover plates, tie-plates and lattice bars. The pairs of trusses are symmetrically spaced about the longitudinal center line of the chord, but are not connected. The eye-bars were assembled with the supporting trusses in the storage yard and the middle pins put in place. They were then taken out on the bridge and hoisted into position, one-half the bars in each panel being placed at one time.

As soon as the eye-bars and supporting trusses were erected, the adjusting erection links for the top chords, illustrated in Fig. 10, were placed in position. These links were made up of a series of plates pin-connected together at the end. The plates were made of such lengths that the same links could be used panel after panel by removing or inserting extra lengths of plate to suit the varying lengths of bridge main panels. Small adjustments were obtained by means of one 100-ton jack in each link reacting against sliding cross-girder heads connecting to the plates at each end of the jack. The links, at the ends, engaged brackets which were in turn connected to the main compression vertical posts. The top-chord eye-bars had the pin holes at each end slotted ¼ in. on the side remote from the bearing surface, and these adjusting links were used to draw the top-chord main-panel points together so that the top-chord pins could be easily driven in the elongated pin holes of the eye-bars. These top-chord links also took care of any erection stress in the top-chord panel until the eye-bar pins at each end of the panel were driven. The links were placed in pairs over each chord and were put in position and connected up as soon as the panel of eye-bars with the supporting trusses was placed. They remained in this position until the eye-bars and supporting trusses in the following panel were erected. The pins at the shore end of this latter panel were then driven and the links moved forward into the next panel.

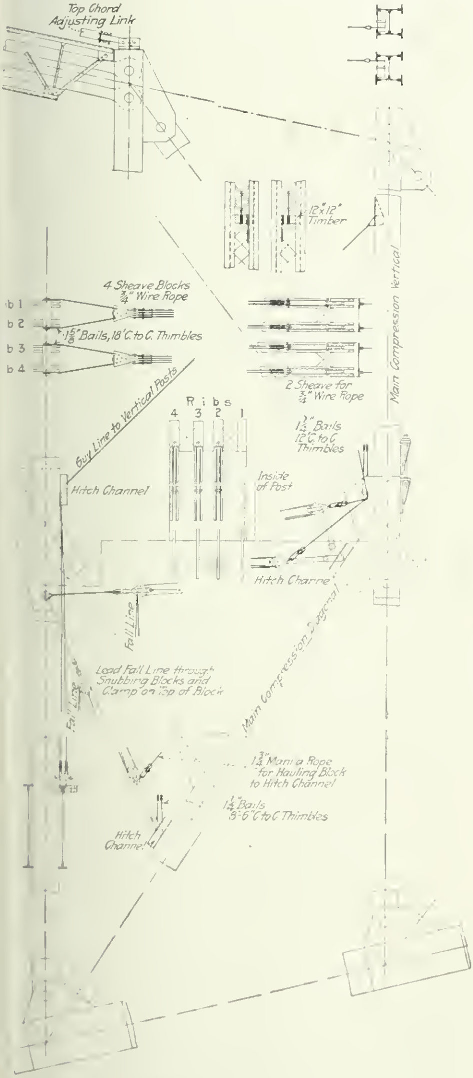

Top Chord Adjusting Link
12"x12" Timber
4 Sheave Blocks ¾" Wire Rope
b 1
b 2
b 3
b 4
1⅝" Bails, 18' C. to C. Thimbles
2 Sheave for ¾" Wire Rope
Main Compression Vertical
Guy Line to Vertical Posts
Ribs
4
3
2
1
1¼" Bails 12' C. to C. Thimbles
Hitch Channel
Inside of Post
Hitch Channel
Fall Line
Main Compression Diagonal
Lead Fall Line through Snubbing Blocks and Clamp on Top of Block
Fall Line
1¾" Manila Rope for Hauling Block to Hitch Channel
1¼" Bails 3'-6" C to C Thimbles
Hitch Channel

FIG. 7. ERECTION OF DIAGONALS

All the material in the panel C16-C14 was now completely erected except the sway bracing for the vertical post CU14-CM14 and that for the upper half of the main compression diagonals, CM14-CL16, which could not be placed until the traveler had moved forward out of the way.

Completing Sway Bracing

The traveler was next advanced until the front legs rested at panel point CF14. The erection bridge was moved forward into position to take the chord members of the following panel and the erection of this next panel and the panels following was proceeded with in a manner practically identical with that followed for the first main panel, as previously described. When the traveler was moved forward to panel point CF13, the sway bracing for the vertical compression post, CU14-CM14, was placed in position; and when the traveler was moved forward to panel point CF12 the portal bracing of the main compression diagonal, CM14-CM15, was erected by the rear booms of the traveler.

The placing of this bracing finished the erection of the complete system of sway bracing for the compression web members in the first main panel. This system of sway bracing is a double-intersection system designed to take both tension and compression in each member, and follows the line of members from CU14 to CM14 to CL16. It takes the panel wind shear from the top-chord and web members of the trusses, carrying it to the plane of the bottom lateral system. Throughout the cantilever and anchor arms there is no top-chord lateral bracing, but in each main panel there is a system of web bracing similar to that just described.

Progress Dates

As already stated, the erection of the first main panel of the south cantilever arm C16-C14 was started April 1, 1916. On Friday, Apr. 28, the traveler was moved forward to panel point CF14, the first main panel being practically completed. The number of days, 10 hr. to each day, actually worked was 22½, only 2½ days having been lost on account of high winds and rainy weather. The amount of steel erected during this time was in the neighborhood of 3,100 tons and included the placing of the largest, longest and heaviest members of the cantilever arm. An average of 200 men for each working day were employed on the work, including from six to eight gangs of riveters.

The material in the second main panel was completely erected by May 26. The steel in this panel weighed approximately 2,650 tons, and was erected in 18 working days. The 1,960 tons in the third main panel was placed by June 12, in 13 working days. The methods employed in the erection of the material in these two panels were similar to those described before, with nothing especially worthy of note except perhaps the placing of the traction truss in the third main panel.

This traction truss is placed in the plane of the sway bracing for the main compression diagonals below the floor line and forms part of the sway-bracing system for this panel. The truss is connected up to the track girders at the floor line and takes care of the traction between the expansion joints at the main post and at panel point CF7. This truss is a double-intersection latticed girder designed throughout to take both tension and compression in each member. It is 22 ft. deep and 88 ft. long, and weighed in the assembled condition 52,000 lb. It was riveted up completely on the floor of the bridge in front of the traveler and then lifted and placed in position in one piece, using the two main hoists of the front crane of the traveler and the two forward derrick booms.

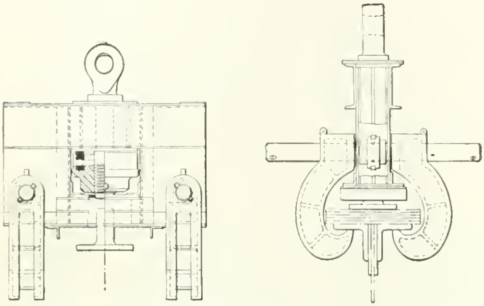


FIG. 8. LIFTING CONNECTION FOR QUEBEC BRIDGE FLOOR-BEAMS

As the traveler progressed toward the end of the cantilever arm, the members handled were lighter and the field splices fewer and smaller. The rate of progress was therefore greatly increased. By July 10 the traveler had completed the erection of six main panels of the bridge and was standing at panel point 4. The fourth, fifth and sixth main panels were erected in 22 working days, the total weight of steel in these panels amounting to approximately 3,600 tons.

The traveler was moved to its last position at the end of the seventh main panel on July 20. The weight of the steel in the last two main panels amounted to about 1,280 tons. This was placed in 18 working days.

The south cantilever arm was therefore completely erected between Apr. 1 and July 28, 1916. The total weight of steel placed was about 13,000 tons. This material was erected in 92 working days, about 27 days being lost from high winds, inclement weather, Sundays and legal holidays. The south cantilever arm was completed over a month ahead of schedule time and in over 25% less working time than for the north arm.

The pin holes in the eye-bars used in the anchorage chain and the top chord of the anchor arms had each been slotted ½ in., making a total of 2 in. adjustment for each top-chord main panel. The upper pin holes of the main tension diagonals of the anchor arm had also been slotted 2 in. The anchor arms were cambered and the elevations of the tops of the falsework columns carrying the anchor-arm trusses were made of such a height as to allow the top-chord main-panel points to be brought 1 in. closer together than the manufactured length of the eye-bars demanded; slotting the holes enabled this to be done without any difficulty. The purpose of this camber was to avoid as far as possible any trouble that might arise in driving the huge pins connecting the main truss members.

Anchor-Arm Movement

As the erection of the cantilever arms proceeded, the slack in the anchor-arm top chords and main tension diagonals was taken up gradually and almost imperceptibly panel after panel. The first effect of cantilevering, in raising the bottom-chord panel points of the anchor arm, was observed after bottom chord CL11-CL10 had been placed. At this time the middle panel points AL6-8 and 10 of the anchor-arm bottom chord had lifted about $\frac{3}{16}$ of an inch. As the traveler moved forward panel after panel on the cantilever arm, these bottom-chord panel points of the anchor arm were observed to lift in amounts varying from ¼ to ⅜ in. for each additional panel of cantilever-arm material erected. When the traveler was moved out to the end of the sixth main panel of the cantilever arm, the slack in the chain of anchorage bars at the anchor piers was observed to be gradually taken up. This showed that the erection of the cantilever arm had reached a point where the weight of the cantilever arm plus the weight of the traveler slightly overbalanced the weight of the anchor arm. Jacks were therefore placed under the falsework columns supporting panel point No. 2 of the anchor arm. The toggles in the chain of anchor bars were eased off; the jacks were then pumped up and the anchor arm was lifted until the chain of anchor bars at the anchor pier became taut. Steel shims were then driven in under the false-

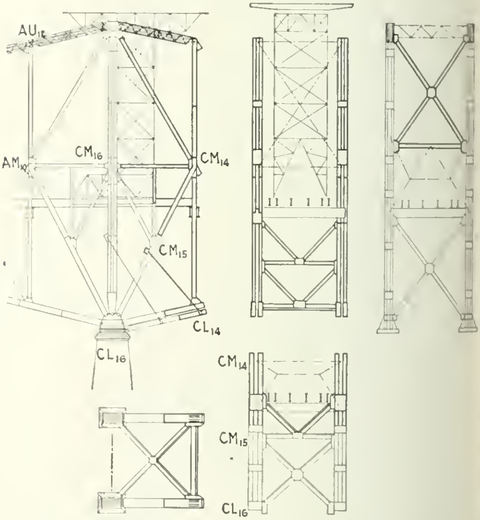


FIG. 9. TRAVELER MOVED UPON CANTILEVER

work columns at panel point No. 2. and the erection of the remaining panels of the cantilever arm proceeded.

The work of erection of the large compression members was greatly facilitated by the high degree of accuracy that had been required in the shop work. All members which were spliced together in the field were temporarily assembled in the shop and their splices reamed and matchmarked to insure a perfect fit in the field. All holes for field connections, other than field splices in main members, were drilled to a steel templet $\frac{5}{16}$ in. thick, with case-hardened thimbles $1\frac{5}{16}$ in. deep. Where it was necessary to take the pieces apart for shipping and handling, the respective pieces reamed together were natchmarked so that they could be reassembled in the ame relative position in the final setting up in the field. n the field-splicing of main members, the two portions f the members were accurately faced, assembled in the hop to exact length, and held firmly in position with ods and turnbuckles. The splice material was then laced in position and the holes finally drilled through he main and splice material.

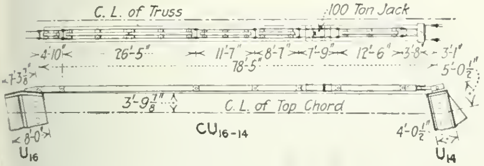


FIG. 10. ERECTION LINKS FOR TOP CHORDS

The workmanship and finish required throughout in he shop was the best that the most suitable modern mahinery and skilled labor could give. All finished measrements were made with standardized tapes lying flat nd supported at frequent intervals, firmly held at one nd, and under a tension of 10 lb. The policy of ssembling, reaming and matchmarking all members with eld splices has been found to give the best of satisfacion, even though it involved considerable extra expense n the shop. The connections in the field were made ith so little trouble and loss of time that it is considred that the extra shop cost was fully warranted.

Assembling the Suspended Span

With the completion of the south cantilever arm the ridge is in readiness for the floating in and hoisting to place of the suspended span. This span is 610 ft. ng, 88 ft. wide and weighs in the floating-in condition pproximately 5,000 tons. The greater part of the floor eel will be left off during the floating-in operation and ill be placed by means of derrick cars after the span is upled up to the ends of the cantilever arms.

The suspended span has been erected in the shallow aters of Victoria Cove, about three miles below the ridge site. The work of erection proceeded simultaneusly with that of the south cantilever arm. Foundaons for the falsework bents supporting the trusses and e approach track were prepared at the periods of low de during the season of 1915. This work was rather fficult and could not be carried on with any great speed the time available was only from two to four hours ch day. During erection, the suspended span was suported on staging placed under each panel point. The aveler which erected the north-shore cantilever and anchor arms was erected on bents immediately adjacent to the staging of the span, with the top trusses and traveling cranes left off. All the steel was handled by means of four 70-ft. 30-ton booms, placed one at each of the four corners of the traveler. After the span had been completely erected on the staging, the intermediate staging supports were removed and the span swung on the end supports.

Floating In the Span

In this condition six scows, 32 ft. wide and 160 ft. long, with 11 ft. 7 in. draft, will be floated in and placed under panel points at each end of the span. The valves in the bottom of the scows will be opened and the scows sunk until they rest on their foundation supports. The cross-girders and bracing which transfer the load of the span to the scows will then be placed. To raise the span from the end supports preparatory to floating out, the scows will be drained at low tide and the bottom valves closed; then as the tide rises the span will be lifted gradually and will be in readiness to proceed on its journey to the bridge site, if the weather and tide conditions are considered favorable. While the span is being moved to the bridge site, it will be kept under control by means of tugs of sufficient power capacity to overcome all anticipated resistances due to wind or current. Arriving at the bridge site, the span will be anchored to the ends of hanging trusses, coupled up to hanger slabs provided at each of the four corners of the cantilever arms, and raised into its final position by means of movable jacking girders and eight 1,000-ton hydraulic jacks, two at each corner.

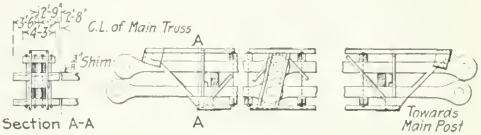


FIG. 11. PANEL OF TOP-CHORD EYE-BARS AND SUPPORTING TRUSS

The work is being carried out under the supervision of the Board of Engineers, Quebec Bridge, consisting of C. N. Monsarrat (Chairman and Chief Engineer), Ralph Modjeski and H. P. Borden. The St. Lawrence Bridge Company is the contractor for the superstructure, George H. Duggan, being Chief Engineer, George F. Porter, Engineer of Construction, W. B. Fortune, Superintendent, and S. P. Mitchell, Consulting Engineer of Erection.

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Competition of Government Engineers with engineers in private practice is agitating the engineering profession in New Zealand. At the annual meeting of the New Zealand Society of Civil Engineers a discussion on this subject is reported as follows in the "Commonwealth Engineer":

Mr. H. F. Toogood stated that the Lake Takapuna Board of Control had requisitioned the government for the services of an engineer to report on the water system. The writer expressed the opinion that the society should protest against local bodies "sponging" on the government for engineers' services. Mr. J. A. Menzies said there were county councils in Otago that employed engineers at £180 per annum and got the government to supply plans which, if the county council employed fully qualified men, would mean the employment of engineers at £300 or £400 per annum. The following resolution was carried: "That the attention of the council should be drawn to the fact that a local body has requested the government to grant the services of one of its engineers to report on a matter of engineering, and that the council be requested to take the matter into consideration with a view to taking such steps as may be necessary for the protection of engineers in private practice."

Surveying Dam Sites in the Grand Canyon

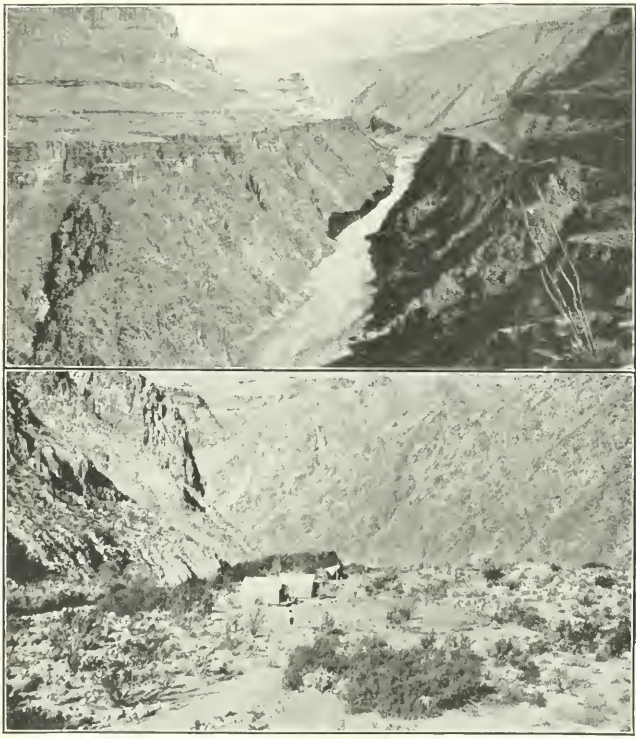
What promises to be one of the most interesting hydroelectric developments in this country has been initiated by the Grand Cañon Power Development Co., the moving spirit of which is James B. Girand, City Engineer of Phoenix, Ariz., and former Territorial Engineer of Arizona. Few engineers are more familiar with the power possibilities of the Colorado River. After many explorations and reconnoissance surveys, he obtained in 1915 from the Secretaries of the Interior and of Agriculture rights on six power sites in the Grand Cañon.

One of these sites, which has been fully explored and surveyed during the present year, is shown in the accompanying views. It is in a little-known but easily accessible part of the Grand Cañon. This is at the foot of Peach Springs wash, at the mouth of Diamond Creek. It is reached by a wagon road from Peach Springs, 21 mi. distant on the main line of the Atchison, Topeka & Santa Fe Ry., being, it is said, the only place in the Grand Cañon where a wagon may be driven to the water's edge.

The survey camp shown in one of the views was established early in the present year. Extensive topographic surveys and soundings of the river have been made. The difficulties of such surveys are more easily imagined by those familiar with Grand Cañon topography, or from the photographs, than can be described.

The sides of the cañon rise abruptly 600 or 800 ft. above the river. Then there is a shelf more or less regular, back of which are a bluff and another shelf and then another bluff. The lowest stratum is granite, and in places many great boulders of granite line the river's edge, so that there is no scarcity of construction material. There is practically no soil, and all survey stations have to be drilled into the rock.

All topography was taken by stadia, and all survey stations were established by triangulation and stadia. A base line about 200 ft. long was laid out at the mouth of the creek along the river bank, and from the ends of this base line the survey was extended for several thousand feet on either side of the river.



VIEW OF THE GRAND CAÑON OF THE COLORADO; SURVEYORS' CAMP AT DIAMOND CREEK

DAM SITE AT DIAMOND CREEK IN THE GRAND CAÑON OF THE COLORADO

The Colorado River has a mean monthly discharge of about 30,000 sec.-ft. The total fall embraced in the six proposed dam sites is approximately 600 ft. The original project was to build six 100-ft. dams of the overflow type and to utilize the entire fall of the river. The average fall here is about 5.9 ft. per mi. The site shown, however, is such an excellent one that plans have been prepared for a 250-ft. dam at this place.

The bedrock of the river bottom is here only 25 ft. below mean low water. There is no silt on the river bottom, but there is plenty in the water itself, which has literally the color of sand. On account of the grade and the section, the cañon of course provides little storage capacity; but it is intended to develop only the normal flow of the river, so that silting up of the reservoirs behind the dams would be no detriment.

Construction work could be carried on at seasons of low water when the flow of the river could be diverted through a tunnel, to be later used for the power-plant intake. The present wagon road may be made passable for motor trucks, or it is possible a railway will be built to the dam site. Diamond Creek furnishes a water-supply for camp and construction purposes.

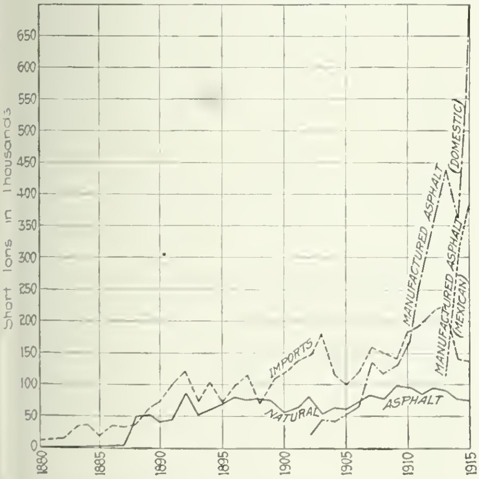
The Peach Springs dam site is about 80 mi., in a straight line, below Grand Cañon, where the Santa Fe Ry.'s Hotel El Tovar is located. At the river's edge the topography is much the same as it is at the foot of the famous Bright Angel Trail.

Increasing Use of Asphalt

The tremendous increase in the production of asphalt from the time it began to be used to any great extent for street paving to the end of the year 1915 is shown in the recent Bulletin II:13 of the United States Geological Survey. The total production in 1882 was 3,000 tons, valued at $10,500 ($3.50 a ton), and in 1915 the amount was 1,266,824 short tons, valued at $9,652,866 ($7.63 a ton). The production has thus increased several hundred-fold, and the value per ton has more than doubled.

The accompanying diagram shows the production differentiated into natural asphalt, imported asphalt, that manufactured from domestic petroleum and that manufactured from Mexican petroleum. The enormous increase in the manufactured asphalts is apparent, but this includes (in 1915) nearly half a million tons of asphaltic road oil.

The number of plants supplying manufactured asphalt n the United States in 1915 was 39, of which 28 utilzed exclusively domestic petroleums and 9 exclusively Mexican petroleums, while 2 utilized petroleums from both sources. The manufactured asphalts did not become factor until 1902.



MARKETED PRODUCTION OF ASPHALT, 1880 TO 1915 INCLUSIVE

The European War has adversely affected the asphalt production of Trinidad and Venezuela, because European demand for Trinidad asphalt formerly averaged about the same as that of the United States; but during 1915 the European demand fell off 57,000 long tons. This decrease was, however, largely made up by an increased demand in the United States.

There are still large undeveloped deposits of asphalt in Cuba, and during the last year the bituminous sands of northern Alberta, in Canada, have been used successfully for pavements.

Recommended Pavements for Boston Streets

A committee of engineers appointed by the Mayor of Boston, Mass, to make recommendations as to the policy to be followed in repaving the city's streets reported on June 15. The report consists of two typewritten pages. The major part of it follows:

> The types of surfacing recommended for the various classes of streets are:
>
> Class 1. Heavy traffic streets—Granite blocks laid on portland-cement concrete base not less than 6 in. in thickness, the joints to be filled with portland cement grout; in the case of excessive grades, pitch to be substituted for grout in the upper inch or so of the joints in order to provide better foothold for horses.
>
> Class 2. Main arteries—The same type of pavement as Class 1, with a few exceptions where the surroundings require a smoother and less noisy surface, such as wood blocks or the best grades of bituminous pavements.
>
> Class 3. Retail shopping and office building districts—Treated wood-block pavements, the best grades of bituminous pavements on a portland-cement concrete base. At the present time the only wood recommended for wood-block pavements is long-leaf yellow pine.
>
> Class 4. Residential districts in the city proper—Treated wood-block pavements, the best grade of bituminous pavements or portland-cement concrete pavements; the choice to be determined by the intensity and character of the traffic.
>
> Class 5. Suburb and residential districts—Cheaper types of bituminous pavements, using old macadam surfaces for the base where suitable, or portland-cement concrete pavements.
>
> Class 6. Park roads carrying only pleasure traffic—Bituminous pavements using old macadam for the base where suitable, or portland-cement concrete pavements.

The committee deemed it inadvisable and unnecessary to prepare new specifications for the pavements recommended in view of the fact that most excellent specifications have been carefully prepared after thorough discussions by experts, and adopted by organizations of high standing. It was recommended that paving work done by the city and the provisions and requirements of any guarantees relating to such work should conform substantially to specifications adopted by the American Society of Municipal Improvements for granite block, wood block and bituminous pavements; for portland-cement concrete surfaces the work should conform substantially to the standard specifications of the American Concrete Institute.

The committee were: James H. Sullivan, division engineer, Public Works Department; H. J. Hughes, professor of civil engineering at Harvard University; G. C. Emerson, consulting engineer, Boston Finance Commission; John R. Rablin, chief engineer of the Metropolitan Park Commission, and A. W. Dean, chief engineer of the Massachusetts Highway Commission.

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The Changes in Incandescent Electric Lamps are indicated in a report presented at the recent annual meeting of the National Electric Light Association, at Chicago. The total number of lamps sold for domestic purposes in 1915 was about 110,000,000 of which 78.89% were tungsten-filament lamps, with "Gem" lamps (metallized-carbon filament) 15.68% and carbon lamps only 5.43%. The tantalum lamp has disappeared during the past two years.

Engineering Literature

Retaining Walls and Bins

EARTH PRESSURE, RETAINING WALLS AND BINS—By William Cain, M. Am. Soc. C. E., Professor of Mathematics, University of North Carolina. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 287; 99 illustrations. $2.50 net.

REVIEWED BY EDWARD GODFREY*

The author first takes up the theories of earth pressures, treating the fill behind a wall as a mass with a small cohesion. He next develops the theory of earth pressure, considering the earth as a noncohesive granular mass. Coming to retaining walls, he emphasizes the features of design that must be considered for stability and safety. Returning to the theory of earth pressures, the bracing of trench lagging and the pressures on tunnels are discussed. The sixth chapter takes up grain and coal bins and finds their theoretical stresses and pressures. An appendix of about 35 pages is chiefly a theoretic treatment of wedge-shaped reinforced-concrete beams. A second appendix, of four pages, is devoted to experiments on model retaining walls. The book contains useful tabular data, such as the coefficients of friction and angles of slope of various substances.

The author again proves himself a master of the theories of engineering mechanics. Some sound principles of reinforced-concrete design are enunciated, such as the need of easy curves (or the error of sharp bends) in rods under high stress (25 diameters of the rod for the radius of curve), the need of ample area in bearing for anchoring pieces, the need of proper anchorage for tension rods, as in the counterfort of a retaining wall. The latter point is nullified, however, by the sample design; for while the text on page 163 apologizes for the lack of proper anchorage if simple rods are embedded 10 in. in a wall, the figure on page 165 shows just this. The author points out the necessity of improvement in the matter of this anchorage and suggests the use of punched vertical steel angles, but he does not show this in his figure and thus depart from standard, illogical design.

This treatment of the counterforted retaining wall appears to be an attempt to justify some existing design, as the figure departs so radically from the theory of such walls as developed by the author. Take, for example, the vertical slab. This is reinforced all the way from top to bottom with continuous rods near both front and back face, with equal area of steel. His theory shows only an outward load, which would require only one-half of this reinforcement. Similarly, the base slab is reinforced near both top and bottom all the way and even under the vertical wall, where no bending could possibly exist; the rest of the slab could have only one sign of bending moment.

Professor Cain calls the counterfort a triangular beam. He applies the intricate theory, to which he devotes 35 pages in his appendix, to the solution of this beam. Then he finds that the design is all the way to 50% too strong; this does not show much confidence in the theory nor a need of one so complex.

The reviewer pointed out a number of years ago that the counterfort of a retaining wall is not a beam, but merely the concrete covering of tie-rods connecting the vertical slab and the horizontal slab. Professor Cain considers this counterfort as a beam, though in his solution he ignores one great force—namely, the shear—applied externally along the front edge, adjacent to the vertical slab.

The author has carried standard nomenclature to an extreme, scattering the values through the volume, a thing very annoying to the user of the book who has not time to make a week's study. For example, to use the tables of retaining walls on page 116 one must refer to page 107 for several of the values; page 89 tells the meaning of K; page 94, of K_1; page 22, Fig. 6, of a; on page 113 one can learn the meaning of A, by reading the text and guessing it; on page 110 one learns that the wall is 1 ft. high. Would it not be better for an author to use the first letters that come into his head for these values and explain their meaning close to the table, so that the user, who has not time to read or review the whole book, may readily get their meaning?

The pressure of earth that is found in nature (not dry sifted and washed sand of laboratory experiments) is so variable and unknowable that fine theories seem ridiculous. Most fills will stand against a board fence until frost or a heavy rain exerts forces not in the theory at all. But the same stability that will resist frost and a lubricated wedge of mud will be supplied if the fill be considered a liquid of a weight say one-sixth, or one-quarter, or some other fraction of the actual weight of the fill. In fact, this fraction can be selected or computed to give practically identical results with the fine-spun theory, and the equivalent fluid-pressure method is immensely easier of application. As a trial, the reviewer worked out the forces for the coal bin on page 227 by the simple method. They were near enough to those found by Professor Cain to give identical results in the design.

On page 127 a section of a retaining wall cut from point A downward to the right does not touch any steel, though this section is under heavy bending stress. The same is true of the figure on page 140. The reviewer has publicly pointed out many times this common blunder in the design of L- and T-shaped retaining walls.

On page 163 the author speaks of the little rods in a counterfort "acting like stirrups in resisting diagonal tension." Until some champion arises who can explain how stirrups perform this office it would be better to use anchored diagonal rods, whose action is quite simple and positive.

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Many public-service commissions furnish newspapers with authentic but unofficial typewritten abstracts of their various important activities, but the Illinois Commission appears to be the first with an official printed monthly bulletin intended for general distribution. No. 1 appeared under date of Apr. 1. Besides notes on important cases finished, there is a complete list of orders entered.

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*Structural Engineer, Robert W. Hunt & Co., Pittsburgh, Penn.

Steel Heat Treatment

STEEL AND ITS HEAT TREATMENT—By Denison K. Bullens, Consulting Metallurgist. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. vii + 431; 223 illustrations. $3.75 net.

Reviewed by C. J. Yarnall*

The heat treating of steel has developed so rapidly in the past few years that the small as well as the large manufacturer has found it necessary to install a special department, equipped with competent men and appliances for the treatment of material and the careful checking of temperatures. The steel trade has demanded a steel with a high efficiency, to withstand constant vibration and shock and at the same time keep the section down to a minimum, to reduce not only the cost, but the weight.

Heat treating meets this requirement. High- as well as low-grade steels will give a higher ultimate strength, better ductility and a finer molecular structure after being intelligently treated than in their normal condition, as is proved by the book under review. The book is profusely illustrated, and the various points in the manufacture and treating of steel are ably portrayed by the writer. A collection of valuable information is found between its covers, not only to the professional man, but to the ayman as well.

Beginning with the low-carbon steels and gradually working into the high-carbon and alloy steels, critical ranges are given, methods of quenching and temperatures for the drawback, construction of furnaces, etc.

Modern requirements demand some very large solid orgings on which it would be interesting to have data. This book deals lightly with anything larger than a car or locomotive axle, but as a whole it is valuable.

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Gas-Engine Ignition

GAS-ENGINE IGNITION—Prepared in the Extension Division of the University of Wisconsin by Earle B. Norris, M. E., Associate Professor of Mechanical Engineering; Robert K. Winning, B.S., Assistant Professor of Electrical Engineering, and William C. Weaver, B.S., Research Engineer, Western Electric Co.; formerly Instructor in Electrical Engineering. New York: McGraw-Hill Book Co. [Engineering Education Series.] Cloth; 6x9 in.; pp. ix + 174; 209 illustrations. $1.50 net.

Few engineers realize the development reached in he art of firing fuel charges in internal-combustion ngines—for indeed it is a distinct line of effort in hich apparatus designed and manufactured by a few pecialists is used by the great army of engine manuacturers the country over. This book will acquaint any ntelligent man with this field, be he graduate engineer r factory employee. The text evidently has been very arefully prepared with a view to home study, and is orthy of the stamp it bears "prepared in the Extension Division of the University of Wisconsin."

The older schemes like hot-tube ignition are quickly assed over to get at the various electric-spark systems, hich are grouped under such main topics as jump-spark attery equipment, low-tension magnetos, high-tension magnetos and direct-current machines. The chapter rouping is split up into smaller complete elements, owever, for promoting study. Great attention is paid o the details of various commercial magnetos and their nterrupters and spark distributors. There are a few hapters on such elementary matters as batteries, generaion of electromotive force, direct and alternating curents.

Panama Canal Construction

THE CONSTRUCTION OF THE PANAMA CANAL—By William L Sibert, Brigadier-General, U. S. A., formerly Member of the Isthmian Canal Commission and in charge of the building of the Gatun locks and dam and of the channel from Gatun to the Atlantic Ocean, and John F. Stevens, formerly Chief Engineer and Member of the Isthmian Canal Commission. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. x + 339; 23 illustrations. $2 net.

THE PANAMA CANAL: An Engineering Treatise—Prepared by engineers and other specialists in charge of the various branches of the work and presented at the International Engineering Congress, San Francisco, Calif., 1915; under the direction of George W. Goethals, M. Am. Soc. C. E., Major-General, U. S. A., Governor of the Canal Zone, formerly Chairman and Chief Engineer, Isthmian Canal Commission. A series of papers covering in full detail the technical problems involved in the construction of the Panama Canal—geology, climatology, municipal engineering, dredging, hydraulics, power plants, etc. In two volumes. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 527 and 483; numerous text illustrations and folding plates. $7.50 per set.

In writing a book on the Panama Canal the puzzle is to know what to put in and what to leave out. Within the limits of the single modest volume by General Sibert and Mr. Stevens no very complete story of the canal work was of course possible. What the authors have done is to give a sort of birdseye view of the work of construction, presenting the facts and figures which are of most general interest.

General Sibert is the author of the introductory chapter containing a rapid sketch of the changes in personnel of the canal's working force, from the appointment of the first canal commission on Mar. 3, 1904. Former Chief Engineer Stevens contributes the following six chapters, which cover the preparatory period from the beginning of operations in 1904 to the transfer of the task to the army engineers in March, 1907. Mr. Stevens uses much of his space to review the controversy over the question whether the canal should be built at sea level or with locks and then describes the important preliminary work, such as the rebuilding of the Panama R.R., the development of working plans and the assembling, control, housing and feeding of the labor forces. General Sibert is the author of the remaining chapters, which cover the period from March, 1907, to April, 1914. His chapter on the construction of Gatun dam is especially noteworthy, as there are a number of events in connection with the building of this greatest of hydraulic-fill dams which have not been generally known and which General Sibert here puts on record.

The publishers of the book have shown poor judgment in issuing it with uncut edges, so that the reader has to use a paper cutter continually. A book of this sort, to be read by busy men, should never be issued in such form.

The papers on the Panama Canal which were presented at the International Engineering Congress held at San Francisco in September last have been printed in two volumes. By a special arrangement with the managers of the congress, the two volumes (which are distributed free to those engineers who originally became members of the congress and made the selection of these volumes as their choice of the publications) are now made available to others.

Most of the numerous books which have been published on the Panama Canal have given comparatively little attention to the technical engineering features. This publication is therefore the first complete technical account of the engineering work of the Panama Canal. There are in the two volumes 25 different papers, and the authors include most of the leading engineers who were responsible for the design and execution of the work. The introduction is by General Goethals, who contributes also paper No. 10—on the dry excavation of the canal—a chapter which would of course have been written by the late Colonel Gaillard, except for his untimely death.

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*Chief Mill Inspector, Board of Engineers, Quebec Bridge, 00 Mifflin Ave., Wilkinsburg, Penn.

The titles and authors of a few of the chapters will give an idea of the scope of the work: Dr. Emory R. Johnson discusses the commercial and trade aspects of the canal; Canal Zone geology is treated by Donald S. Macdonald; sanitation by Charles F. Mason; municipal engineering by Henry W. Durham and George M. Wells; the purchase of supplies for the canal is described by Major Boggs. The Gatun locks, dam and spillway are described by General Sibert, and the corresponding works on the Pacific division by S. F. Williamson. Papers on the locks and different features connected with them are contributed by General Hodges, L. D. Cornish, Henry Goldmark and R. H. Whitehead. Admiral Rousseau describes the terminal works, dry docks and wharves, and F. H. Cooke the coaling plants and floating cranes.

It is of great value to have the technical data accumulated in the Panama Canal work made available to the profession. These books should certainly find a place in every engineering reference library.

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World Doings in 1915

THE NEW INTERNATIONAL YEAR BOOK: A Compendium of the World's Progress for the Year 1915—Editor, Frank Moore Colby, M. A.; Associate Editors, Allen Leon Churchill and Horatio S. Krans, Ph.D. New York: Dodd, Mead & Co. Cloth; 7x10 in.; pp. 752; illustrated. $5 net.

THE AMERICAN YEAR BOOK: A Record of Events and Progress, 1915—Edited by Francis G. Wickware, with Coöperation of a Supervisory Board Representing National Learned Societies. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. 862. $3.50.

Each of these excellent annuals follows the general plan of former years. The "International" is "an encyclopedia of the year, with the titles arranged in a single alphabet." The "American" presents its material under thirty-three department heads, such as "American History," "Municipal Government," "Manufactures," "Engineering," "Literature and Language," with many subheads under each department—the whole followed by a long, detailed index. As the titles imply, the "International" is broader in general scope than the "American," but the departmental plan of the "American" enables it to present summary reviews of a whole scientific or other field of knowledge. Each plan has its advantages and it is fortunate that with two such good yearbooks in the field different plans are employed. The engineering articles are a feature of each annual. The "International" alone has illustrations. Both contain much statistical matter.

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Descriptive Geometry

PRACTICAL DESCRIPTIVE GEOMETRY—By William Griswold Smith, M E., Assistant Professor of Descriptive Geometry and Kinematics, Armour Institute of Technology. Second edition, revised, enlarged and reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. x + 256; 187 illustrations. $2 net.

Taking advantage of suggestions received from various users of the first edition since the book was published in 1912, the author, according to his preface, has made a number of changes in the present edition, the most important of which he states as follows:

1. The division into more chapters.
2. A more logical sequence of certain portions of the text.
3. The notation of points and planes.
4. Graphic layout for exercises
5. More exercises of a practical nature, embracing more lines of engineering endeavor.
6. Number of new solutions, utilizing auxiliary planes more frequently.
7. A better system of perspective drawing.
8. A chapter on the intersection of plane solids.

On weighing various suggestions (mostly from architects) as to the treatment of perspective in the new edition the author chose conical projections, a process which he says "is sane, in that it is a direct application of principles of descriptive geometry, and is easy and swift in operation."

A review of the first edition of this book appeared in *Engineering News* for Mar. 13, 1915.

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The Engineer in Fiction

THE STRANGE CASES OF MASON BRANT—By Nevil Monroe Hopkins. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 304; illustrated. $1.25 net.

Professor Hopkins, the versatile teacher-engineer of George Washington University, has produced here some very entertaining and creditable detective stories of the Conan Doyle order—with a little more emphasis on the fiendish use of science in crime. The volume contains the record of three cases in which the cunning of Mason Brant (very like Sherlock Holmes in his keen powers of observation and deduction) unravels a murder mystery and clears the name of a beautiful girl—for some one else to woo and win.

The last tale while the most successful as a detective yarn also possesses a certain charm, at least for ardent young engineers, with its depicting of fateful circumstances that repeatedly threw together a winsome miss and a wholesome boy just out of his technical school. The first meeting was when the girl's Pullman on the New Haven road stopped opposite a tower that the hero was inspecting and brought her blushingly face to face with him—and a big monkey wrench. The last meeting leads to the tender admission that the boy, about to become chief electrical engineer of the electrified New Jersey Central, has become, in the girl's words, "as deeply a part of me as the color is of the rose."

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Concrete-Road Construction

PROCEEDINGS OF SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING, Held at Chicago, Feb 15-18, 1916—Chicago (111 West Washington St.): J. P. Beck, Secretary. Paper; 6x9 in.; pp. 328; illustrated. $1

In the discussions in the conference whose proceedings are reported in this volume, this report was several times referred to as the Bible of the concrete-road engineer. No engineer interested in any way in the construction of highways or street pavements can afford to be without this report any longer than the time required to send for and receive it. The art of concrete-road construction has developed so rapidly during the past two years that none of the standard textbooks on road construction present uptodate information on this subject. The rapid advance of the concrete road in public favor and the great improvement in its quality, as a result of careful attention to such details of practice as are covered in this volume, are facts that should be known to every highway engineer.

Of course, the volume is not a treatise nor a pocketbook. The committee reports and discussions present a diversity of views on many topics, and the reader will be obliged to study carefully the opposing views and form his own conclusions.

Public Health Protection

AMERICAN PUBLIC HEALTH PROTECTION—By Henry Bixby Hemenway, A.M., M.D., author of "The Legal Principles of Public Health Administration," etc. Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 5x8 in.; pp. 283. $1.25 net.

A wide reading of this book by those interested in im-roving public-health administration, but uninformed r misinformed as to what uptodate health-protective ork is and how it can best be carried out, would be a reat benefit to the whole country. The author has a rue conception of these matters and puts his ideas in an nteresting and forcible way. His book is nontechnical.

After a sketch of the development of public-health work this and other countries and an outline of present-day ealth agencies in the United States, the author compares edical and sanitary education and shows how far the rmer falls short of meeting public-health needs. hanged social, economic and scientific conditions in eir relation to health problems are noted. There are apters on medical inspection of schools, health-depart-ent organization and the training of health officers.

As a whole, the book is notably sane, progressive and ee from apparent errors. A few sentences on sewage sposal may mislead the uninformed, chiefly as regards e Imhoff tank.

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British Sewer-Pipe Standards

RITISH STANDARD SPECIFICATION FOR SALT-GLAZED WARE PIPES—The Engineering Standards Committee; Leslie S. Robertson, M. Inst. C. E., Secretary. London, England: Crosby Lockwood & Son. Paper; 8x13 in.; pp. 10. 5s. net.

A sectional committee on vitrified pipe was appointed May, 1911, by the committee mentioned in the fore-ing title. The report was completed three years later d published in August, 1914, but by inadvertence has t been given well-deserved notice in these columns. The ctional committee was composed of thirty-three mem-rs representing the British Government, Crown Agen-s for the Colonies, the London County Council, several ties, many societies, and also pipe manufacturers. Sir aurice FitzMaurice was chairman. A draft of a stand-d specification proposed by a committee of the Institu-n of Municipal and County Engineers and another aft of specifications proposed by a committee of manu-cturers were considered in framing the specifications re presented, which have been approved by both the tional and general committees. The specifications oper fill only five pages of large open type, besides ich there is a table of joint dimensions.

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ngineers and Military Service

E ENGINEER IN WAR; With Special Reference to the Training of the Engineer to Meet the Military Obligations of Citizenship—By P. S. Bond, M. Am. Soc C. E., Major, Corps of Engineers, United States Army; Honor Graduate, Army Field Engineer School; Graduate, Army Staff College. [Reprinted, with revisions and additions, from "Engineering Record."] New York: McGraw-Hill Book Co. Flexible leather; 5x7 in.; pp. xv + 187; 70 illustrations. $1.50 net.

Books like this one of Major Bond's and the earlier e of Captain Robinson are of special interest to engi-ers at this time—forming as they do a permanent ord of lecture courses given in several cities of the ntry. Such a record is obviously better than a care-lly prepared transcript of scratch notes. The scope these courses is now so well known that the ground vered by this little volume can be stated by saying at it follows the lectures, in showing civilian engineers what military engineering comprises and how everything is subordinated to tactical considerations. The discussions open with the military policy of the United States and close with the military duties of citizenship. In between are found a few such specific topics as tools, stream crossings, roads, field fortifications, reconnaissance mapping, demolitions and camp sanitation.

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Novel Electrical Textbook

ELECTRICAL ENGINEERING FIRST COURSE—By Ernst Julius Berg, Professor of Electrical Engineering, and Walter Lyman Upson, Associate Professor of Electrical Engineering, Union College, Schenectady, N. Y. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 416; 296 illustrations. $4 net.

Teachers of electrical engineering may be surprised to hear of a text by these authors, on account of their known objections to prescribed texts. Their effort here has been to make this text a concise record of ideas that should sink in during lectures rather than a full and clear exposition, which treatment they reserve for oral presentation in the classroom.

The book contains a large number of problems, many worked out fully or in part, so that the student has an example, a record, of how an engineer attacks engineering work. There is no particular novelty in the ground covered—direct-current generators and motors coming first (with a few necessary fundamental topics), then the ballistic galvanometer, alternating-current waves, symbolic method in calculations, properties of alternating-current circuits, the wattmeter, electrostatics and finally alternating-current machinery. Mathematical expression is not spared.

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Chemists' Handbook

THE METALLURGISTS' AND CHEMISTS' HANDBOOK: A Reference Book of Tables and Data for the Student and Metallurgist—Compiled by Donald M. Liddell, Consulting Metallurgical Engineer and Sometime Managing Editor of "The Engineering and Mining Journal." New York: McGraw-Hill Book Co. Flexible leather; 4x7 in.; pp. vii + 603. $4 net.

The data presented by Mr. Liddell have been selected in part as the result of experience with readers of the *Engineering and Mining Journal* which must have promoted an intelligent and happy choice of material. There are first given tables of weights and measures, and mathematical quantities. Then there are statistics of the price and production of various metals. Physical constants of common metals, gases, chemicals, etc., are assembled in one section and followed by a summary of chemical laws and practices, and data therefor. There are also sections on sampling and assaying, ore dressing, cyanidation, general metallurgy, fuels and mechanical engineering, the latter covering such pertinent topics as belt conveyors, standard pipe fittings, ropes and chains, knots and hitches, compressed air, cost of buildings, etc.

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Some Eminent Mechanics

ENGLISH AND AMERICAN TOOL BUILDERS—By Joseph Wickham Roe, Assistant Professor of Machine Design, Sheffield Scientific School, Yale University. New Haven, Conn. Yale University Press. Cloth; 7x10 in.; pp. xv + 315; 57 illustrations. $3 net

The author has evidently been impressed with the great debt that modern industry owes to a few great mechanics, eminent tool builders, and has with this attractive volume made a formal history of their work. Only Englishmen and Americans are considered, the author holding that the French have been only ingenious adapters, the Swiss skilled operators and the Germans not developed before the important tools took shape. The book really traces the rise of tool building. Among the many men whose names stand out are Bramah, Bentham, Brunel, Maudslay, Clement, Whitworth, Nasmyth, Murray, Fox and Roberts in England, and Colt, Whitney, North, Lawrence, Stone, Howe, Hartness, Darling, Pond, Putnam, Evans, Sellers, Bement, Warner and Swasey in America.

New York Highway Guide

OFFICIAL BULLETIN FOR 1915, NEW YORK STATE COMMISSION OF HIGHWAYS—Albany, N. Y. Paper; 6x9 in.; pp. 357.

Engineers who are interested in highway construction and who may wish to visit New York and examine the state road work should by all means secure a copy of this bulletin. It is made up of tables giving for every highway in the state its number (which can also be found on the sign post at the side of the road), length in miles, width of pavement and of roadway, materials used in construction, date when the contract was let, date of acceptance of the road, year when the pavement was resurfaced, pavement at present on the road and the cost per square yard of pavement and per mile of 16-ft. highway. Other tables list the highways by counties, show the status of through state routes, status of highways under contract and awaiting contract, and contracts for repairs.

Hydrated Lime for Masonry

HYDRATED LIME; HISTORY, MANUFACTURE AND USES IN PLASTER, MORTAR, CONCRETE: A Manual for the Architect, Engineer, Contractor and Builder—By E. W. Lazell, Ph.D., M. Am. Soc. M. E. Pittsburgh, Penn. (Arrott Building): Hydrated Lime Bureau. Paper; 6x9 in.; pp. 95; illustrated.

The processes of manufacture of hydrated lime, the properties of the material and the methods of its application to various kinds of masonry work are not too well understood by engineers and contractors. This book has been prepared to supply such a need. It is particularly strong in the history of hydrated lime and the methods of its manufacture. The value of the material in its later application—that is, in making concrete more plastic and waterproof—is not so thoroughly entered into, probably because the amount of information available on these latter subjects is still quite meager.

American Steel Trade Directory

DIRECTORY OF THE IRON AND STEEL WORKS OF THE UNITED STATES AND CANADA, 1916—New York. The American Iron and Steel Institute (61 Broadway): James T. McCleary, Secretary. Cloth; 6x9 in.; pp. 437. $12.

For many years the late James M. Swank, as Secretary of the American Iron and Steel Association of Philadelphia, compiled and published annually a directory of the iron- and steel-making plants of the United States, which was a much-valued reference book. At Mr. Swank's death, the work was given up; but the need for such a volume compiled by a responsible authority has been so great that its publication has been resumed by the American Iron and Steel Institute, of which James T. McCleary is Secretary. It is eight years since the last revision of Mr. Swank's work was published. Since that time, the changes in the industry have been so many and so sweeping that the present volume is an entirely new book. In place of the geographic arrangement of former directories, most of the space in this work is taken up with a list of the properties owned by the different iron- and steel-making companies, arranged in alphabetical order. Supplementing this are four lists, each arranged geographically, of blast furnaces, steel-making plants, steel foundries and rolling mills. Then follow lists of manufacturers of twenty different classes of iron and steel products, such as billets, bars, structural shapes, wire rods, black sheets, muck bar, tool steel, rails, seamless tubes, nails, etc. By the use of a system of abbreviations, it has been possible in comparatively small space to present for each works listed a fairly complete statement of its equipment, furnaces, machinery, etc., and its annual capacity. The Iron and Steel Institute is to be congratulated on this publication.

Howe's Cast Iron and Steel

THE METALLOGRAPHY OF STEEL AND CAST IRON—By Henry Marion Howe, Professor Emeritus of Metallurgy in Columbia University. New York: McGraw-Hill Book Co. Cloth; 7x11 in.; pp. xxviii + 641; 123 text illustrations, 45 plates. $10 net.

REVIEWED BY F. N. SPELLER[*]

Professor Howe's new book is indeed a monumental treatise. It contains the results of much original work. It abounds with new hypotheses and ideas that cannot fail to stimulate the thoughtful reader. Each of the many topics considered is thoroughly treated. There are some chapters dealing with the more abstruse phases of this complex subject that the average metallurgical reader will probably pass over for the present. The text is expressed with the author's well-known clearness and purity of style.

The title seems altogether too narrow for the field covered; or, to put it in another way, the author has forced the boundaries of metallography out and laid the way open for a broader scope for this science.

A large index and 45 plates, each one averaging several good-sized microphotographs, are inserted at the back of the book. These illustrations are well prepared and clearly reproduced, but the hurried reader will probably wish that they had been scattered appropriately throughout the text.

Those who read any considerable portion of the book will undoubtedly join with the reviewer in wishing the author similar success in the preparation of the series of volumes to follow on allied subjects.

Useful Set of Rate Tables

STANDARD IMPROVED RATE TABLES for Manufacturers, Engineers, Bankers, Brokers, Contractors and Shippers—Calculated by John W. Marshall. New York: Boorum & Pease Co. Cloth; 7x9 in. $4.

The prime purpose of the rate tables is to facilitate rapid calculation of the earnings of employees. Given a man's hourly rate and the number of hours he worked, to find his total earnings is a matter of merely turning to the right page. The latter is easily done by the aid of a thumb index of hourly rates running from 10c. to 80c. For example: If a man is earning 31½c. an hour and it is desired to know what is due him for 16½ hr. work, turn to the section thumbed "32" and on the left-hand page opposite 16½ will be found $5.20. Similar tabulations are given for those paid on a weekly or a monthly basis.

These tables can be employed elsewhere than in the timekeeper's office—for instance, the cost of freight on any number of pounds or tons at a given rate can easily be computed. In short, these are rate tables, which means that whenever the rate and the quantity are known, the total cost can be determined at a glance.

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[*] Metallurgical Engineer, National Tube Co., Pittsburgh, Penn.

Novel Logarithm Tables

FIVE-FIGURE MATHEMATICAL TABLES, Consisting of Logs and Cologs of Numbers from 1 to 40,000; Illogs (Antilogs) of Numbers from 0.0000 to 0.9999; Lologs (Logs of Logs) of Numbers from 0.00100 to 1.000; Illologs (Antilologs) of Numbers from 6.0 to 0.5000, Together with an Explanatory Introduction and Numerous Examples; also, Trigonometrical Functions and Their Logs of Angles from 0° to 90° at Intervals of 1 Minute, with Subsidiary Tables —Compiled by E. Chappell, B.Sc., A. C. G. I., Assoc. M. Inst. C. E., Temporary Naval Instructor R. N., Late Lecturer in Engineering at the City and Guilds' (Engineering) College, Imperial College of Science and Technology, London, S. W. London: W. & R. Chambers. [New York: D. Van Nostrand Co.] Cloth; 6x9 in.; pp. xvi + 320. $2 net.

Special tables for exponential calculations make this ook a new appearance among logarithm tables. The uthor has computed logarithms of logarithms (loglogs), nd their inverse, or antiloglogs.

The use of these two new tables involves a peculiar ifficulty. There are two sets of anti-values for a given glog, corresponding to positive and negative values of he intermediate stage or simple log, or to numbers reater and less than 1. To meet this difficulty, the ntiloglog table is arranged in duplicate, one with the ntry figures printed in red (for anti-values below 1.0), he other with the same figures printed in black. imilarly the loglog table is printed in red for entry alues below 1.0, and in black for the remainder. The tervals of both tables are varied in striking manner suit the different conditions of accuracy and the differ- nt requirements of use.

The book also contains, besides an ordinary log table, table of cologs, which in itself is a rarity. It also as values and logarithms of the trigonometric funcons, and here the author again is iconoclastic. The ble runs 89° and gives sin, log sin, tan, log tan, sec d log sec; of course, the co-functions are read from e same figures, starting from the bottom of the page, here the complementary angles are printed.

The author is not merely original, as the foregoing oves, but he attempts to reform terminology. For ntilog" he says "illog," for "loglog" he says "lolog," d for "antiloglog" he says "illolog." These innovations not reduce the value of the tables.

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Engineering Profession

NGINEERING AS A PROFESSION—By Milo S Ketchum, C.E., Dean of the Collage of Engineering. Boulder, Colo.: University of Colorado. Bulletin No. 98. Paper; 5x8 in ; pp. 27.

In this little pamphlet are reprinted five brief papers Professor Ketchum, the titles of which are: "Why o To College?" "The Value of a Technical Education"; he Making of an Engineer"; "The Field of the ngineer"; "Opportunities of the Engineer." Professor etchum's opinions on the much discussed subject of e status of the engineering profession and its outlook r the future will doubtless be read with interest by a uch wider circle than the students for whom the articles re originally written.

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Technical-Periodical Index

IE INDUSTRIAL ARTS INDEX: Subject Index to a Selected List of Engineering and Trade Periodicals for 1915 Edited by Marion E. Potter, Louise D. Teich and Helen M. Craig Third Annual Cumulation. White Plains, N. Y.: The H. W. Wilson Co. Cloth; 7x10 in.; pp. 509.

The present is the largest and most complete of the ree annual volumes of the "Industrial Arts Index" thus r issued. This publication is rapidly gaining recogtion as the best general index of technical literature available, and deservedly so as it seems to be compiled with care and reasonable thoroughness.

The main scheme of the index is to distribute the subjects covered under many headings of restricted scope, avoiding numerous entries under broad general headings. For instance, in this volume to find an article on Imhoff tanks it is not necessary to turn to Sewage Disposal and look through a long list, but merely to look under Imhoff Tanks. In short, the scheme is to index under the key word of the title and not under the general subject heading.

Carried out understandingly, this makes the most handy kind of index for quick and ready reference; but thus to carry it out requires that the indexer have more knowledge of the article than can be had from reading the title. The writer who describes an Imhoff tank sewage-disposal works and inadvertently fails to bring Imhoff tank into the title will find his article not under Imhoff Tanks, but under Sewage Disposal. Under Imhoff Tanks he will find no cross-references to articles mainly on Imhoff tanks, which are entered under Sewage Disposal.

Again, there is always the likelihood that indexers unfamiliar with engineering practice will separate the same or similar work because it is described under different headings, which are practically synonymous. Such headings, for instance are water conduits and aqueducts. It is not unlikely that two articles on the same structure would thus be separated solely owing to a matter of taste in the one who wrote the title.

However, it is believed that these disadvantages are less serious than those of broad classifications, for the regular use of an index soon makes one so familiar with the indexer's methods as to be able readily to trace out all possible headings that are likely to contain articles bearing on the subject in question. These idiosyncrasies of every indexer, however, illustrate why no printed book index can ever serve the same purpose or be of the same value as a card index compiled by the person who uses it and who knows the subject he is indexing.

One feature particularly to be commended in the "Industrial Arts Index" is the indexing of articles under localities as well as under subjects.

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Park Engineering

PARKS AND PARK ENGINEERING By William T. Lyle, Assoc. M. Am. Soc. C. E., Professor of Municipal Engineering at Lafayette College. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. viii + 130; 38 full-page plates. $1.25 net.

Considering how much money has been expended in the acquisition and development of public parks during the last few decades, the meagerness of the printed matter on the practical aspects of park acquisition and construction is remarkable. Professor Lyle has therefore done well to expand his park lectures to students of municipal engineering and publish them in book form. Although designed primarily for young engineers engaged in park work, the author also had in mind some engineers older in years but not in experience, as well as park commissioners. He has modestly refrained from encroaching on the cherished domain of the landscape architect, but gives a few accepted landscape principles.

The book opens with a few pages on the desirability and classification of parks, how to set the getting of them in motion, and the necessary topographical and hydrographical surveys. The author next considers the design of underdrains, sewers, paths, drives and other engineering features. The choice between day labor and contract work, together with contract letting and supervision, is next taken up. Finally there is a chapter on construction.

The book fulfills the author's purpose so well that it is to be hoped he will soon have an opportunity to enlarge it, particularly along lines of engineering design and construction that have been modified to meet park-work needs.

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Gas Engineering Practice

PROCEEDINGS OF THE INTERNATIONAL GAS CONGRESS Held at San Francisco, Calif., Sept. 27-Oct. 2, 1915. New York (29 W. 39th St.): George G. Ramsdell, Secretary. Cloth; 6x9 in.; pp. 670; illustrated.

Like most of the other congresses held in San Francisco last fall, the International Gas Congress was international chiefly in name. It did bring together, however, a notable assemblage of the leading gas engineers of the United States, and the papers presented form a summary of uptodate practice in gas engineering. Notwithstanding the fact that many gas companies are controlled by electric lighting interests, the "Proceedings" of the Congress indicate that gas is being actively pushed as an illuminant in competition with electricity. Besides the technical papers, considerable attention was given in the Congress to the discussion of the relations of the companies to the public and to regulating bodies.

⁂

Commission-Manager Charter

A MODEL CITY CHARTER AND MUNICIPAL HOME RULE, as Prepared by the Committee on Municipal Program of the National Municipal League (North American Building, Philadelphia, Penn.) Paper; 6x9 in.; pp. 59. 50c.

As far back as 1900 a committee of the National Municipal League, after several years of work, completed and the league adopted a model city charter of the so-called Federal type. It provided for a mayor and city council, with all legislative powers vested in the latter and executive powers in the former. Shortly after the model charter of 1900 was adopted, the Galveston storm and flood ushered in the commission plan of city government; and strangely enough, a dozen years or so later the Dayton flood, while not initiating the commission-manager plan, did bring it prominently to the front.

About the time of the adoption of the Dayton charter the National Municipal League created a new Municipal Program Committee, of which M. N. Baker, of the editorial staff of *Engineering News* was a member. That committee has drawn up a new model city charter providing for the commission-manager plan of government and giving prominence also to municipal home rule.

The new model charter follows pretty closely in its general features the now fairly familiar type of commission-manager charter as exemplified at Dayton and elsewhere. Great care has also been given to the section on "Municipal Franchises," and a short section on "City Planning," drafted by Mr. Baker, has been added.

⁂

Power Test Committee Rules

RULES FOR CONDUCTING PERFORMANCE TESTS OF POWER-PLANT APPARATUS—Report of Power Test Committee. New York (29 West 39th St.): American Society of Mechanical Engineers. Paper; 6x9 in.; pp. 215; 27 illustrations.

The Power Test Committee of the American Society of Mechanical Engineers was appointed in 1909 to revise the old codes of the society relating to tests of boilers, pumping engines and other power apparatus, and to extend the code to apply to new forms of power apparatus, including water power. The committee consisted of George H. Barrus, D. S. Jacobus, William Kent, Albert C. Wood, Edward F. Miller, L. P. Breckenridge, Arthur West and Edward T. Adams. It presented a preliminary report in December, 1912. This report was widely distributed, received extended discussion and criticism and has now been finally revised. The code covers tests of boilers, reciprocating steam engines, steam turbines, pumping machinery, compressors, blowers and fans, complete steam-power plants, locomotives, gas producers, gas and oil engines and waterwheels. Besides the code proper, appendices covering some 50 pages discuss special subjects in connection with power-plant testing. The council of the society on Dec. 7, 1915, voted to appoint a permanent committee to interpret this code when called upon to do so, make revisions when found desirable and modify the rules to meet new conditions as they may arise in the future.

⁂

Detailed studies of the rainfall records of a single city, designed primarily for engineers, are not so common but what a hearty welcome will be accorded to a couple of thin pamphlets under the title, "Rainfall Data of Berkeley, California" (University of California Publications in Engineering, Vol. 1, No. 5 and No. 6, pp. 69-81 and 83-116). The first pamphlet, by W. G. Reed, gives monthly, seasonal and intensity figures for the period 1887 to 1914. The second pamphlet, by Mr. Reed and Marshall K. White, summarizes intensity studies based on the records of the recording rain-gage of the Engineering Department of the University from 1911 to 1915.

⁂

Maps of the United States for 1, 5 and 15c. each, according to size and detail, with reductions for wholesale orders, are offered by the United States Geological Survey, Washington, D. C. By a recent ruling, postmasters are now permitted to handle Geological Survey maps and are allowed a small commission on their sales. This will doubtless prove to be a great convenience to many, particularly in the smaller places of the country.

⁂

The surprising amount of information that can be got together on what at first might appear to be a minor detail of engineering practice is illustrated by a hundred-page pamphlet entitled "Highway Bridge Floors," recently reprinted from Vol. 31 of the "Proceedings" of the Engineers' Society of Western Pennsylvania. The pamphlet consists of a lengthy paper read before the society on Nov. 9, 1915, by Charles M. Spofford, Professor of Civil Engineering, Massachusetts Institute of Technology, followed by considerable discussion by members of the society named. Drawings and halftone views illustrate the paper.

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A card-index form to announce newly published books is being used by John Wiley & Sons. The date of publication appears on the top of the card, followed by the surname of the author and the title of the book as a catchline. The full name and title of the author follow, together with the size and price of the book and a brief summary or description of its contents. On the reverse side of the card a complete table of contents is given. Of course, the name and address of the publisher are also made known. These cards may be filed under the name of either the author or the book and may serve as a reminder of possible books to be purchased, or they may form the nucleus of a card catalog.

⁂

Two recent pamphlet reprints from the "Journal of Agricultural Research" of the United States Department of Agriculture are of unusual interest to hydraulic engineers. One (Vol. 5, No. 24) describes a new irrigation meter consisting of a self-cleaning weir, easily built and operated and accurate. The velocity of entering water increases until it passes the weir notch; the box has only a quarter the depth for a full contraction weir. The second booklet (Vol. 5, No. 23) shows the results of an nvestigation into the Francis and Cipoletti formulas for he small weir sizes used in irrigation service. Briefly ummarized, the older formulas give results within 1½% (Cipoletti) and 2% (Francis) of actual discharges; new ormulas are deduced that agree more closely.

⁂

As a possible guide for the city- and town-planning oards required by law in Massachusetts, "A Schedule f Civic Surveys" has been prepared by Arthur C. Comey, member of the Homestead Commission, and is being listributed by the commission (N. F. Sterling, Secreary, State House, Boston, Mass.). The main divisions f the schedule are as follows: (1) Underlying factors, ncluding physical conditions or sources and use of land; 2) circulation, including streets, transportation, utilities, ood supply and disposal; (3) public affairs, embracing dministration of health, education and recreation; (4) ocial conditions, including housing, work, welfare and uisances; (5) finances and law. The bulletin contains me commendable suggestions regarding the maps that ould be provided in connection with a civic survey.

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The work of the United States Lighthouse Service is o little appreciated by either the general or the engieering public. The service is well organized and is rrying out in admirable fashion the guarding of the asts, large lakes and rivers of the United States. For e benefit of those who are anxious to learn the details f the Lighthouse Service work a book entitled "United tates Lighthouse Service" has been published by the epartment of Commerce. (Superintendent of Docuents, Washington, D. C.; 15c.)

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or mphlets listed in these columns is given in each entry. If e book or pamphlet is for sale and the price is known by e editor, the price is stated in each entry. Where no price given it does not necessarily follow that the book or pamhlet can be obtained without cost. Many, but not all, of the mphlets, however, can be secured without cost, at least by closing postage. Persons who are in doubt as to the means be pursued to obtain copies of the publications listed in ese columns should apply for information to the stated pubsher, or in case of books or papers privately printed, then the author or other person indicated in the notice.]

HE ALASKAN MINING INDUSTRY IN 1915—By Alfred H. Brooks. Bulletin 642-A, United States Geological Survey. Washington, D. C. Paper; 6x9 in., pp. 71.

RRECTION OF ECHOES AND REVERBERATION IN THE AUDITORIUM, UNIVERSITY OF ILLINOIS—By F. R. Watson and James M. White. Urbana, Ill.: Engineering Experiment Station, University of Illinois. Bulletin No. 87. Paper; 6x9 in.; pp. 20; illustrated. 15c.

Besides the subject matter mentioned in the title this mphlet contains an extension of the bibliography printed in ulletin 73 of this series, entitled "Acoustics of Auditoriums."

EXCERPTS FROM THE FIRE PREVENTION LAWS AND ORGANIZATIONS OF EASTERN CITIES with Recommendations for Establishing a San Francisco Bureau of Fire Prevention (From Report by Heller & Wilson, Consulting Engineers.) San Francisco: Board of Fire Commissioners. Paper: 8x11 in.; pp. 36.

THE EXTENT TO WHICH SEWAGE CAN BE PURIFIED BY PRACTICAL METHODS OF ARTIFICIAL TREATMENT NOW IN USE—Reprinted from the Proceedings of the Engineers' Society of Western Pennsylvania, Vol. 32, pp. 226-270. By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, Boston, Mass. Paper; 6x9 in.; illustrated.

FUNDAMENTALS OF A COST SYSTEM FOR MANUFACTURERS—Washington, D. C.: Federal Trade Commission. Paper: 6x9 in.; pp. 31.

HANDBOOK FOR HIGHWAY ENGINEERS: Containing Information Ordinarily Used in the Design and Construction of Roads Warranting an Expenditure of $5,000 to $30,000 per Mile Part I. Principles of Design. Part II. Practice of Design and Construction—By Wilson G. Harger, C. E., First Assistant Engineer, New York State Department of Highways, and Edmund A. Bonney, Supervising Engineer, New York State Department of Highways. Second edition entirely revised and enlarged. New York: McGraw-Hill Book Co., Inc London: Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C. Leather; 4x7 in.; pp. 609; illustrated. $3 net.

HOW TO BUILD UP FURNACE EFFICIENCY: A Handbook of Fuel Economy—By Joseph W. Hays, author of "The Chemistry of Combustion," "Combustion and Smokeless Furnaces," etc. Tenth edition, revised and enlarged. Rogers Park, Chicago: Jos. W. Hays. Paper; 5x8 in.; pp. 154; $1.

HYDRAULIC FLOW REVIEWED: A Book of Reference of Standard Experiments on Pipes, Channels, Notches, Weirs and Circular Orifices, Together with New Formulas relating Thereto—By Alfred A. Barnes, A. C. G. I. New York: Spon & Chamberlain. Cloth; 6x10 in.; pp. 158; Illustrated with frontispiece and 2 folding plates. $4.50.

THE LEGACY OF THE EXPOSITION—Interpretation of the Intellectual and Moral Heritage left to Mankind by the World Celebration at San Francisco in 1915. San Francisco: The Panama-Pacific International Exposition. Cardboard; 7x10 in.; pp. 187.

Numerous short laudatory letters, alphabetically arranged, the publication of which suggests that the authorities were at their wits' end to know what to do with surplus funds or else were quite carried away with so many songs of praise.

THE MELTING OF SNOW—By Robert E. Horton. (Reprinted from Monthly Weather Review, December, 1915, 43: 599-605.) Washington, D. C.: United States Department of Agriculture, Weather Bureau. Paper; 9x12 in.; pp. 7; illustrated.

PROCEEDINGS OF THE THIRTEENTH ANNUAL CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION Held at Pittsburgh, Penn., Feb. 28 to Mar. 3, 1916, together with Reports of the Executive Secretary and Treasurer Presented at the Annual Meeting, Feb. 4, 1916; List of Members, etc., New York: American Road Builders' Association. Paper; 6x9 in.; pp. 263.

PUBLIC SERVICE COMMISSION, SECOND DISTRICT, STATE OF NEW YORK—Annual Report for the Year Ended Dec. 31, 1914. Vol. III. Albany, N. Y. Cloth; 10x12 in.; pp. 325.

PUBLIC WORKS DEPARTMENT, MADRAS PRESIDENCY—Administration Report for the Year 1914-1915. Part II. Irrigation. Madras: Superintendent, Government Press Cardboard; 8x13 in.; pp. 270; diagrams. 5s.

QUESTIONS AND ANSWERS RELATING TO MODERN AUTOMOBILE DESIGN, CONSTRUCTION, DRIVING AND REPAIR: A Practical Treatise Consisting of Thirty-Nine Lessons in the Form of Questions and Answers Written with Special Reference to the Requirements of the Nontechnical Reader Desiring Easily Understood Explanatory Matter Relating to All Branches of Automobiling—By Victor W. Page, M. E. New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 701; 387 illustrations. $1.50.

Includes all latest 1916 developments, with complete discussion of electric starting and lighting systems.

THE REMOVAL OF IRON FROM MUNICIPAL WATER SUPPLIES—By James W. Schwab. Engineering Bulletin No. 7. Bulletin No. 1, Division of State Chemical Research. Lawrence, Kan.: University of Kansas. Paper; 6x9 in.; pp. 41; illustrated.

THE SLIDE RULE: A Practical Manual—By Charles N. Pickworth, editor of "The Mechanical World"; author of "Logarithms for Beginners." Fourteenth edition. New York: D. Van Nostrand Co. Linen; 5x7 in.; pp. 124; illustrated; $1 net.

STRAIGHT AMERICA: A Call to National Service—By Frances A. Kellor. New York: The Macmillan Co. Cardboard; 4x7 in ; pp. 193

STRENGTH AND OTHER PROPERTIES OF CONCRETES AS AFFECTED BY MATERIALS AND METHODS OF PREPARATION—By R. J. Wig, Engineer Physicist, G. M. Williams, Assistant Engineer Physicist, and E. R. Gates, Assistant Physicist. Technologic Papers of the Bureau of Standards, No. 58. Washington, D. C Paper; 7x10 in.; pp. 172; illustrated

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA—By Charles Proteus Steinmetz, A. M., Ph. D. Fifth edition thoroughly revised and entirely reset. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C. Cloth; 6x10 in.; pp. 180; illustrated. $4 net.

WATER RESOURCES OF SAN DIEGO COUNTY—Report of the Water Committee to the Board of Directors of the San Diego Chamber of Commerce, May 15, 1916 (C. S. Alverson, Hydraulic Engineer). Paper, 4x6 in.; pp. 46.

Field and Office

Demolishing Old Steel Bridge and Handling Heavy Girders

By Smith O. Steere*

The demolition of an old three-span 400-ft. lenticular truss bridge across the Allegheny River at Main St. in Salamanca, N. Y., was accomplished by the Owego Bridge Co., of Owego, N. Y., as follows: Falsework of 8x8-in. hemlock timber and swaybracing was erected under each of the three spans of the old bridge. Then, beginning at the south bank, each truss was slightly jacked up and blocked so that it rested on the falsework. The procedure then consisted in disconnecting the members of the truss by hand-cutting of the rivets, commencing with the top swaybracing, the top chord members and the diagonal and vertical members of the trusses, and lowering them one by one with a stiff-leg derrick to waiting trucks. This was continued until all of the superstructure above the floor was removed. The flooring, old car tracks, stringers, floor-beams and lower-chord members were then removed, beginning at the north shore span and proceeding toward the storage piles back from the south shore. It required 22 working days to demolish the old bridge, at an approximate cost of $3 per lin.ft. of bridge.

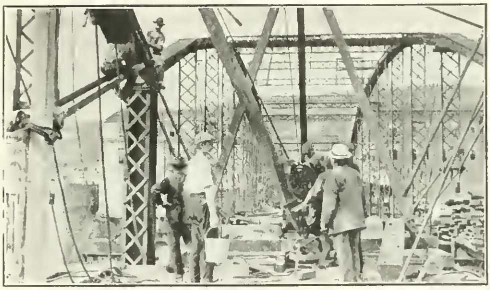


FIG. 1. HAND DERRICK TAKING DOWN MEMBERS OF OLD TRUSSES, SALAMANCA BRIDGE

The three stone river piers of the old bridge were razed to low-water mark by drilling and breaking the stone into man-size pieces. A portion of these stones was used in the concrete, while the rest was wasted at the upstream end and along the sides of the piers.

The new bridge is a plate-girder cantilever bridge of five spans varying from 74 to 92 ft. long. The large cantilever girders, 116 ft. long and weighing 26 tons, were delivered at the railroad station ½ mi. south of the bridge on three flat-cars, one middle spacing car, and two end supporting cars. The girders, mounted on triangular shipping frames, were raised from the cars and then lowered to greased rails resting on timber blocking. Jacks placed near each end of the girders forced them sidewise over the rails to additional timber blocking, whence they were lowered to the heavy beam trucks. Mounted on these beam trucks, they were snubbed to the bridge site and out over falsework, where again they were blocked up, the beam trucks removed, and then lowered and placed in their respective positions over the piers.

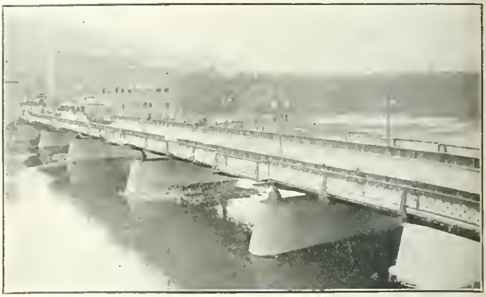


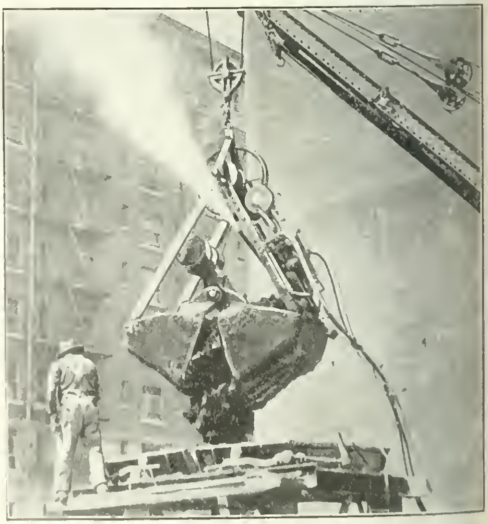
FIG. 2. NEW PLATE-GIRDER CANTILEVER BRIDGE

When the girders for a unit of the bridge were placed in position, a stiff-leg derrick swung the floor beams and stringers and other light parts to their proper places.

⁂

Clamshell Bucket Closed By Steam Engine

Foundations of buildings in Portland, Ore., are in general upon a close clay soil that underlies the city to a great depth. This material is very difficult to handle with ordinary buckets, and where the area excavated is too small to warrant installing a revolving



A CLAMSHELL WITH ATTACHED STEAM ENGINE

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*Assistant Engineer, New York Highway Department; Montela, Ulster County, N. Y.

shovel the practice has been to load skips by hand. The skips are hoisted from the pit by a revolving derrick and dumped onto a portable trap platform from which the wagons are loaded.

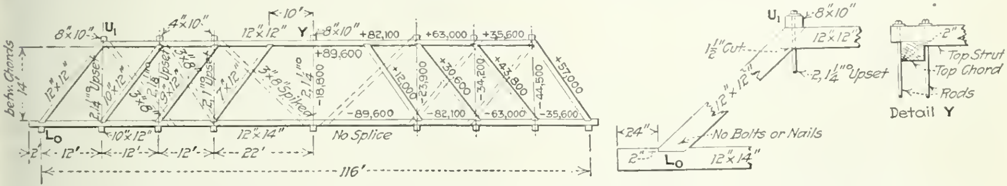
C. J. Cook, of the C. J. Cook Co.—a contractor who handles much of the basement excavation work in Portland—has recently devised for this work a clamshell bucket closed by a small two-cylinder steam engine, which gives sufficient digging power to handle this material very well. The bucket is a reconstructed Williams clamshell, and the engine is geared to a pair of differential drums. Steam is supplied by hose from the derrick boiler, and the control is by valves at the hand of the derrick engineer.

⁂

A Rural Highway Bridge of Strange Design

By Henry Blood*

The bridge shown in the accompanying sketch crosses the south fork of the Santian River at Cascadia, Ore., a summer resort on the edge of the Cascade Range. It is on a county road, and is used by practically all vehicles passing up or down the valley. Quite a number of automobile parties, with or without camping outfits, use it. As the road is in poor condition, the loads are limited, but still may be considerable. The bridge was built in 1915.



STRESS DIAGRAM AND THE DESIGN DETAILS OF THE CASCADIA HIGHWAY BRIDGE IN OREGON

Floor-beams, 10x12-in.; stringers, 7 lines 3x12-in.; 3-in. floor planks; no portals or swaybracing; bottom laterals about 6-in. diameter spiked; diagonals cut in chords about 2 in.; dead load = 750 lb. per lin.ft.; live-load = 960 lb. per lin.ft.; 116-ft. span; 16-ft. roadway; trusses 15 ft. deep c. to c.; covered sides and roof

There are several unusual features. All the larger timbers have been hewn out, as they were too large for the local sawmill. The bottom chords are single sticks 12x14 in. by 120 ft. long without splices. The top chords are also without splices. No metal was used except the vertical rods, plate washers for the rods, and nails. Plenty of good Douglas fir timber could be obtained within a short distance; iron and steel had to be hauled 32 mi. There are no portals, swaybracing or top laterals, but the gable roof and sides help to stiffen.

The most interesting point is the absence of web bracing in the central portion of the bridge, while the center floor-beam, carrying 22 ft. of floor, is hung from the top chord on a 20-ft. span. The rods are not well proportioned to take the increasing shear toward the ends, but if the two 1¼-in. upset rods at the center should ever be loaded to 15,000 lb. per sq.in., what would happen to the bridge? Allowing 20% for continuous action of the chord, and neglecting the weakening effect of the 2-in. notches for diagonals, the extreme fiber stress due to bending would be 6,100 lb. per sq.in. The average modulus of rupture of Douglas fir at breaking is 5,000 to 5,400 lb. per sq.in. The bottom chord cannot help, as the floor-beam is suspended below it.

The dead load is about 750 lb. per lin.ft. If the live-load is taken at 60 lb. per sq.ft., or 960 lb. per lin.ft. of bridge, the load on the center rods is 18,800 lb., and the stresses are those given in the sketch. The direct stress in the center panel of the top chord is 622 lb. per sq.in. and the compression due to bending—allowing 20% for continuity as before—is 3,133 lb. per sq. in., making a maximum compressive stress of 3,755 lb. per sq.in. The usual working stress is 1,200 to 1,600 lb., reduced by a column formula.

The effect of moving loads is not provided for: The 3x8 counters are merely spiked to the outside of the chords with two or three nails at each end.

Not far from this bridge there is a similar one of 60-ft. span. The construction is the same, but the center floor-beam carries only 16 ft. of floor, and the distance between the upper ends of diagonals is only 8 ft. The top chords are 12x12s.

Plans for both bridges probably were prepared by the county bridge carpenter. The workmanship was good, but there was a little oversight in design.

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*Engineer, Bureau of Bridges, Portland, Ore.

New Lubrication System for Construction Machinery*

By S. E. Lawrence†

The lubrication of machinery used on construction work is an unsatisfactory process at best. The varied types and kinds of machines, the changing conditions of work, the exposure of parts to weather, and the personal equation, all combine to make proper lubrication a more serious problem than most persons realize. Here is discussed only the steam, or cylinder and valve, side of this question and the special system devised for the construction machinery employed chiefly on Ohio River Lock and Dam No. 43, which is being built by hired labor under the direction of the Louisville office, Maj. J. C. Oakes in charge.

The chief difficulties were (1) securing a proper lubricant (which means principally a lubricant of proper viscosity at the temperature at which it is to work), (2) the delivery of lubricant, free from foreign matter and at a reasonable price, to the engine, (3) a lubricator that will properly admit it to the steam space, (4) intelligent use of lubricant by the operator.

On most construction work each machine has its oil cans to start with but as a job progresses, and with all the care that is exercised, it is not many weeks before tomato cans are in evidence in place of properly protected oil containers.

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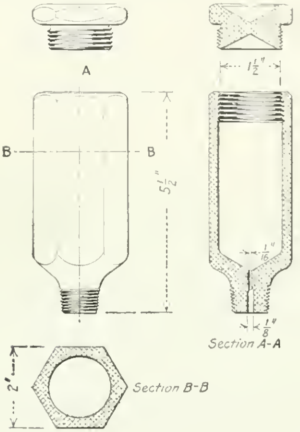
*From notes in "Professional Memoirs, Corps of Engineers, U. S. Army, and Engineer Department at Large," August, 1916.

†Junior Mechanical Engineer, U. S. Engineer Department at Large; Superintendent of Machinery and Floating Plant, Lock and Dam 13, Ohio River.

Too often the filling of the lubricator is left to a fireman or oiler who is not very familiar with the inside workings and shortcomings of a slightly out-of-repair lubricator. It is safe to say that 50% of the enginemen employed on construction work are not familiar with the principles and repair of the single- and double-connection sight-feed lubricators commonly used; a still smaller percentage are familiar with mechanically operated lubricators and oil pumps. When oil is permitted to get dirty and clog the small valves damage is usually done to the engine cylinder and rings before the difficulty is remedied.

When an engine exhausts directly into the air, as most construction engines do, much of the lubricating oil, as generally used, is blown through the cylinder and valve ports. Lubricating oils, unless of an expensive grade with a high viscosity, usually become "thin" under ordinary steam temperatures, and if a regular supply is not forthcoming dry rings result; also, practically no lubrication is afforded the piston-rod packing because of the strong exhaust scavenging the cylinder of its oil surplus.



DAVIS LUBRICATOR FOR CONSTRUCTION MACHINERY

Through intermittent use, in a hoisting engine, pile-driver engine, steam pile-hammer, mixer engine, crane, etc., condensation is apt to take place even with the best of drainage; rough usage and a quick opening of the throttle is the rule and not the exception. These factors determine the conditions that have to be accepted and a system must be devised to meet them. The ideal lubricant must be of such a nature that it will eliminate friction, as far as possible. It must be of a consistency that will perform this function at the temperature of the cylinder. It must have sufficient adhesion to the rings, cylinder walls and valves so as to be of service for more than one revolution of the engine; if it can go farther and serve other desirable ends it adds much to its desirability. Such other purposes may be the lubrication of piston rod and piston-rod packing, protection of valve, valve seat and steam spaces from rust, when the engine is temporarily out of commission, the filling of pits or uneven places in cylinders that have been neglected, increasing the compression by filling space between worn rings and cylinder walls, etc.

When an engine is working at varying speeds there is need of lubrication in the cylinder and valves directly in proportion to the number of its revolutions—a ratio that is not maintained by the regular feed of the ordinary lubricator, which admits so many drops per minute irrespective of the changing of the revolutions of the engines.

After a practical study of the difficulties to be overcome a system of steam lubrication for the machinery used on the construction of Lock and Dam No. 43, Ohio River, was worked out.

The container or lubricator devised is a simple valveless cylinder, as shown in the accompanying sketch, consisting of a short section of hexagon bar brass or Muntz metal, turned down and threaded on the outside of the lower end. The top is threaded on the inside and a cap of the same material turned to screw tightly into it. A small hole is drilled through the bottom of the cup. The size of this orifice was varied and experimented with, for the various engines on which it was to be used, until a satisfactory feed was obtained. This container is screwed directly into the steam pipe, steam chest, or, in some cases, directly into the head of the cylinder, the lubricant placed in it and cap securely screwed down, the regular outside shape making this a simple matter for an ordinary wrench.

The lubricant used consists of a mixture of flake graphite, cylinder oil and sufficient wax to form a mass of a consistency that can be easily handled and molded into cartridges which will retain their form under all ordinary atmospheric temperatures. By experiment, it was found that a cartridge of a certain diameter and length would supply a certain engine for a stated length of time and the amount placed in the lubricator was gaged accordingly. After the cartridge was introduced, no further attention was necessary until the determined time had expired—a day's run usually.

It was found that the change of pressure in the steam space, induced by the events of the stroke, regulated the feed from the lubricator automatically. The more the r.p.m. the faster the feed, and when the engine stopped the feed stopped; when the steam was again turned on the feeding was again resumed. The heat of the steam reduced the lubricant to a fluid state, which permitted it to pass through the orifice in pulsations. It would not run out without the assistance of unbalanced steam pressure, however.

The cartridges are molded in an improvised wooden mold and cut into different lengths, each one representing 8-hr. run for some particular engine, wrapped in paper and given to the engineman, a week's supply at a time. The simplicity of the lubricator, with its valveless automatic operation, eliminated the personal factor to a great extent and earned for it the name, "The Davis Fool-Proof Valveless," by which it is locally known and under which name a patent is now pending, G. M. Davis being the man largely responsible for perfecting the device.

After a period of use, the engines that had been equipped were examined and everything was found in excellent condition. The cylinder walls, valves and steam chests were found coated with a thin layer of graphite and the piston packing was shown to be impregnated with it. It was also found that the engine could be operated for from two to three days without additional lubricant being required.

A lubricator of sufficient size to contain a day's run for an 8x8-in. engine was produced for approximately 75c. and replaced a 1-pint double-connection sight-feed lubricator of standard make costing from $7 up. The lubricant for an 8-hr. run cost 2½c. and did the work of 1 qt. of cylinder oil which costs 16 to 55c. per gal. and more. Taken at the lowest price paid there was a saving of 60% over the former costs of lubrication. The saving in packing was hard to estimate, but it is safe to say that the packing lasted in most cases from one-third to one-half longer in the hardest worked engines and in some special cases much longer.

In one favorable instance—on a vertical engine operating the floating machine shop, one of the first engines on which the scheme was tried—the original fibrous piston-rod packing is still in use after two years, part of this time operating 16 hr. a day. The accumulation of graphite in the packing has necessitated slacking off instead of tightening up the piston-rod gland.

The following different kinds and types of machines were fitted with this system: Steam pile-hammers, pile-driver and derrick engines, horizontal reciprocating engines (sizes up to 16x22 in.), vertical shop engines, locomotive cranes, generator engines (650 r.p.m.), locomotives, and also on steam pumps of various sizes.

During the past winter (1915-1916), when the machinery of the Lock and Dam No. 43, Ohio River, plant was overhauled, it was not found necessary to rebore a single cylinder or replace a single broken ring or piston rod on any of the engines which had been so equipped. One cylinder left exposed to air for two months showed no sign of rust. There were, of course, no repairs necessary to lubricators, there being no parts or valves subject to deterioration.

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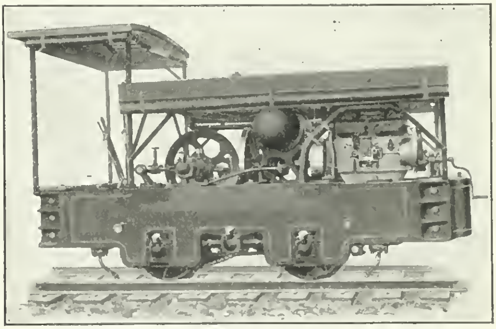
Contractors' Gasoline Dinkey with Friction Drive

A type of gasoline locomotive now in use on construction work and industrial service (and also in mines) has as one of its main features a friction drive for variable-speed transmission. In the locomotive shown in the accompanying view, the four-cylinder vertical engine at the right drives the face wheel or friction disk at the left of the tank. Against the face of this disk runs the rim of the wheel on the transverse shaft, this wheel being fitted with a fiber ring. Speed is varied by shifting this wheel laterally along its shaft so as to ride against the higher or lower speed portions of the disk. A sprocket chain from this shaft drives a countershaft with chain drives to both axles.

The frame is composed of four heavy castings, giving weight and stability. Pockets in the end castings provide for convenient coupling to cars of different heights. The 3-ton locomotive illustrated has an engine of 23 hp. (at 1,000 r.p.m.) driving a 23-in. friction disk and 22-in. fiber-faced wheel. It is mounted on four 18-in. steel wheels, with a wheelbase of 39 in. All bearings are fitted with flexible roller bearings, except that double-row ball bearings are used for the shaft of the friction disk. The machine has a maximum speed of about 10 mi. per hr, and a drawbar pull of 1,200 lb. at 5 mi. per hr. It carries 20 gal. of gasoline and 50 gal. of water and consumes 5 to 6 gal. of gasoline in a 10-hr. working day. The 6-ton machine has a 50-hp. engine giving the same maximum speed, but a drawbar pull of 2,400 lb. at 5 mi. per hr.

The engines are built for tracks of 24- to 56½-in. gage and with or without a cab, according to the character of the service which they are to perform. They are built by the J. D. Fate Co., of Plymouth, Ohio., which has recently introduced a number of improvements upon the earlier design. In service the mechanism is protected by curtains, but these are rolled up in the view in order to show the machinery.

These engines have been used on several large construction jobs, including the Louisville & Portland canal lock at Louisville, Ky., Ohio River dam No. 48, New York State highway work, the Boston drydock and the Halifax harbor works. There are nine of them at work on the Winnipeg aqueduct, where they haul concrete in trains of three or four steel hopper cars of ¾-yd. capacity. The length of haul is about ½ mi. The records of the United States Engineer Office for work done on Ohio River dam No. 48 (by the Ohio River Contract Co.) shower that from Aug. 6 to Oct. 23, 1915, with two of these engines 9,810 batches of concrete (9,136 yd.) were placed in 269 working hours, or at the rate of 36.5 batches per hour. The most rapid work was 46 batches placed in 1 hr. The total mileage for the two engines was 1,667 mi., with a haul ranging from 215 to 790 ft. The labor cost was 37½c. per hr. as compared with $1.40 per hr. for horse haulage.

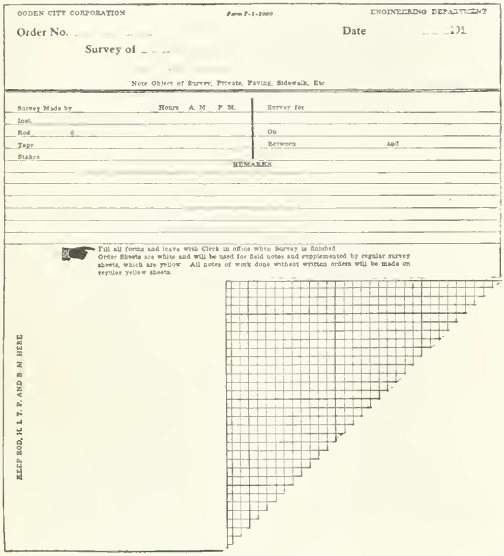


GASOLINE LOCOMOTIVE FOR CONSTRUCTION WORK AND INDUSTRIAL RAILWAYS

On the New York State highway between Syracuse and Bridgeport two of the 3-ton locomotives of 24-ton gage were used by Phelan & Sullivan, the contractors, in 1915. Each engine would take a train of nine 1½-yd. cars of gravel and make 10 trips per day, with a haul of 2¼ mi., and could take 12 cars when necessary. The cost for wages, gasoline and oil was about 5c. per yd. On other work the engines serve steam shovels handling cars of excavated material.

NOTES

Loose-Leaf Notes for Surveys on blank forms of an unusual type are employed by the city engineering department of Ogden, Utah. A reproduction of one of these forms is shown in reduced scale; the full size is 8x9 in.—on yellow paper. The sheet is folded in the middle and laid between board covers provided for that purpose. An elastic band over the middle fold holds the sheet in the binder. The front page of the folded sheet is for a brief description of the survey, by whom made, date, etc. The two facing pages form a single sheet 8x9 in. of square-ruled cross-section paper, each square being ⅛ in. on a side. This of course is for the sketch. The back page of the folded sheet is for the survey notes. The city engineer of Ogden is Joseph M. Tracy.



OGDEN CITY CORPORATION Form F-1-3000 ENGINEERING DEPARTMENT

Order No. Date 191

Survey of

Note Object of Survey, Private, Paving, Sidewalk, Etc

Survey Made by Hours A. M. P. M.

Inst.

Rod 6

Tape

Stakes

Survey for

On

Between and

REMARKS

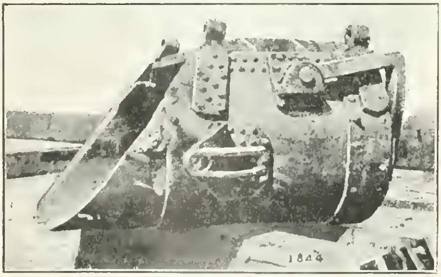
Fill all forms and leave with Clerk in office when Survey is finished

Order Sheets are white and will be used for field notes and supplemented by regular survey sheets, which are yellow. All notes of work done without written orders will be made on regular yellow sheets.

KEEP ROD, H. I. T. P. AND B. M. HERE

LOOSE-LEAF NOTE FORM FOR OGDEN CITY SURVEYS
One corner turned back to show ruling on reverse side of sheet

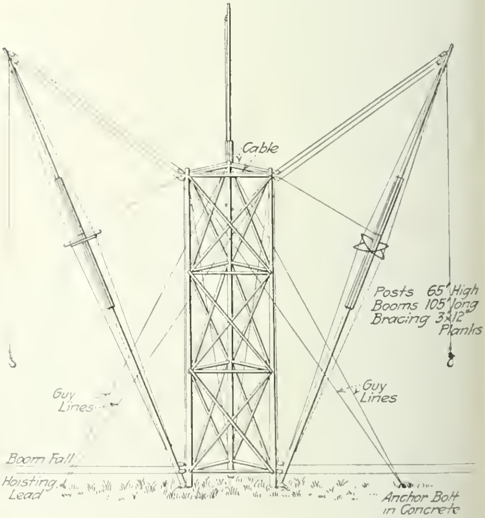
A Dredge Dipper Was Repaired by Welding and the process was described by T. E. Rosselle in "Reactions." The large dipper of the "Grampus"—operating in 30 ft. of water at the ocean ferry and steamship docks at Key West—was broken in several places while at work. The bottom on which the dredge is working is of coral formation that is very hard on the dipper. The break occurred across the entire mouthpiece, which is 2 in. thick. The spare dipper was unavailable at the time, so the broken dipper had to be repaired immediately. The welding was accomplished successfully with about 75 lb. of "Railroad Thermit." The dipper is shown in the view. Two other welds were made on this dipper, using about 100 lb. of Thermit each, the breaks being about 16 in. long. Oxyacetylene was used for cutting out the parts to be welded and also for cutting off the metal left in the pouring gates.



DIPPER OF DREDGE "GRAMPUS" REPAIRED BY WELDING

An Odd Laboratory Explosion recently occurred at the University of Illinois and was described in the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society. A pestle and mortar were used for grinding about 15 lb. of chlorate of potash, and after the grinding was completed the pestle and mortar were thoroughly washed and dried. A few days later the same outfit was used for crushing pumice stone, and the work had barely started when an explosion occurred and the mortar and pestle were broken to pieces. The room was filled with sulphur fumes, and fine particles of sulphur were found upon the floor. The presence of the sulphur was a mystery until it was found upon examination that the joint between the handle and body of the pestle was sealed with sulphur. It is believed that a small quantity of chlorate of potash found its way into a crevice in the sulphur seal, and that it combined with the sulphur to cause an explosion when the pestle was jarred in the process of grinding the pumice. The accident led to a thorough examination of other pestles of the same type in the laboratory, and it was found that each of them contained sulphur in amounts varying from one-third to three-quarters of an ounce. Chlorate of potash is rich in oxygen, and for that reason must be handled with great care.

Erecting the Canacao Radio Towers—The first 90 ft. of the Canacao Radio Towers, recently erected in the Philippine Islands, was placed by three 105-ft. booms swung from a centrally located falsework tower shown in the sketch. These booms were operated by hoisting engines located on platforms directly behind the three tower footings. The booms were rigged as shown. A 40-ft. length of 12x12-in. was butt-spliced to a 65-ft. Oregon pine pile with four 40-ft. 8x8's bolted across the joints. After one of the booms had broken in two, a ¾-in. cable truss was arranged. When the tower was 90 ft. high the falsework was dismantled and moved 1,000 ft. north to the site of the second tower, and a short boom was then mounted on each leg and swung from the main column. With this and a light pair of shearlegs it was possible to place all the steel up to the 150-ft. elevation. This method of erection, described by P. E. M. Wheat, Assistant Engineer, Bridge Division, Bureau of Public Works, Manila, P. I., in the "Quarterly Bulletin," is similar to the method employed in erecting the Darien towers. Identical stations are being erected at San Diego, Calif., and at Pearl Harbor, Hawaii. The towers are 600 ft. high. The Canacao towers and station should be finished by Jan. 1, 1917.



THREE-BOOM TOWER THAT ERECTED FIRST 90 FT. OF CANACAO RADIO TOWERS IN PHILIPPINE ISLANDS

Editorials

Public Interest Paramount in Railway Strikes

A member of the engineering staff of a railway in the South (Robert T. Frazier. Nashville, Chattanooga & St. Louis Railway) is engaged in an unusual piece of work—for an engineer. He is giving publicity to the idea that the threatened railway strike is being agitated for the benefit of only 16% of railway employees, and that the strike as it has been planned would injure the 84% out of measure. He therefore pleads for action that would put differences that cause or threaten strikes in the hands of the Interstate Commerce Commission or some other competent jurisdiction.

The case for powerful measures to prevent railway strikes is broader and stronger than the 84 to 16 percentages urged by Mr. Frazier. It is rather a 99 to 1 percentage, or nearly the whole population of the country against a comparatively few railway owners and their employees. This the public itself has been slow to realize and slower yet to make of practical effect. But a change is already apparent. It was largely due to a dawning recognition of its interest and its power on the part of the public that the New York street railway strike came to so speedy an end a few days ago. The same underlying cause explains the balanced deliberations of last week over the threatened steam railway strike.

If the railway officials and their employees cannot agree on fair wages and working conditions without stopping or even seriously threatening to stop business and cause food shortages and other disaster everywhere, then the public must find a way by which adequate railway service will be put first and differences between employers and employed be settled afterward.

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More Funds To Study Rainfall Are Needed at Once

Not a drop of rainfall was reported by the observers of the Weather Bureau in all of West Virginia on the day of the Coal River "cloudburst" and flood. There were no observing stations in the area covered by the storm. A serious error will therefore vitiate our records of flood-storms and precipitation. And, be it remembered, it is from the figures of these records that we design our flood-protection works and spillways.

We must have better records, safer records. The security of all dams and flood works depends on the accuracy of the recorded rainfall figures.

Errors such as that in West Virginia have probably occurred many times. There are now in the records various local storms of great intensity and small areal extent that were observed only by chance. Thus, in one instance in Ohio a storm of unprecedented intensity—vitally important in relation to the expenditure of millions of dollars for flood works—was observed only because it happened to center directly over an observing station. But stations are many miles apart, often many hundreds of miles, and the happenings between stations remain unknown to the records. Well-founded suspicions have been entertained heretofore that many important storms went unobserved and unrecorded. These suspicions become practical certainties in the light of the present case.

A great increase in number of rainfall stations is needed, and needed at once. The Weather Bureau should be put in possession of sufficient funds by the present Congress. Efforts to secure such increase have been made, but with only insignificant success. The time has now come when the question must be handled in radical fashion. Further delay in laying a broad foundation of definite knowledge on which to erect the costly structure of future waterway and flood works jeopardizes lives and dollars.

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The Work at Quebec

New standards in bridge work are established by the erection of the Quebec Bridge. Methods of micrometric precision were applied, and, broadly viewed, the crude processes of steel erection were placed on a scientific basis. The field problems have been handled with the same boldness in scrapping traditions, and the same ingenuity, that marked the design of the epoch making K-truss project.

The methods developed and applied are new and full of bold pioneer spirit in almost every part. Under these conditions it is hard to pick out one element as of outstanding importance. Yet with respect to the general problems of bridge engineering first place must be given to that part of the work by which the bottom-chord secondaries were eliminated—down to a small residual, at least.

The idea underlying this operation is not new, but prior attempts to turn it into reality have been of elementary character and of doubtful efficacy. For Quebec a system of machine-like perfection of action was employed, and definite results produced. Through this success the secondary-stress problem is advanced into a wholly new stage.

In the operation referred to, a strong, stable platform was provided out ahead of the bridge already erected; the chord member about to be erected was laid on this platform, its rear end rigidly connected to the preceding chord section, and its forward end then bent by hydraulic jacks sufficiently to make connection with its meeting web members—an amount so adjusted in the prior construction that when the bridge is finished the chord will be under direct endwise compression, without distortion by bending.

It is useful to recall the action which produces these secondary stresses, stresses arising from the deflection of the bridge rather than primarily from the load.

Note first that the bridge truss is made up of triangles; then notice that the position of any particular triangle with respect to the whole truss is such that at least one of its three bars is in tension, and at least one in compression, when the bridge is loaded. Of course the compressed bars shorten, while the others stretch, when the load is applied, and thus the ratios of the sides of the triangle change, that is the triangle changes its shape, and its angles change slightly. That is, the angles change if the three bars are joined to each other by easy-moving hinges. But the members of a bridge truss are not ordinarily so joined; instead, they are connected either by stiff-fitted pin joints or by rigid riveting, and the angles between them cannot change. The result is that the three bars of the triangle, in trying to change their angles, become bent.

This action takes place whenever a load comes on the bridge. Each bar or member then bends slightly, besides being compressed or stretched by its direct axial stress; it returns when the load goes off the bridge. The bending of the bar means stress—unnecessary stress—superadded to the regular axial stress which it is the particular duty of that bar to resist. One of two things is then true: Either the bending stress, the "secondary stress," encroaches on the safety margin of the bridge, or else we spend extra money in providing additional strength in every member. The former was the universal case until recent years, and is still the common case. The most advanced practice of today is to calculate the amount of secondary stress, and provide strength to resist it.

Bending of the members, secondary stress, is thus an inevitable concomitant of deflection. We have to note that secondary stress arises when a bridge deflects under its own weight. It is erected, let us say, in horizontal and unstressed position, being supported on falsework; when the wedges are knocked out it deflects, and its members experience secondary stresses. Or, it is erected by cantilevering. The triangle set in place at the forward end is practically free from stress at the time it is joined up, whereas later it is put under heavy stress by the weight of that part of the bridge built outward from it; and this stress means bending.

In very large bridges the dead-load stress is much greater than the live-load stress, and correspondingly the secondary stress due to deflection under the weight of the bridge itself is much more serious a factor than the live-load secondary. In fact, the live-load bending may be neglected, if only the dead-load bending can be taken care of.

By bending a bridge member while erecting it—springing it into place so bent that it will be just straightened by the oppositely acting bending which occurs under full dead-load, secondary stress is eliminated, so far as dead-load is concerned. This theoretical possibility has been realized partially in the past by connecting a member rigidly at its rear end when erecting it and then springing its forward end to place for connecting the triangle by using rope tackle. In place of this crude procedure the Quebec Bridge erectors substituted a beautiful mechanical system, which so far as the bottom chord is concerned gives full control of the bending and makes possible the measurement of both the bending force and the deflection.

The most spectacular operation of the Quebec Bridge enterprise remains. The suspended span must be hoisted from the river level 150 ft. up into place. This operation involves untried elements in its mechanism, and will place a crown of distinction on the heads that direct its successful accomplishment. In its relation to the engineering problems of bridge construction, however, it can hardly take higher place than the work already done in erecting the two great cantilevers as they are pictured in panoramic view on another page. An authoritative detail description of the procedure, prepared for *Engineering News* and published in this issue, will enable the reader to appreciate the notable character of the performance.

Monthly Guide to Engineering Books and Pamphlets

Engineers like doctors may be divided into two classes: Those who keep abreast of their profession by securing and reading the best literature of the day and those who are "too busy to read" or who let themselves think they are too poor to buy books and periodicals.

The busier the engineer or the leaner his pocketbook—in fact or fancy—the greater the need that he should know just what is the newest and best in engineering literature. To this end for nearly fourteen years no pains have been spared by *Engineering News* to announce immediately and describe and estimate as promptly as is consistent with careful weighing all new technical books that promise to be of interest and value to its readers—or indeed that have no such promise and therefore should be avoided. As a convenience to all concerned these announcements are made in the third issue of each month, thereby passing a goodly number of publications in review and simplifying the task of those who wish to order the books they must buy or to send the proper person a request for some of the many good publications that may be had for the asking.

The foregoing remarks have been prompted by the number and variety of volumes noted in the "Engineering Literature" section of this issue. To those who have passed it by as beyond—we hope none regard it as beneath—their interest we make bold to ask that they turn back and glance over the 35 reviews and notes and the 20 acknowledgments of books and pamphlets fresh from the press—some of which will be reviewed in later issues.

What Engineers Can Do To Stop Infantile Paralysis

Knowledge of the way typhoid fever, cholera, yellow fever, and malaria are spread from person to person has given engineers opportunities which they have embraced with marked success. Who knows but what before the present outbreak of infantile paralysis is over the mystery as to how the disease is spread from person to person will have been cleared away and there will stand revealed other points of attack for engineers? It does not seem likely that such will be the case but it is possible.

Meanwhile the large number of engineers who have learned the principles of sanitary science and public health, even if no more than to have their minds cleared of some of the silly traditions of an ignorant past, can perform a useful part in their several communities. They can seize upon the present awakening to a single health menace and press home the importance of securing a competent local health-protective agency that will guard against not merely infantile paralysis but all other communicable diseases as well.

Policemen with shotguns at city borders are not going to kill or scare off disease germs, as so many communities backward in real health-protective agencies seem to think. A trained health officer at the center of the town, with as many trained assistants as the size of the town and the conditions of the moment may require, is the only real safeguard. The sanitary engineer can drive home this and other simple but fundamental principles of public health. And until the scanty supply of trained health officers is increased a thousandfold, the better trained and more experienced sanitary engineers of the country should be eagerly sought by municipalities to equip the ranks of health officers.

The utter inadequateness of the health service of scores of cities and towns shown during the last few weeks should create such a demand for trained health officers as would fill our schools of public health and our well-conceived courses in sanitary engineering to overflowing. It should also serve to remove the suicidal provision of the health laws of New York and some other states, prohibiting the employment of other than physicians as health officers.

What Does Night Work Cost Compared with Day?

What percentage of extra cost is involved where construction work is carried on with a night shift? In view of the frequency with which night forces are worked it is astonishing how little dependable data are available as to the comparative cost of the two classes of work.

Under ordinary conditions of course day work is more efficient than night work. Other factors sometimes reverse this condition. In track work on a street railway for example, a night gang can accomplish more than the day force, which would be frequently interrupted by the passage of cars. In hot climates or in summer, the men can work harder at night as they are not exposed to the sun. Ordinarily, however, daytime labor is more economical.

Engineering News has made inquiries respecting the relative cost of night work, and an interesting response has come, through the courtesy of M. J. Caples, Vice-President of the Chesapeake & Ohio Northern Ry., from W. Michel, Chief Engineer of the railway. The building of this 28-mi. line—which involved the moving of 3,600,000 yd. of material—has been comprehensively treated in *Engineering News,* especially as regards the excavation (Jan. 6, 1916, pp. 6-11), filling and bridge work. Mr. Michel's letter follows:

> Owing to a greater quantity of excavation to be made at Summit Cut than at any other point on the section, it was deemed advisable to double-shift the shovel in this particular cut. Up to the present time very moderate results have been accomplished, due to causes which were almost wholly unavoidable—principally rain.
>
> The material in this cut is of a very tenacious blue gumbo, found in layers varying from 1 to 12 in. in thickness. The material loads in huge, irregular pieces, which makes it most difficult to handle on the dump and creates a danger of overturning the cars. During wet weather this material becomes very slippery, making it next to impossible to hold a trestle while dumping it therefrom.
>
> Another cause of the failure to accomplish better results is that the haul now exceeds 5½ mi. This is largely overcome by increasing the number of trains and crews. It has been found that four train crews with trains of 12 cars each are able to keep the shovel, on night shift, well engaged, where the track to the dump is in fairly good condition.
>
> The speed of trains at night is restricted to 8 or 10 mi. per hr., in order to lessen the possibility of derailments. Crews are instructed to run on "smoke" orders—that is, until they meet a train from opposite direction. The "empty" train usually takes siding so as to delay "loaded" trains as little as possible. Sidings are installed about 1 mi. apart.
>
> The very rainy spring season here prevented starting night work until May. The average output of the one shovel (a 70-ton Bucyrus) has been nearly 1,000 yd. per night, counting only the nights it was able to operate.
>
> The shovel is well lighted—both inside and out—by electricity. The small generator is driven by a turbine engine. This plant takes a negligible amount of steam to operate. The incandescent lights used are placed at the most convenient points about the shovel. The work on the dump is illuminated with fair success by acetylene lights.
>
> The book cost of night work has been less per cubic yard than that of day, owing to the fact that no track, shop or repair forces are maintained at night. It would be difficult to give any definite relative cost per yard of material handled nights to that handled days, from the data accumulated during the short time the night work has been in operation. It is the writer's opinion, however, that for an equal expenditure night work will accomplish about 75% as much as day work. This has proved out very close on other work that I am familiar with.

This report covers experience on only one job. We shall be glad to hear from other engineers and contractors as to their experience.

New York State Road Policy

The problem of New Jersey in dealing with future road building, detailed in *Engineering News* of Aug. 3, under the caption "Wanted: A State Road Policy" is not likely to be satisfactorily answered by adopting New York State's policy.

Compare these two parallel paragraphs, one from the editorial referred to and the other from a statement by Edwin Duffey, Commissioner of Highways of New York State, in the New York *Evening Post* of Aug. 5:

> New Jersey is unfortunate in this respect: Because of her early activity in road construction she has expended many millions of dollars in the construction of water-bound macadam roads, a type of construction admirably suited to the horse-drawn traffic which existed at the time the roads were built, but wholly unsuited for the motor traffic of the present day. The various makeshifts that have been tried during the past decade to enable water-bound macadam to stand motor traffic have involved large expense and have generally proved unsatisfactory in service.

> The experience of the New York State Highway Department shows, all conditions of course included, that the average cost of water-bound macadam road has been about $10,000 a mile; that of a bituminous road, penetration method, about $13,000 a mile; a first-class concrete road about $15,000 a mile; a brick pavement about $25,000 a mile. These figures include engineering and inspection. Under the present policy of the Department, the roads being built are almost wholly the water-bound and bituminous-macadam types.

These New York State roads being built from the proceeds of a second 50-year bond issue are *almost wholly* of the water-bound and bituminous (penetration) macadam type! At the Worcester Road Congress last December, Mr. Duffey stated that over 50% of the roads then under construction in New York were water-bound macadam, and presumably the present proportion is at least as much.

Almost in the same breath Mr. Duffey states that "maintenance, repair and upkeep of improved roads is the great highway problem of today," and that in 1915 it cost an average of $1,055 per mi. to maintain 2,298 mi. of water-bound macadam! The reason for this present policy Mr. Duffey does not state. Is it because New York has already spent the greater part of a second $50,000,000-bond issue on a 12,000-mi. road still far from complete and is trying to stretch the inadequate remainder over as many miles as possible?

Letters to the Editor

Relation Between Road Costs and Terminal Costs

Sir—The editorial on railway freight-rate discrimination, resulting from failure to charge for terminal expenses, in *Engineering News* of July 25, I regard as the ablest paper on this subject that has appeared for 25 years. It may interest your readers to know that a prominent Pennsylvania engineer, the late Col. Joseph D. Potts, who died in 1894, was an early advocate of the separation of road cost from terminal costs in making rates. Colonel Potts read a paper on this subject in 1892 (reprinted in 1911) in which the matter was succinctly stated as follows:

> We must have a separation of terminal and transfer charges from road charges. Terminals are costly and their expenses cannot easily be cheapened. The great future economies will be made in the movement of freight between terminals.

For your further information I inclose tables showing some typical freight rates at New York City. In shipping sugar from New York to Cleveland, Ohio, 623 mi., the official rate for many years was 17c. per 100 lb. Out of this the shipper was allowed by the trunk-line railroads 4.2c. per 100 lb. for lighterage at New York and 2c. per 100 lb. for cartage, leaving the railway 10.8c. per 100 lb. for its transportation, including terminal expenses at Cleveland.

The 900,000 tons of cement used on the Panama Canal was shipped from Jersey City and other New Jersey terminals at a cost of 60c. per ton less than it could have been shipped from New York, or $540,000.

In the case of the 425,000 tons of steel rails recently sold to the Russian Government, they could be shipped from Jersey City and other New Jersey terminals 70c. per ton cheaper than from New York, or $297,500.

I trust all interests will eventually realize what frightful waste and injustice are perpetuated by such discriminations and what is the inevitable result upon railway revenues. **Frank L. Neall.**

102 E. Mermaid Lane, Philadelphia, Penn.,
July 26, 1916.

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Measuring Railway Curves on the Arc

Sir—Referring to the question raised by Theron A. Palmer, *Engineering News*, June 29, 1916, p. 1240, the writer suggests that Mr. Palmer merely proposes one arbitrary definition of the degree of curve for another, when consideration of the various elements of a curve in relation to the radius obviates all arbitrary assumptions. From a mathematical consideration radius of curvature should be substituted for degree of curve.

The writer believes that degree of curve is a makeshift that should be discarded by engineers, who are supposed to be versed in mathematics. A knowledge of the mathematics of circles and other curves for polar and rectangular coördinates is part of the equipment of every engineer. Why not use that equipment? Does every engineer appreciate that he is applying polar coördinates when he runs in a simple railroad curve by deflection angles and chord measurements? How many engineers stop to consider that they can make practical use of the equation of a circle, $x^2 + y^2 = R^2$, or any of its derivatives?

To analyze briefly the definition of degree of curve as generally accepted and as proposed by Mr. Palmer, let R = radius; L = arc length; I = angle at center subtending arc; C = chord, and D = degree of curve; then

$I = L/R \times 57.29578$[1];

$R = L/I \times 57.29578$;

$L = I/R \times 0.01745329$;

$C = 2\,R \times sin\ \tfrac{1}{2}$;

$$R = \left(\frac{C}{2\,sin\ \frac{1}{2}}\right)$$

As generally used, $R = \dfrac{100\,ft.\ (arbitrary)}{2\ sin\ D/2} = 573.65$ ft. in the case of the so-called 10° curve; and for 60° of central angle, $L = 60 \times 573.65$ ft. $\times\ 0.01745329 =$ 600.73 ft. of arc = six 100-ft. chords.

Mr. Palmer's method would make the radius of a 10° curve 5,729.578/10 = 572.95 ft., an equally arbitrary assumption; the length of arc would be 60×572.95 ft. $\times\ 0.01745329 = 600$ ft.; and the six chord lengths would be $6 \times 2 \times 572.95$ ft. $\times\ sin\ 10°/2 = 99.898 \times 6$.

Either method gives correct results for the particular radius, but why not discard the idea of degree of curve and compute the arc, chord, deflection angle, etc., with reference to the radius desired?

The writer agrees that the length of a railway curve should be based on the arc length, but is it too much trouble to compute the arc length?

It may be well to add that both horizontal and vertical railway curves were placed on the Gatun locks, Panama Canal, by actual arc measurements. **J. A. Kitts.**

Quincy, Calif., July 24, 1916.

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Buckling of Concrete Roads

Sir—I have noticed with interest the editorial on the creeping and heaving of concrete roads, in the issue of June 22, 1916, being in a position this summer to study the faults of a concrete road in one of the southern counties of New York State. The road is a fraction over 12 mi. long. Parts of it were constructed with an aggregate of broken stone and the balance of local gravel, the sand in both cases being local material.

Where the road has been constructed of broken stone, no trouble has developed; but on the gravel-concrete parts, seven joints have buckled to date (July 26), and in each case considerable pavement has been destroyed. All breaks are located in a distance of 8,600 ft. and can be defined as follows: Sta. 1, 9.5 lin.ft. of pavement destroyed; Sta. 19, 19 ft.; Sta. 32+50, 8; Sta. 55+50, 5.5; Sta. 65+50, 5; Sta. 75+90, 10; Sta. 86, 16 lin.ft. of pavement.

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[1] The derivation of these values may be found in "Engineering News," Mar. 26, 1908, p. 347.

At the joints Sta. 19 and 86, the pavement was broken up about equal distances on either side of the joint. The pavement is 16 ft. wide, 6¾ in. thick at the center, and 4¾ in. thick at the edges. The joints are ⅜-in. wood strips spaced 30 ft. apart.

The portion of road where buckling occurred is devoid of shade trees and is subjected to the action of the sun over a great area. The season has been unusually wet, and the absorption and drying out of moisture have undoubtedly played an important part. The trouble developed on a very hot day, which had recently been preceded by a spell of heavy rainfall.

Preliminary to buckling, the concrete at a joint starts to powder and small bits of concrete spall off. The slabs then rise and remain that way for perhaps a day or more, depending upon the weather conditions, before breaking up entirely. The final break usually occurs when the weather is very hot. In each case the break has occurred in the afternoon.

The most recent break (at Sta. 86) split the slab up into pieces 4 or 5 ft. square. A noticeable movement in the pavement was evident for at least 500 ft. on one side of the joint, showing plainly where the edges of the pavement had parted from the shoulder material. I also noticed in two cases an overlapping of slabs of from 2 to 2½ in. The life of the concrete at the breaks has been entirely destroyed; specimens of concrete taken out are crumbled with ease.

I suggest that if transverse concrete baffle-walls of sufficient width to prevent shearing were placed in the subgrade and the concrete pavement made monolithic with these walls, it might tend to prevent creeping of the pavement and at the same time strengthen the pavement against longitudinal cracks. S. H. E.

Sayville, N. Y., Aug. 1, 1916.

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Viaduct vs. Fill at Astoria

Sir—In the June 22 issue of *Engineering News* I note an article on "Concrete Viaduct Versus Fill for Street Elevation." Although the article is not signed, it is evident, from the content, that it is written by an advocate of the fill.

Several gross errors were made in both the statement of facts and conclusions drawn as to the value of the various methods of improvement. The table (Fig. 2) gives the estimated cost of the viaduct at $57 whereas the true estimate of the committee referred to in your article was $48.18. The actual bid received for this work was $47.09. The cost of a fill ($19.40) is, in the first place, too low, and in the second place does not include various features necessary to make it a structure comparable to the viaduct.

By referring to Fig. 2 it will be noted that the fill (Scheme No. 2) slopes beyond the property line and encroaches on private property. The municipality has no power to improve on private property and as the property in question is entirely devoted to retail business the owners thereof desire to retain their basement space and would strenuously object to any encroachment thereon. The construction of retaining walls is therefore the only type of construction possible other than the viaduct.

The two types of improvement with retaining walls are quoted at $41.70 and $49.60. These costs when compared with the bid price of $46.20 for the viaduct show the viaduct to be the cheapest when its obvious advantages are considered. The viaduct allows entrance to basements through the sidewalk area, which is allowed by only one of the retaining wall schemes. It also creates a subway of very ample dimensions, which would permit the work of construction and repair of all underground systems without tearing up of pavements or interference with surface traffic in any way. It also relieved the city of the expenditure at this time of about $25,000 for installation of new water mains.

Streets are at present very narrow and the design was such as to permit the widening of the structure at a future date and with a minimum of loss of work already in place. Retaining walls could not, of course, be moved back.

The bid price of $46.20 not only included the concrete structure complete and hard surfaced, but also tile walls along each curb line, complete drainage provisions, manholes, ventilating system and lighting system.

The majority of property owners were in favor of the viaduct. The specifications did not limit the surfacing to one patented bituminous material, but called for several types of bituminous pavements as well as brick and wood block. It so happened that the patented material proved the most acceptable as to price.

In conclusion I would state that the property owners have petitioned for a wooden viaduct with hard surface pavement, in preference to a sand fill which your unknown contributor states was to be built.

G. T. McClean,
City Engineer.

Astoria, Ore., July 7, 1916.

[As the estimates for the four types of structure, given in *Engineering News*, were made by the same engineers (there is no "committee" referred to in the article) it is fair to assume that bids on the other types would have been as much lower than the estimates as was the bid on the concrete viaduct.

The petition for a wooden viaduct was made subsequent to the publication of the article.—Editor.]

NOTES AND QUERIES

Sacramento Weir—In the news article on the new weir to be built as part of the flood-control project of Sacramento, Calif., published on page 1204 of "Engineering News" of June 22, 1916, San Francisco was inadvertently inserted in the title and the address of the contractor (Teichert & Ambrose) was wrongly given as San Francisco, instead of Sacramento.—Frank C. Miller, City Engineer.

Formulas for Reinforced Footing Offsets—The formula for bond stress given by Clifford Older in the issue of July 6, 1916, p. 18, was printed with the left-hand term inverted; the numerical values, however, made the error apparent. The expression should read

$$\frac{V}{jd} = \frac{6{,}000}{0.92 \times 12} = 544$$

Attention is called to the value of d in the formulas on p. 19. In accordance with standard practice this is the effective depth of the footing, i.e., the distance from compression side to center of steel; the text erroneously described it as the gross depth of the footing. Further, the diagram for amount of steel, upper half of Fig. 2, p. 19, is to be read with the value f_s instead of f_c, as given both on the curve and on the scale of ordinates at the right. The diagram, Fig. 2, is applicable to offsets of any horizontal projection, so long as the gross depth is 18 in. and the net depth 12 in. The title of the diagram, "Diagram for Shear and Bond in 18-In. Footing Offset 12 In Deep" refers to gross depth of 18 in., and not to 18-in. projection.

Water Flow Increases with Rising Temperature

By W. L. Butcher*

The fact that the flow of water against fixed resistance increases appreciably with the temperature, was somewhat of a revelation to the writer and is presented here to bring it to the attention of others who may also have been misled by the ordinarily available books on the subject. No pretense is made of revealing anything new in hydraulics.

The question arose from a conversation with a steam-fitter in a certain large industrial establishment. On a roof there was a large wooden tank, holding some 90,000 gal., which received water pumped from engine condensers at a temperature of some 110° or 120° F. From the tank 36 small pipes (2½ to 3 in.) led to various parts of the building where the water was used in manufacturing processes. The steam-fitter inquired in picturesque language why on Sunday mornings when repairs were to be made and when everyone was in a hurry to finish the work, it took longer to empty the tank than on weekdays when no one cared how long it took. The writer was at first inclined to scoff at the claim.

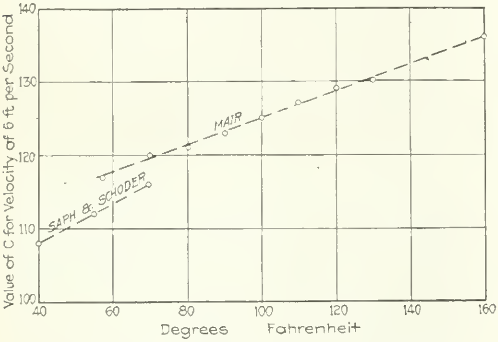

DIAGRAM SHOWING VALUES OF C IN V = √rs
At different temperatures in a 1½-in. pipe for a velocity of 6 ft. per sec.

The only condition which appeared to be different on Sundays than on other days of the week was the temperature. The water had a chance to cool off from Saturday noon until Sunday morning. Other engineers also treated the matter very lightly and considered that there could be no practical difference in the time of emptying under the two conditions.

A search in most of the readily available works on hydraulics also revealed the fact that the matter of temperature was either entirely passed over or treated as being of no practical importance except in very small pipes and at velocities below "critical" ones. Unwin's work was the only one consulted which went into the matter at all seriously, and of this more will be said presently. In books on heating and ventilating or house piping there also was very little. On pursuing the matter still further, however, the following statements were found in papers before the American Society of Civil Engineers (*Transactions*, Vol. 47, p. 313: Vol. 51, p. 255).

> Other experiments performed by the writers on a 2-in. brass pipe have shown that the effect of temperature on loss of head is a very important factor.
>
> The accepted idea in this matter is that the effect of temperature is negligible in pipes of commercial size. . . After the experiments had progressed far enough and several different temperatures of water had been experimented with it became evident that there is nothing to support the notion that the effect of temperature is negligible in large smooth pipes.

Unwin, on p. 143 of his "Treatise on Hydraulics" (1907 edition) says:

> The four results with a bright brass disk . . . show that the friction diminishes with unexpected rapidity as the temperature increases. The diminution is sensible even for a few degrees difference of temperature and hence it appears that a correction for temperature ought to be introduced in experiments on the flow of water in pipes and channels.

These facts are brought out strikingly in the accompanying diagram, which shows that the steam-fitter's complaint had some basis of fact. The diagram was made up from results of old experiments. The studies covering the greatest range of temperature for pipes of commercial size are apparently those of J. G. Mair, mentioned by Unwin (*Proceedings*, Institution of Civil Engineers, Vol. 84). His experiments on a 1½-in. brass pipe ranged from a temperature of 57 to 160° F. and for this range he found values of m in the formula $\frac{h}{l} = \frac{mv^{1.795}}{d^{1.2} \,.\, 2g}$, the meaning of the various symbols being obvious.

For the purpose of reducing his values of m to the more familiar c in the Chezy formula, we obtain by equating the similar values of s the following for a 1½-in. brass pipe:

$$c = \frac{13.03\, V^{0.102}}{\sqrt{m}}$$

For a velocity of 6 ft. per sec. using values of m given by Mair we obtain the following results:

Temperature, Deg. F.	Value of C
57	117
70	120
80	121
90	123
100	125
110	127
120	129
130	130
160	136

Saph and Schoder experimenting on a similar brass pipe obtained the following results, as read from a diagram presented by them in the *Transactions* of the American Society of Civil Engineers, Vol. 51, p. 290:

Temperature, Deg. F	Loss of Head, Ft. per 100 Ft.
40	9.7
55	9.1
70	8.6

From which we obtain for a velocity of 6 ft. per sec. the following values of c.

Temperature, Deg. F.	Value of C
40	108
55	112
70	116

Now it seems to the writer that where well authenticated experiments are in existence showing such a range of values that within the possibilities of many practical problems it may be found that the flow of water is increased by a mere change in temperature of the water from very cold to very hot as much as 25%—and possibly more in old tuberculated pipes but concerning which no experiments are available—such possibilities should be accentuated in standard works. It is certain that the engineer who perhaps does not claim to be a deep student of the subject will gain the idea from most of the standard works, if he gets any idea at all on the subject, that the matter of temperature is of no importance.

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*Metcalf & Eddy, 14 Beacon St., Boston, Mass.

Organizing Officers' Reserve Corps, United States Army

Provisions for officers and enlisted reserve corps, contained in the National Defense Act as approved June 3, 1916, and the regulations prescribed by the President have been made effective by War Department General Orders No. 32, dated July 28, 1916. A memorandum giving information on the Engineer Officers' Reserve Corps has been issued by the Chief of Engineers, United States Army, dated Aug. 1, 1916. The following paragraphs are reprinted for the information of engineers interested:

Applicants commissioned in the Officers' Reserve Corps will rank in the various sections according to grades and to length of service in their grades. Commissions will be issued for periods of five years. No age limits apply to the Engineer Officers' Reserve Corps.

Except as otherwise herein provided, a member of the Officers' Reserve Corps shall not be subject to call for service in time of peace, and whenever called upon for service shall not, without his consent, be so called in a lower grade than that held by him in said reserve corps. In time of actual or threatened hostilities the President may order members of the Officers' Reserve Corps, subject to physical examination, to temporary duty with the Regular Army, or as officers in volunteer or other organizations that may be authorized by law, or as officers at recruit rendezvous and depots or on other duty. They may be promoted to vacancies in volunteer organizations or to temporary vacancies in the Regular Army, as prescribed in the act. While reserve officers are on such service, they shall be entitled to the pay and allowances of the corresponding grades in the Regular Army.

Department commanders and the Chief of Engineers when authorized by the Secretary of War may order reserve officers of their departments or corps to duty with troops in the field or at field exercises or for instruction for periods not to exceed 15 days in any one calendar year. While so serving, such officers shall receive the pay and allowances of their respective grades in the Regular Army. These periods will not be extended except with the consent of the reserve officers concerned.

The examining board will ordinarily be composed of one officer of the Corps of Engineers, one member of the Engineer Officers' Reserve Corps and one officer of the Medical Corps or the Medical Officers' Reserve Corps.

The mental examination of no applicant will be undertaken who, in the judgment of the board, is not physically qualified to discharge in active service all the duties of an officer of the grade in which the applicant seeks a commission in the Officers' Reserve Corps; nor of anyone who has any mental infirmity or deformity of body, or whose moral fitness has not been duly established.

No person shall be examined for appointment in the Engineer Officers' Reserve Corps unless he has a letter from the Chief of Engineers authorizing his examination. Such a letter to an applicant will be the acknowledgment of the receipt of his application.

If an applicant has served in the Regular Army of the United States, or in any of the volunteer forces of the United States, or in the organized militia of any state or territory or the District of Columbia, he shall submit his discharge papers for each term of service; if still in service of any of the organizations named, he shall submit recommendations of his immediate and higher commanders.

If an applicant has attended or pursued a regular course of instruction in any military school or college of the United States, or has graduated from any educational institution to which an officer of the army or navy has been detailed as superintendent or professor pursuant to law, he shall, if a graduate, be required to present a diploma or certificate of graduation from such military school, college or educational institution, or, if not a graduate, a certificate showing the amount and character of training, theoretical or practical, satisfactorily completed thereat.

Every applicant will be subjected to a rigid physical examination which shall include the ordinary analysis of the urine, and if there be found to exist any cause of disqualification which might in the future impair his efficiency as an officer, he will be rejected. Defects of vision resulting from errors of refraction which are not excessive and which may be entirely corrected by glasses do not disqualify unless they are due to or are accompanied by organic disease.

Candidates for appointment in the Engineer Officers' Reserve Corps will be examined either (a) for duty with combatant engineer troops or other duties in the service of the front, or (b) for special service on the lines of communications or other points in rear, including engineer work in connection with seacoast defenses, as hereinafter indicated. Officers appointed under (b) will not ordinarily be assigned to combatant duties, but will be subject to such assignment whenever needed. The examinations shall be especially directed to ascertaining the practical capacity of the applicant, and the record of previous service and training of the applicant shall be considered as a part of the examination.

Military experience or training in the Regular Army, Volunteers or National Guard, or at training camps or educational institutions, will be noted and reported by the board and considered in making the recommendations.

A. QUALIFICATIONS FOR RESERVE OFFICERS, SERVICE OF THE FRONT

1. For First and Second Lieutenants

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or have qualified for the grade of junior engineer, civil, electrical, or mechanical or higher grade in the civil service, or he must be a graduate from an approved engineering college, or have been in the active practice of engineering for at least two years.

2. For Captains

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or be eligible for the grade of assistant engineer in the Engineer Department at large, or a corresponding engineer grade in the civil service in another department of the Government service, or have held a commission in the Corps of Engineers of the Regular Army, or shall be a professional engineer not less than 28 years of age, who shall have been in the active practice of his profession for at least 8 years and have had responsible charge of work as principal or assistant for at least 2 years. The graduation from a school of engineering of recognized reputation shall be considered as equivalent to 2 years of active practice.

(c) Knowledge of the principles of military organization and operations, as illustrated in Infantry Drill Regulations, Parts I (to include School of the Company) and II, and Field Service Regulations, Part I and Part II (Articles I, II, IV, VI); and of the general principles of field fortifications, as illustrated in the Engineer Field Manual, Chapter V.

3. For Majors

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must hold the grade of Assistant Engineer in the Engineer Department at large, or corresponding engineer grade in the civil service in another department, or have held a commission in the Corps of Engineers of the Regular Army not more than two grades below that for which he desires to be listed, or shall be a professional engineer not less than 35 years of age, and shall have been in the active practice of his profession for 15 years, who shall have had responsible charge of work for at least 5 years, and shall be qualified to design as well as to direct engineering work. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to 2 years of active practice.

(c) In addition to fulfilling the qualifications given in paragraph 3 (a) and (b), the candidate will be required to pass an examination on the following subjects:

Drill Regulations—Parts I (School of the Company and Battalion only), II, III, Infantry Drill Regulations.

Field Service Regulations, entire text.

Duties of Engineer officers and troops in war, as illustrated in the Engineer Field Manual and Bulletin No. 4, Vol. I, of the office of the Chief of Staff.

Coöperation between the various arms of the service, as illustrated in "Technique of Modern Tactics" (Bond and McDonough), Chapters VIII, IX, XI and XII.

All examinations will be oral.

B. QUALIFICATIONS FOR RESERVE OFFICERS, SPECIAL SERVICES

Candidates desiring appointment in special services must be qualified for at least one of the duties assigned to the Corps of Engineers by the following extracts from Army Regulations:

> 1493. The duties of the Corps of Engineers comprise reconnoitering and surveying for military purposes, including the laying out of camps; selection of sites and formation of plans and estimates for military defenses; construction and repair of fortifications and their accessories; . . . the installation of electric power plants and electric power cable

connected with seacoast batteries; . . . construction and repair of military roads, railroads and bridges; military demolitions; . . . In time of war within the theater of operations it has charge of the location, design and construction of wharves, piers, landings, storehouses, hospitals and other structures of general interest, and of the construction, maintenance and repair of roads, ferries, bridges and incidental structures, and of the construction, maintenance and operation of railroads under military control, including the construction and operation of armored trains.

No oral or professional examinations will be required, but recommendations of boards will be required in lieu of such examinations. Candidates will submit evidence of their actual employment in corresponding or higher positions in civil life and references to persons under whom they have been or are employed.

Reserve officers from the following civilian occupations will be required for the special services of the Corps of Engineers: Bridge engineers, constructing engineers (earth and concrete), constructing engineers (wharves, piers and buildings), electrical engineers (for small plants and power lines), highway engineers, mining engineers (skilled in tunneling and use of explosives), railroad engineers (construction and maintenance), railroad operating officials, sanitary engineers, topographical engineers.

There is an opportunity also for engineers to engage in professional service under the Quartermaster Corps, especially the service of technical inspection of supplies. A division of Reserve Quartermaster Officers is provided, "whose duties are not administrative" and who do not need knowledge of army administration, transport regulations, transportation, military law, hippology, etc. Among the fields of knowledge and experience stated in General Order No. 32 are railroad operating and mechanical department; superintending engineer or inspector of construction and repair, navigation company; ship-construction companies; automobile, wagon and machine manufacturing companies; president, secretary or manager of any large business; building or construction company; civil, mechanical, electrical, sanitary and structural engineering.

Cleveland Engineering Society to the Rescue

By C. E. Drayer*

In recent years building-code legislation in Cleveland has been drafted by the building department of the city, acting with a Joint Building Code Committee composed of five members from the building-code committees of the Cleveland Engineering Society, the Cleveland Chapter of the American Institute of Architects and the Builders Exchange. There was no little surprise, therefore, when on about May 1 the Cleveland Engineering Society was informed that an ordinance revising the plumbing section of the building code had been initiated and introduced into the City Council by the Journeymen Plumbers' Union. It appeared that the ordinance was likely to be put through the council without taking the advice of the Joint Building Code Committee. This committee felt that it could take no action in the matter without being requested to do so by the council.

It was clear that if there was to be any opposition to the proposed revision it would have to be organized by the Cleveland Engineering Society. The ordinance had advanced to the hearing stage on a Friday preceding the third reading and passage on the next Monday night. Quick and vigorous action was necessary. Letters were written to the secretaries of the various civic organizations in Cleveland, explaining briefly a few of the worst features of the proposed code and asking that representatives be present at the hearing and assist in getting the code considered in its many complex elements on its merits. The response was so generous that the council committee room in the new City Hall was dedicated at its first hearing by the attendance of an unusually large number of citizens and by the display of a much livelier interest than is usually shown at committee hearings. The engineering society asked the council committee to refer the proposed ordinance to the Joint Building Code Committee and suggested that this committee during consideration of the plumbing legislation be augmented by five representatives of the Master Plumbers' Association and five of the Journeymen Plumbers' Union. After a strenuous two hours, during which the chief plumbing inspector, who is also president of the Journeymen Plumbers' Union, could show no good reason for immediate passage of the ordinance, postponement for one week was secured.

During this week's stay the Joint Building Code Committee, already mentioned, concluded it might take a hand in the affair after all without being requested to do so by the City Council. Accordingly, it held a meeting to which it invited three master plumbers and the president of the union plumbers. The latter excused himself from attendance on the plea that he was in the employ of the city. At this meeting it was unanimously decided that the only thing to do was to go into the hearing prepared to discuss the code at whatever length might be necessary, but to make strong appeal for postponement of action until fall. At the council-committee hearing the Joint Building Code Committee, with a large delegation backing it, was successful in securing the desired postponement. At that time the council committee planned to hold a hearing each Friday through the summer vacation of the full council, which would give ample time to get the plumbing section of the code revised—and it does need revision. Later on, however, the council committee decided to dispense with the proposed hearings and to leave the proposed ordinance in the hands of the Joint Building Code Committee, augmented as suggested by the engineering society, with the understanding that this enlarged committee will report next fall.

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*Secretary, Cleveland Engineering Society, Cleveland, Ohio.

Spaulding Dam To Be Raised from 225 to 260 Ft.

By F. G. Mudgett*

As described in *Engineering News*, Dec. 11, 1913, p. 1163, and June 3, 1915, p. 1057, the Spaulding dam on the South Yuba power development of the Pacific Gas and Electric Co. is designed eventually to be 305 ft. high. For its initial use, however, it was completed only to a height of 225 ft. Contracts have just been signed for a further elevation of 35 ft., bringing the height up to 260 ft.

The dam is located on the South Yuba River in the high Sierras of Nevada County, California. The idea of damming the waters of the South Yuba at that point had presented itself to the company's engineers as early as 1906, but the plans of the engineers were postponed on account of the great disaster of that year. But a start was finally made, and the diversion of waters from the South Yuba River at the dam through tunnel and canal into Bear Valley and for the construction of a power house in the Bear River Gorge, some 9 mi. below Lake

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*Engineering Department, Pacific Gas and Electric Co., San Francisco, Calif.

Spaulding, at the point where a static head of 1,375 ft. was obtainable, was put under way and completed by Thanksgiving Day, 1913.

From the Drum power house it was proposed to utilize the water after its release several times over in its course through mountain and valley down to the point of its arrival in the City of Auburn, about 47 mi. below. The fall of water between the two points is approximately 4,300 ft., and it was found possible to survey sites for a chain of no less than three power developments in all. Altogether the plans called for an aggregate development of something like 162,000 hp.

In December, 1915, work on the Clipper Gap (Halsey) and Auburn (Wise) hydro plants was taken up where it had been abandoned in 1913. As these power houses will be completed this year, it becomes desirable to raise Spaulding dam to provide a greater stored water-supply for these stations, which will hold up the average power load during the dry months of the year.

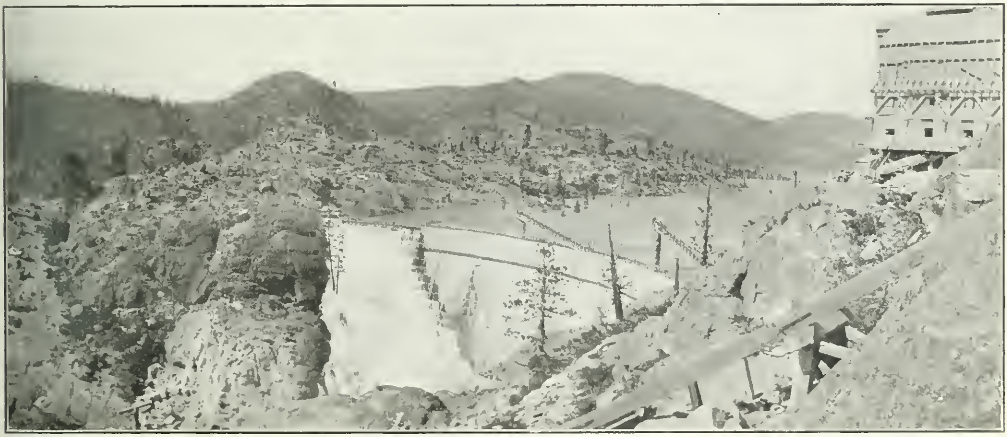
Raising Spaulding dam to a height of 260 ft. from its present height of 225 ft. and building the two necessary concrete spillway dams will increase the available storage in the lake by 20,400 acre ft., and the average available output during the short-water season from the Drum, Halsey and Wise power plants by 5,100 kw. over and above the output that can be obtained with the present height of the dam.

The dam itself is arched in plan and is of the type developed by the engineers of the company. It features a varying radius of the upstream side at different elevations, so that the pressure is kept as nearly constant as possible; in other words, we have what is called a "constant-angle arched dam," which gives a very desirable structure since the arch action in the dam can be utilized to a maximum degree at each elevation, tending greatly toward economy of section. The present Spaulding dam is provided with sufficient concrete in its section of the arch above El. 4,660 ft. so that it will stand an extension of 35 ft. in height above the present crest elevation (4,825 ft.) without any addition to its thickness.

In the year 1913, 153,806 cu.yd. of concrete was poured, and now in raising the structure to a height of 260 ft. about 16,000 cu.yd. will be added in the main dam. There will be two concrete spillway dams entirely distinct from the main dam, located in an adjoining cañon. Spillway dam No. 2 will contain less than 1,000 cu.yd., and spillway dam No. 3 about 7,500 cu.yd. of concrete.

The site of the construction plant is some 2 mi. from Smart, a small station on the Southern Pacific in Nevada County. From here at the beginning of the undertaking, standard and narrow-gage lines were run to a point high above the work, for easy delivery of machinery and material. The speed requirements necessitated at the dam a plant installation of a character that would allow for the placing of large masses of concrete daily. The plant consisted in 1913 of four No. 14, 42-cu.ft. Smith mixers, each of which could deliver 1 cu.yd. of concrete every 2 min., making it possible to place as much as 1,300 cu.yd. of concrete per day as an average daily output for one month. The best month's record shows 40,485 cu.yd.

It was the perfect gravity system that made it possible to distribute this tremendous mass of concrete over the large area of the dam in the short time. The only limitation arose from the transportation problem of getting the concrete materials to the front. In the present work only two of these mixers will be operated, as with the increasing height of the dam it becomes necessary to use a tram on a trestle, in place of the main chutes. The mixers empty their contents into a chute 2½ ft. deep and 2 ft. wide, which zigzags down the cañon to the dam. There the concrete was picked up by a 24-in. conveyor belt and distributed to the dam. The chutes will now discharge to a hopper for tram-car delivery. The concrete to the spillway dams will be delivered by a small railroad running across the main dam after its completion.


LAKE SPAULDING DAM AT HEIGHT OF 225 FT. SPILLING 300,000 SEC.-FT.

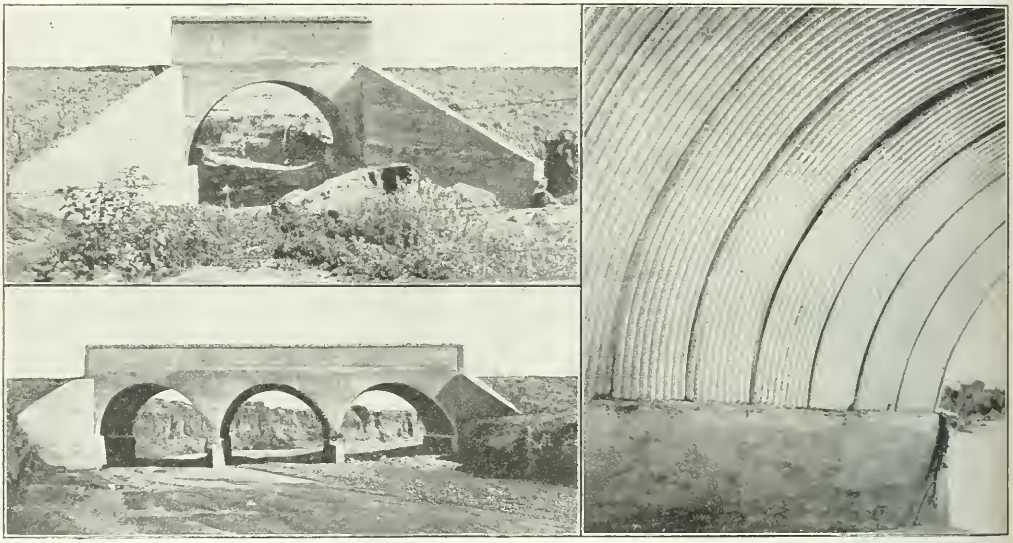
On account of the limited time for completion, bids were received early in July for handling the work entirely under contract, and it has been found advisable to let a contract for the completion of the work on or before Dec. 1, 1916.

The construction work will be carried on by Twohy Brothers, using the plans and specifications of the company, with P. M. Dowling as chief engineer and H. C. Vensano, civil and hydraulic engineer, as chief assistant engineer, having O. W. Peterson as resident engineer to supervise and inspect the work at the front.

Iron Culverts Used for Arch Construction in Arizona

The high cost of packing materials for culvert construction on new county roads in the mountain districts has led to considerable use in Arizona of corrugated steel for culverts—even in arch culverts as large as 12-ft. diameter.

Figs. 1 and 2 show culverts of this type. The metal comes in plates bent to a quadrant. They are riveted in the field to form semicircular arches. Concrete spandrel walls are used, but the entire load of the fill is carried on the thin corrugated arch sheet—about $\frac{1}{10}$ in. or No. 10 gage, which rests on the abutment.



FIGS. 1 TO 3. CORRUGATED-STEEL ARCH BRIDGES ON ARIZONA ROADS

Figs. 1 and 2 (on left)—Single and triple arches of typical design. Fig. 3 (on right)—Near view of under side of one of the arches

An arch of this type costs less than a concrete culvert and is built more quickly, but its use is confined to isolated places where concrete materials are scarce and transportation costs high.

The thickness of the spandrel at the grade of the roadway is 12 in. with a batter of ¼ on 1. The metal has no fastening to the spandrels other than the natural bond of the iron to the concrete. Sometimes rubble masonry is used for the spandrels.

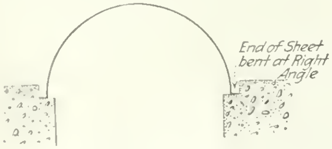


FIG. 4. DIAGRAM SHOWING METHOD OF SUPPORTING METAL AT ABUTMENTS

The way of supporting the arch on the abutments is shown in Fig. 4, and Fig. 3 is a view of the underside of one of the arches showing the sections of corrugated metal.

Gravel Cover on Bridge Floors Must Be Carefully Spread

There is some danger in overloading a highway bridge by unduly thickening the gravel cover to the floor, according to the State Highway Commission of Minnesota. In the *Minnesota Highway Journal* it is stated that with but few exceptions all new steel bridges for which plans were furnished by the Commission are built with concrete slab floors. All such floors should have a gravel wearing surface placed on them, and the same protection should be placed on all reinforced-concrete bridges. It is very important that this covering be thick enough to protect the slab from the horses' calks, and from the mud-hooks on traction-engine wheels, but it is also important to prevent making it so thick that the bridge will be overloaded.

On steel beam spans and short concrete bridges where the extra weight is not serious, the plans of the department call for a gravel covering 4 in. thick at the curb and 5 in. thick at the center of the roadway. But on truss bridges the gravel should be only 2 in. thick at the sides and 4 in. thick at the center. It is not uncommon to find truss bridges with the gravel placed level with the top of the curb and then crowned at the center, giving an average thickness of 9 instead of 3 in.

The weight for each inch of gravel covering on the floor of a 100-ft. truss span, 80-ft. roadway, figured at 120 lb. per cu.ft. is 8.4 tons; where it is made 6 in. extra in thickness the overload is 50 tons. This is a serious overloading and should be carefully watched.

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Another Street Tunnel is to be built in Los Angeles, Calif., to carry Second St. through Bunker Hill. The first plans for the work were for two tunnels side by side, each 30 ft. in width. On July 5 it was decided to substitute a single tunnel 60 ft. in width. The plans and specifications for the work are being prepared by R. W. Stewart, Assistant City Engineer.

News of the Engineering World

Flood in West Virginia

Floods in the Coal River district in West Virginia on Aug. 9 caused a considerable loss of life, wrecked many ouses and damaged coal and railway property to the exent of hundreds of thousands of dollars. Professor Ienry, of the United States Weather Bureau inorms *Engineering News* that there are no official oberving stations in the Coal River drainage area, and that he records for the nearest stations show little or no rain n or for several days before Aug. 9—in fact the Weather lap for Aug. 10 showed no rain in all West Virginia. 'rofessor Henry thinks the floods were due to a heavy ain confined to the Coal Creek watershed in Boone Couny. Later information from the Weater Bureau shows he following rainfall in inches for the three West Viriinia stations nearest the Coal Creek watershed:

	Aug. 8	Aug. 9	Aug. 10
'harleston	...	1.10	...
Kanawha Falls	...	1.50	...
Ieriton	0.22	0.10	0.50

At Point Pleasant, where the Kanawha (which receives 'oal River) joins the Ohio the following river stages 'ere observed from Aug. 7 to 11, inclusive: 7.4, 8.2, .1, 13.6, 10.9.

Reports state that Cabin Creek, a tributary of the Coal, egan to rise rapidly at 8:30 a.m., Aug. 9. Apparently ie flood was at its height in that stream and in Sing 'reek, Little Coal River and Big Coal River about the iiddle of the same day, the flood waters soon reaching ie Kanawha. Some of the villages reported devastated ere Acme, Dames, Eskdale, Kayford, Oakley and 'onda. A considerable mileage of main and branch acks of the Chesapeake and Ohio Railway were reported ashed out. Dr. S. L. Jepson, Health Commissioner of 'est Virginia, sent men to protect and assist the people i the flooded district.

It appears that the valleys in the flooded sections are ery narrow and their sides very steep, giving a quick unoff. In such a valley habitations generally hug close to ie banks of the stream. The fact that the flood occurred i broad daylight would seem to have given time for people rush from their houses before they were overwhelmed, pecially as the flood appears to have been wholly due runoff and not to the sudden release of waters stored hind a dam. All the scanty evidence available indicates iat this must have been a rainfall of great intensity. 'his makes it all the more a cause of regret that the tual rate and total will never be known.

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ake Toxaway Earth Dam Fails

The earth dam forming Lake Toxaway in the mounins of North Carolina about 50 miles south of Asheville, C., failed on Aug. 13 and drained the lake. The ater passed down the Toxaway River into the Chuga iver and eventually into the Savannah River. The first 5 miles of the flow is through sparsely settled territory here little damage could be done and below that the ver channels easily took care of the flood.

The Lake Toxaway Dam, built in 1902 as part of a hotel and resort scheme, was of thoroughly packed and pounded clay, 385 ft. long on the crest, 62 ft. high at the lowest part of the gorge and 20 ft. wide on the crest. The slopes were about 1 on 2 and the dam was 230 ft. wide at its deepest section. About six years ago some fears for its safety led to strengthening by dumping in riprap around the base.

At the time of the July floods of this year it was reported that the dam had failed but this proved not to be so, although it is possible that it was weakened then. At 6 a.m. on Aug. 13 a leak appeared in the base of the dam which widened until complete failure took place about twelve hours later.

After the failure of the dam the following letter was received by D. N. Showalter, Civil Engineer, of West Chester, Penn.

"I noted with much interest the accounts of the failure of the Lake Toxaway Dam. During the winter of 1912-13, I was located at Lake Toxaway investigating the water-power possibilities of the various streams around there.

"The dam was built in the early nineties, and had a heavy stone wall core which was probably 6 or 8 ft. thick at the bottom, narrowing to perhaps 2 ft. at top. The top of the core was some feet below the water surface. The balance of the dam was built of earth fill which contained considerable clay. During the winter of 1911, the waves drove so hard from the three miles of lake surface that they injured the upstream face a little. In the following spring and summer rock was blasted from the hillside at the north end of the dam, and dumped down over the upstream side to act as paving.

"The dam was built on a solid rock foundation which had from one to two feet of earth cover. The rock is not stratified and has practically no open crevices. The site is in fact ideal. When I was there, there had been for several years a small leak near the bottom just north of the stream bed. In my opinion, this was due to the thickness of the core wall, which no doubt had been cracked by the settlement and small movements of the dam.

"The rainfall here is exceeded in only one locality of the United States. Probably the recent heavy rains overtaxed the spillway (which was cut from solid rock at the south end of the dam) and caused several feet of additional pressure on the dam which had been weakened by leakage during the past years.

"Such a dam as this should be built with a thin flexible concrete core wall, well grooved into the rock, heavily reinforced in both directions and extending well above the water surface. Such a wall should not be more than 10 or 12 in. thick, and will then be elastic enough to follow small movements of the dam without injury. It is probable, too, that the side slopes of this earth dam were not as flat as conservative practice would dictate. It is indeed surprising that the dam built on so ideal a site should fail."

Harbor Changes at St. Paul

The recent Federal River and Harbor Bill provides for a survey by the War Department of the harbor at St. Paul, Minn., with a view toward determining whether the Mississippi Channel can be changed near the West Side Bluffs. Steps have been taken to inaugurate this work.

The harbor lines at St. Paul have been the subject of investigation and discussion for a number of years. In 1912 the River and Harbor Commission of St. Paul recommended the shifting of the channel of the river away from St. Paul proper in order to make more room for the proposed new union depot facilities and also to acquire certain lands for industrial purposes. The city engineering department was ordered to make the necessary surveys and soundings and $1,200 was appropriated for the work. The area between the old and the new channel was 390 acres and added to the old river bed with its 323 acres, made a total of 713 acres transferred to the north side of the river. The estimated cost of acquiring land for the new channel with 200-ft. levees on each side and excavating the new channel was two million and a quarter dollars. Nothing further was done on this project as the union depot company was working on plans for a new union depot and track layout and the amount of land required by that project was not definitely determined.

The railroads in 1915 prepared a plan which changed the harbor lines but it was disapproved by the Chief of Engineers, on the ground that the change was not for the benefit of navigation and that no provision was made for river traffic on municipal harbor facilities. The union depot company then withdrew its plans and stated that it would prepare a layout which would not require changing the harbor lines of the river. This was early in 1915 and the company is still working on this plan. The Commercial Club of St. Paul then took up the question of the river channel change and advocated moving it still farther away from the city and close up against the bluff on the south side, in this way acquiring 1,150 acres of land. This proposed channel shortens the river 1.2 mi., increasing the fall of the river 0.7 ft. The matter rested there when Congress put a temporary stop to the controversy by ordering the survey and report which are about to be made.

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New Potomac Bridge Plans

The new bridge across the Potomac River, at Washington, D. C., to replace the old Aqueduct Bridge is to be named the Key Bridge in honor of Francis Scott Key, the author of the "Star Spangled Banner," whose home in Georgetown, D. C., near the bridge site, is still preserved. It has been announced that the bridge will be located just downstream of the present bridge, running from Rosslyn, Va., to a point in Georgetown on M St. between 34th and 35th St. The structure will be a series of five reinforced-concrete arches high enough to accommodate the river traffic without a draw. Navigation of everything but barges and small river craft heads below the site.

The design of the bridge, for which Congress has appropriated $1,200,000 is in charge of the Corps of Engineers, United States Army. The architectural features are to be supplied by N. C. Wyeth, a local architect.

Philadelphia Wants Engineers

Every department of the municipal service of the City of Philadelphia requiring technical engineers has found it difficult to secure men. The positions pay from $900 to $2,500 and these figures have not proved inviting to the high class of men it has been hoped would be secured. To meet the situation, the Civil Service Commission has temporarily suspended the regulations requiring that positions cannot be filled except by those having a citizen's residence in Philadelphia for at least two years prior to appointment. The Commission is advertising for men in other cities, as follows:

> Men wanted in the technical engineering service of the city, including draftsmen, structural and architectural, at salaries ranging from $900 to $2,500 per annum. Work on subways, elevated railways, piers, sewage-disposal plants, grade crossings, bridges and streets. Employment continues for from one to two years and in many cases permanent. For additional information apply to the Civil Service Commission, Room 875, City Hall.

Under this change of rules a number of engineers and draftsmen have come from other cities and are now working in Philadelphia's several departments, such as Public Works, Transit, and Wharves, Docks and Ferries.

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Rail Breaking After Ten Years Wrecks Train

The Interstate Commerce Commission reports this week that investigation of a wreck on the Western Maryland Ry., Jan. 7, 1916, shows the cause to be a 90-lb. top-of-ingot rail breaking after ten years of service. A feature of the case is that the failure was not a single break but a complete shattering of the rail for a length of 11 ft. Of this length 56 pieces were recovered. Traces of several old splits in the rail head and between head and web were discovered. A longitudinal fissure of considerable length was found, being identified as a development from bad, seamy condition of the steel.

The failure is officially attributed to unsound condition of the steel. In no previous case has this cause produced trouble after so long a period as ten years of main-line service.

H. W. Belnap and J. E. Howard made the investigation.

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Cure for Transverse Fissures Claimed Found

The discovery that transverse fissures in rails can be prevented because they result from two specific preventable defects in mill practice is announced by P. H. Dudley, Consulting Engineer, New York Central R.R., in an official bulletin just published by the railway. The actual development of the fissures is "detail growth" under traffic from checks or small rupture planes produced before the rail leaves the rolling mill.

The two mill causes are improper cooling from the rolling heat and the subsequent gagging to straighten the rail before shipment. The former cause, says Mr. Dudley, produces delayed transformations of the structural components of the metal, and has the result of forming a hard non-ductile core in the middle of the head. The gagging then breaks this core, the surface of parting passing between the grains of the metal. Under traffic this break surface grows but now cuts through the grains.

giving rise to the smooth specular surface outside the nucleus of the fissure as seen after complete rupture.

If the gagging is done by stretching the head, the gagging ruptures the hard core of the head in tension. If the ram in gagging bears on the head, so as to stretch the base, a shearing fracture of the hard core is produced. Two types of transverse fissure correspond to these two conditions, says Mr. Dudley, the "intergranular" type and the "coalescent" type, the latter characterized by horizontal or inclined and branching surfaces of rupture.

As complete preventive of these defects, Mr. Dudley recommends reheating the blooms before rolling to the finished rail. He says that no transverse fissures have developed in basic open-hearth rails made under New York Central specifications and rolled from reheated blooms.

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Galveston Causeway Progress

The causeway across Galveston Bay to replace the one washed out by the hurricane of a year ago is still the subject of conference. Last winter a committee of engineers representing the county, the steam railroads and the electric railroads considered a number of different designs for the new crossings, but never reached any decision although at one time it was reported that the design selected comprised a section of 28 reinforced-concrete arch spans similar to the old design; that is, with 0 ft. spans and 3,600 ft. of 50-ft. arch spans over the ld causeway section. This structure was to cost about $1,500,000.

It is now reported that the conference is again to ttempt the selection of a design and to aid in this work board of three outside engineers is to investigate and report on the project. On this board Prof. A. N. Talbot, f the University of Illinois, has been named by the team railroad interests and Prof. George F. Swain, of Harvard University, by the county and the electric lines. These two engineers are to select the third member of he board.

*

A Surface-Car Collision Killed 25 persons and injured 65, ear Johnstown, Penn., on Aug. 12. Press dispatches state hat "the motorman lost control of his car and it crashed nto another at a switch." The accident occurred on the Southern Cambria Ry., between Echo and Brookdale.

The Austin, Tex., Dam continues to be the object of expert ttention. It has now been announced that Edward Wegmann, onsulting Engineer, New York City, has been asked to report on the condition of the dam and to suggest necessary hanges and improvements, especially in regard to the automatic crest gates.

A City Board of Public Utilities, to supervise and regulate he various public-utility corporations in New Orleans, La., s provided for by recent state legislation. The board will e composed of a City Commissioner of Public Utilities and our other members. The members of the board are to be ppointed by the governor.

The Three Boston Engineers ordered reinstated in the ublic Works Department of that city by a recent court deision will have to fight their case in the State Supreme Court, o which Mayor Curley has appealed. The mayor offered to ay the engineers for the time between their political decapiation and the court order reinstating them if they would esign but they refused to do so.

The Office of Public Roads and Rural Engineering is to receive a Federal appropriation of $724,505, according to the rovisions of the Agricultural Appropriation Bill as amended y the Senate. Of this amount, about $320,000 is to be applied o work in connection with good roads; about $200,000 is made vailable for irrigation investigations, most of which is to be pplied to investigations in connection with the use of underround water; and $94,720 is appropriated for drainage invesigations. In addition to this, it is probable that this office will be placed in charge of the work of supervising the Federal appropriation for aid to state road construction. The expenses of the force to carry on this work, however, will be paid directly from that appropriation.

An Appraisal of the Beaver Valley Water Co., which operates water-works plants in western Pennsylvania, has been made by the Public Service Commission of Pennsylvania. Complainants appealed for a reduction of the company's rates and claimed that the true valuation of the company's property was $670,000, whereas the company claimed a valuation of $2,600,000. The commission has appraised the property at $985,000 and allows the company to charge rates to yield an annual return of $135,950. This is based on a 7% return on the appraised valuation, plus an allowance of $63,000 for operating expenses, maintenance and taxes and $12,000 for depreciation. The company has outstanding capital stock representing $1,000,000, bonds for $1,063,000 and notes for $184,000.

Municipal Ownership of Water-Works at Denver, Colo., was involved in a decision handed down by a lower court on July 22, 1916. On Aug. 21, 1915, the Denver Public Utilities Commission, a city board charged with establishing municipal ownership of water-works in Denver, contracted to buy the Antero Reservoir and High Line Canal from the Antero and Lost Park Reservoir Co., of Denver, for $1,050,000. Injunction procedings followed. The decision just handed down seems to uphold the legality of the purchase except for certain alleged contract rights of a third party. In order that issues may be joined to settle these an injunction which holds up the purchase meanwhile was granted. Some opponents of the purchase claim that these issues cannot be cleared and other parties hold that the obstacle will soon be removed.

Work on the Imperial Valley Canals in 1915 is summed up in Superintendent Ray S. Carberry's report to the president and board of directors of the Imperial Water Co. No. 1, which irrigates 100,000 acres of California land. Cleaning was carried on over 294 mi. of canal at a cost of about $102 per mi., as compared with 179 mi. in 1914 at a cost of $113. Thirty miles of canal were cleared at a unit cost of $69; 18 mi. were cleared in 1914 at a cost of $4,343 per mi. (according to the report). Brush was cut on 223 mi. of canal at a cost of $34 per mi.; 331 mi. of brush were cut in 1914 at a unit cost of $33. The repair cost amounted to $1,897.78, as against $1,501.51 for the preceding year. Disk and grader outfits were used on the banks, with the result that the latter were widened, vegetable growth was discouraged and roads were made for caterpillars, dredges and other travel. This work cost $6,258.78 in covering 307 mi. of canal, or $20.39 per mi.

Railway Investigating Commissions are to be set at work by Canada and by the United States. The Canadian commission has already been appointed and consists of Alfred H. Smith, President of the New York Central Lines, Chairman; Sir Henry Drayton, Chairman of the Canadian Board of Railway Commissioners, and Sir George Paish, the famous British financier. The Canadian body's official title is the Railway Board of Enquiry. The Board is to investigate the general problem of transportation, the status of each of the three great transcontinental railway systems, with special reference to the territories which each system serves, the service it is capable of performing in the general scheme of transportation, physical conditions, equipment and capacity, methods of operation, steamship connections and financial status. It is further to consider whether the reorganization of any of the systems or their acquisition by the Government is necessary. The compelling cause for the appointment of this Board in Canada is understood to be the serious deficit which faces most of the Canadian railways except the Canadian Pacific. The extent to which the Government is bound up with these corporations through its guarantees, securities, etc., may make it necessary for the Government to take over the properties and operate them. In the United States, according to the terms of a Senate resolution approved by the House on July 15, a commission made up of five members of the Senate Committee on Interstate Commerce and five members of the House Committee on Interstate and Foreign Commerce is to investigate the Government control and regulation of interstate and foreign transportation, the extent to which present regulation is efficient in protecting the rights of shippers and carriers and promoting the public interest, proposed changes in the organization of the Interstate Commerce Commission and the laws under which it operates, and Government regulation and control of public utilities as compared with Government ownership and operation. The appointment of the commission was recommended by the President in his Annual Message last December. Senator Newlands, the introducer of the resolution and Chairman of the Senate Committee, will probably be one of the members of the Committee, and Representative William C. Adamson, of Georgia, Chairman of the House Committee, will be another member.

PERSONALS

Ross Shreve has resigned as City Engineer of Tillamook, Ore.

H. P. Kerr has been appointed City Engineer of Tillamook, Ore.

C. E. Coles, of York, Penn., has been appointed State Road Superintendent of Westmoreland County.

A. B. Oyler, of Newville, Penn., has been appointed State Road Superintendent of Fayette County, succeeding E. L. Clemmer, resigned.

Nial Rook, of Clearfield, Penn., has been appointed State Road Superintendent of Indiana County, succeeding C. H. Harrison, resigned.

G. N. Wood, recently City Engineer of Chanute, Kan., is now City Engineer of Douglas, Ariz. He was formerly Assistant City Engineer at Douglas.

E. F. Musson, M. Am. Soc. C. E., has been appointed City Engineer of Norwich, N. Y., to succeed C. E. Harris, resigned, as noted elsewhere.

C. E. Harris has resigned as City Engineer of Norwich, N. Y., in order to devote his whole time to private practice. He will continue to make Norwich his headquarters.

Joseph E. Love has resigned as Engineer of the South Dakota Railroad Commission and is now connected with the engineering department of the Chicago Union Station Co., Chicago, Ill.

C. E. Herth, recently Assistant Division Engineer of the Baltimore & Ohio Southwestern R.R., at Seymour, Ind., has been promoted to be Division Engineer of the Illinois division at Flora, Ill.

E. J. Correll, Division Engineer of the Baltimore & Ohio Southwestern R.R., at Chillicothe, Ohio, has been promoted to be District Engineer of Maintenance-of-Way, with office at Cincinnati, Ohio.

James B. Baldridge, Assoc. M. Am. Soc. C. E., formerly in charge of the estimating division of Irwin & Leighton, Philadelphia, Penn., is now Manager of the Philadelphia office of the F. W. Mark Construction Co.

Nathan C. Wyeth, an architect of Washington, D. C., has been appointed to assist the Corps of Engineers, U. S. A., officers in the design of the Key Bridge across the Potomac River to replace the old Aqueduct bridge.

W. R. McCann, M. Am. Inst. E. E., recently private secretary to William A. Shaw of the Illinois Public Utilities Commission, has been appointed Valuation Engineer of the Commission. For several years he was an assistant to Edward Schildhauer, Electrical and Mechanical Engineer of the Panama Canal.

Cecil Hamelin Taylor, M. Am. Soc. M. E., Consulting Engineer of the Republic Motor Truck Co., Alma, Mich., and of the Curtis Aëroplane Co., Hammondsport, N. Y., has left this country for England and France, where he will study aëronautical developments and gasoline motor improvements since the outbreak of the great war.

Roy M. Green has been appointed Assistant Professor of Highway Engineering at the Agricultural and Mechanical College of Texas. He is a graduate of the University of Nebraska and of the course in highway engineering at Columbia University. Recently he has been Testing Engineer and Superintendent of Pavement Construction with Clarke E. Mickey, Consulting Engineer, Lincoln, Neb.

OBITUARY

John Milten, President of the Duluth & Northern Minnesota Ry., died at his home in Duluth, Minn., July 27, aged 67 years.

Emil Swanson, an engineer in the Department of Water Supply, Gas and Electricity of the City of New York, died at his home in Brooklyn, Aug. 9. He was born in Sweden 44 years ago.

Will Christy, Vice-President of the Northern Ohio Traction and Light Co., a prominent banker and capitalist of Akron, Ohio, died Aug. 9. Mr. Christy is given credit for the formation of the Cleveland Construction Co., which built electric railways in many parts of Ohio and Canada.

A. B. Stickney, former President of the Chicago Great Western Ry., died Aug. 9, at his home in St. Paul, Minn., aged 76 years. He was born in Maine in 1840. He was educated and practiced as a lawyer. In 1871, while living in St. Paul, he gave up his law practice to engage in railway promotion. He subsequently took an active part in the railway development of the Northwest and was President of numerous companies, including the Chicago Great Western Ry.

William B. Upton, M. Am. Soc. M. E., whose death was briefly noted in the obituary columns of last week, was for many years a resident of Washington, D. C., and was well known there. He was born in San Francisco in 1856 and was once connected with the Union Iron Works there. Some of the work with which he was connected in Washington was the supervision of construction of the cable-car tracks in Pennsylvania Ave., which he subsequently reconstructed to underground contact electric trolley tracks. He also had charge of electric street railway construction in Tacoma, Wash., and Kansas City, Mo. He is survived by a widow and one son, William Upton, of the United States Geological Survey.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The New England Water-Works Association at its 35th annual convention to be held Sept. 13 to 15 in Portland, Maine, plans to issue an advance catalog of the different appliances and materials to be shown by the exhibitors. Exhibits should be shipped to Charles R. Harris, secretary Exhibit Committee, care of Portland Water District. About 60 spaces have been contracted for by the association and practically all have been spoken for.

The International Irrigation Congress will meet for the 23rd time Oct. 14 to 18. The opening session will be held at the Elephant Butte Dam, which is to be dedicated on Oct. 14. Following this session, there will be the regular business sessions which will be held in El Paso. The secretary is Arthur Hooker, El Paso, Tex.

The National Parks Highway Association was recently organized at Yellowstone, Wyo., with Gus Holmes, president, and L. L. Newton, of Cody, Wyo., secretary. Vice-presidents were elected as follows: For Montana, H. J. Miller; Wyoming, W. A. Deming; Colorado, T. J. Hall; Oregon, Frank C. Riggs; Idaho, Carl Davis.

The American Railway Bridge and Building Association will hold its annual convention in New Orleans Oct. 17 to 19, with headquarters at the Gruenwald Hotel. The Supplymen's Association will meet at the same time.

Appliances and Materials

Railway Ditcher with Three Sets of Engines

A light revolving steam shovel for railway ditching work, having as one of its special features the use of separate engines for the swinging and traveling movements (independent of the main engines), is built by the Browning Co., Cleveland, Ohio. This arrangement is stated to increase the speed and efficiency of operation, as the three sets of movements can be made simultaneously. Thus the machine can be swung while the load is being lifted, and it can be swung and moved forward while the bucket is being returned for a fresh cut. In ditching work the machine travels on a track laid upon the cars of the work train, moving along as it loads the cars.

For the operation of the bucket lines and boom topping-lift there is a double-drum main engine with vertical inverted cylinders 6x8 in., the cylinders being mounted on opposite sides of the frames carrying the cable drums. For swinging, there is a two-cylinder 5x5-in. horizontal engine, geared to a vertical shaft that carries the pinion engaging the circular rack on the underframe. Alongside of this is a similar engine that operates the propelling gear. The entire operation is under the control of one man, who is stationed at the forward end, where he has a clear view of the work. The accompanying view shows the ditcher mounted on its track on a steel-frame flat-car of the Rutland R.R. The equipment includes a large vertical boiler, a 520-gal. water tank and a 1,500-lb. coal bunker.

The axles are fitted with two sets of wheels. On their outer ends are wide double-flanged wheels having a broad tapered tread outside of the outer flange. These provide for carrying the machine on two sets of rails, those on each side being spaced $4\frac{1}{2}$ in. c. to c. and giving a total gage of 7 ft. $4\frac{1}{2}$ in. c. to c. of outer rails. This gives ample stability. If only one rail is used on each side, the rails for each new length of track may be laid inside (or outside) of those on which the truck is standing, and lapping beyond the ends of the latter. This is shown in the accompanying view, in which the rear wheels have the inner tread riding on the rear section of the track, while the front wheels have the outer tread upon the rails of the forward section of track. Upon the same axles (but inside the truck frame) are flanged wheels for running on standard-gage tracks.

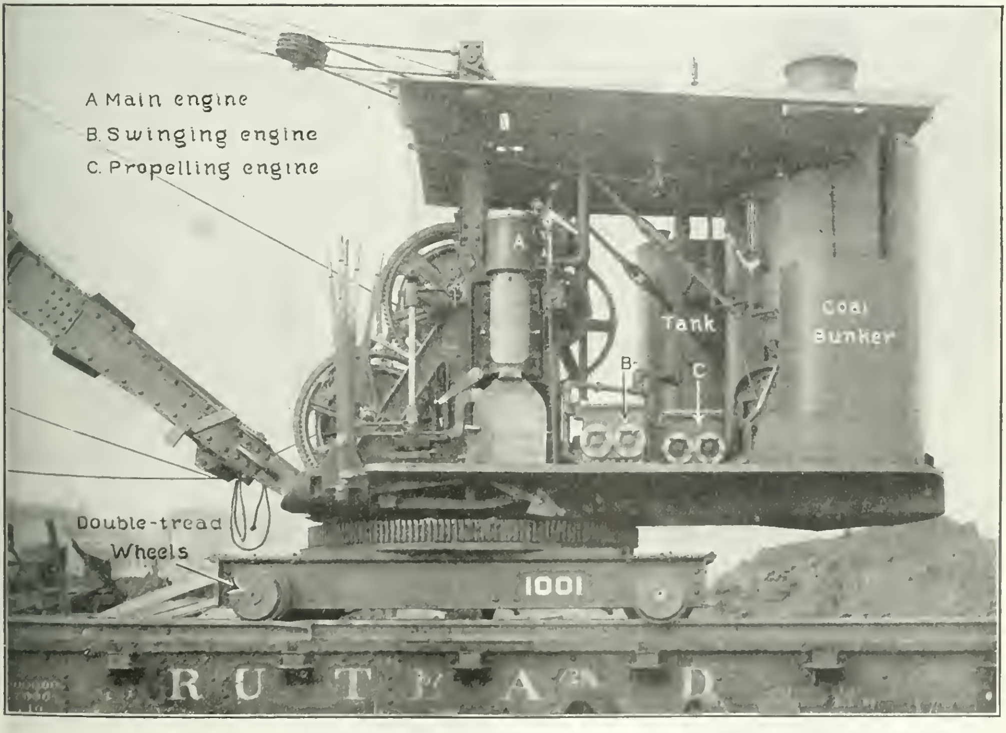
The boom is $26\frac{1}{2}$ ft. long. The dipper is of $\frac{5}{8}$-yd. capacity. When mounted on a flat-car having its floor 4 ft. above the rail, the machine has a maximum height of 18 ft. from track rail to lower edge of dipper door when open, and will cut to a depth of 5 ft. below the track rails.

This machine can be operated also as a dragline excavator or as a locomotive crane, its lifting capacity in the latter case ranging from 4,500 lb. at 30-ft. radius to $7\frac{1}{2}$ tons at 10-ft. radius. Its weight as a ditcher is about 28 tons.

* * *

Improved Steam-Boiler Covering

A new boiler-wall coating, called the "J-M Aertite," has recently been put on the market by the H. W. Johns-Manville Co., of New York City. It is designed to be easily applied by trowel, to be adhesive and flexible. It forms a continuous rubbery blanket over the whole setting. A $\frac{1}{16}$-in. thickness is recommended, for which 25 to 40 lb. per 100 sq.ft. is required.



RAILWAY DITCHER WITH INDEPENDENT ENGINES FOR BUCKET, SWINGING AND PROPELLING MACHINERY

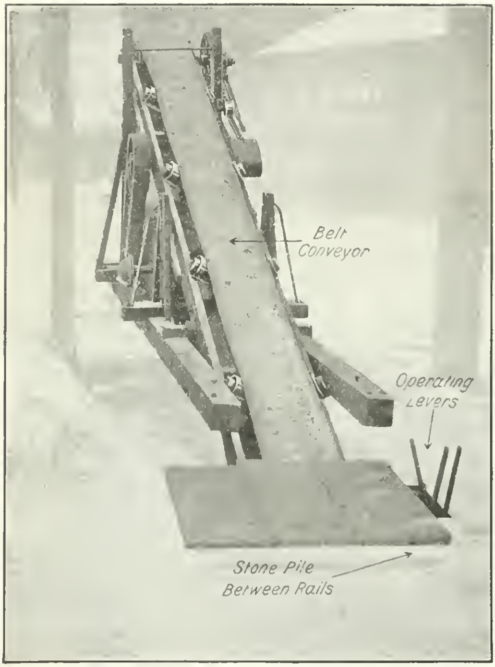
Another Anti-Corrosion Iron

Another iron alloy suitable for castings, to be used in chemical works and where it is desired to avoid rusting or attack by acid and alkali reagents, is being made by the Pacific Foundry Co., Harrison St., San Francisco, Calif. The trade name is "Corrosiron." It is claimed that it can be cast in intricate shapes and can be readily machined.

* * *

Wagon-Loader with Belt Conveyor

For loading stone and gravel from railway cars on supply sidings into wagons for distribution to road or concrete work a portable belt-conveyor device has been introduced. A shallow pit beneath the track accommodates the horizontal end of the belt and this pit is covered with a platform having three rectangular openings with sliding doors. These doors are operated by levers, and serve to regulate the feed to the belt. The upper end of the inclined portion of the conveyor is high enough for wagons to be driven under it. The belt is 16 in. wide and is carried by troughing rollers on a pair of inclined timbers mounted on the sills of a wagon bed. The timbers of the horizontal portion of the belt are hinged to the inclined timbers so that this portion of the belt can be folded up. On the wagon bed is the 4-hp. gasoline engine which operates the belt and runs continuously. A clutch is placed at the head of the inclined frame, so that each driver can start the conveyor when his wagon is in position, and stop it when the wagon is loaded. The speed of the belt is 225 ft. per min., giving a delivery of about 1 cu.yd. per min. The machine is easily hauled from place to place by a team. It is built by the Burch Plow Works Co., of Crestline, Ohio.



BELT CONVEYOR FOR LOADING STONE AND GRAVEL

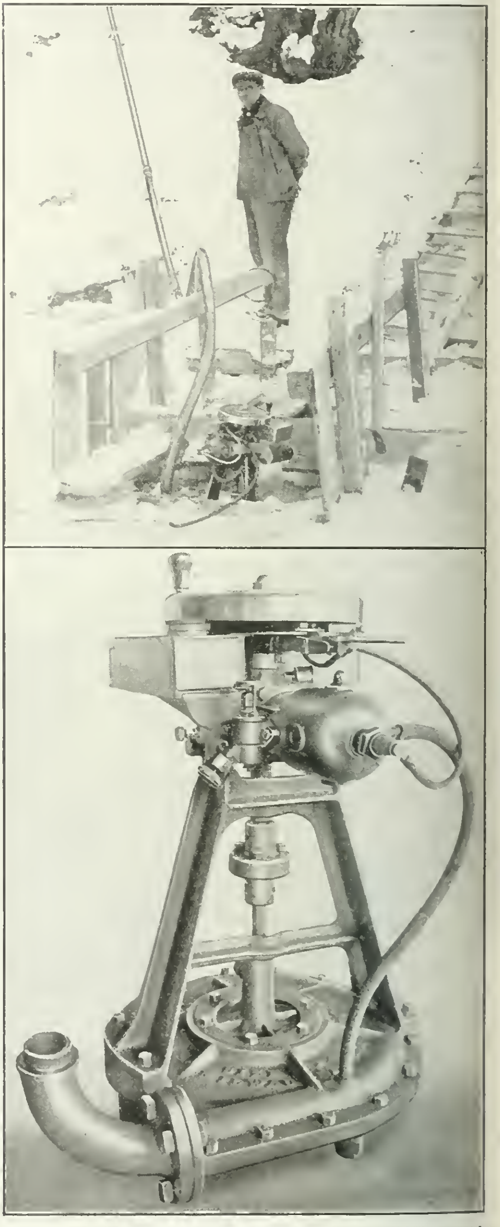
* * *

Portable Pumping Outfit for Construction Work

A portable pumping outfit with centrifugal pump was used to supply water in building a large country residence for A. A. Schlesinger on the upper Milwaukee River, about 6 mi. from Milwaukee. As shown in Fig. 1, the pump was placed in a wood tank or sump in the river. The delivery pipe was carried up the river bank to an elevation of 35 ft. and then along the ground for about 600 ft. to the site.

The outfit has a vertical-shaft pump (Fig. 2) with gasoline motor mounted upon it. The pump is about 15 in. in diameter, with 2-in. suction and 1½-in. discharge. With a 2-hp. motor the capacity is about 2,400 gal. per hr. against a 25-ft. head, while with a 3½-hp. motor the same capacity is given against a 40-ft. head. The oil and gasoline are mixed in the engine tank, so that no attention is required for cylinder lubrication. The outfit requires a floor space of only 17½x24 in. and is 27 to 33 in. high. Its weight is about 133 lb.

A similar outfit has been used in sinking foundation shafts. The pump can be disconnected and the shaft geared to a horizontal shaft carrying a belt pulley for operating a light saw or other tool. These pump and propeller outfits are built by the Evinrude Motor Co., of Milwaukee, Wis.

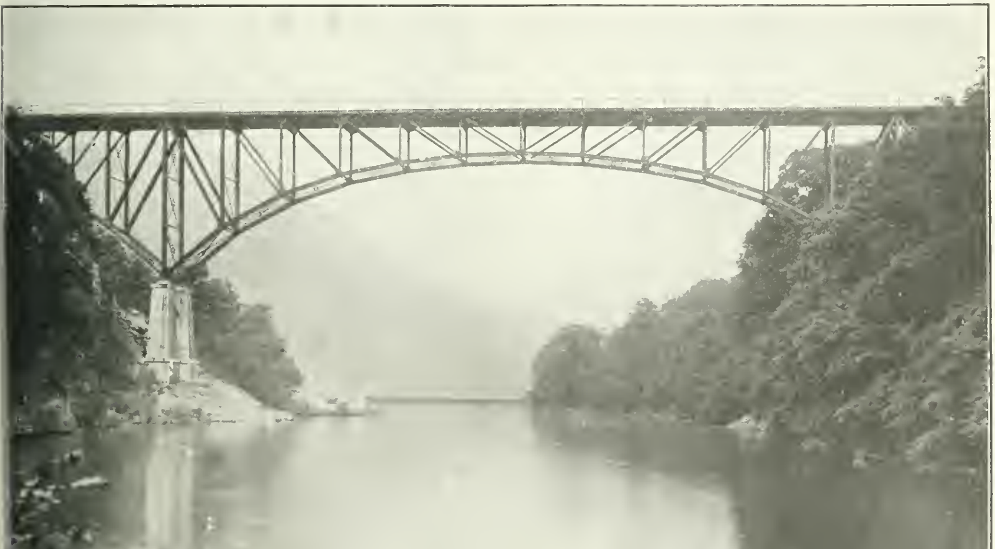


PORTABLE PUMPING OUTFIT WITH 1½-IN. CENTRIFUGAL AND 2-HP. GASOLINE MOTOR

Engineering News

VOLUME 76 AUGUST 24, 1916 NUMBER 8

Popolopen Steel Arch in the Hudson Highlands



STEEL ARCH BRIDGE OVER POPOLOPEN CREEK BETWEEN BEAR MOUNTAIN AND WEST POINT, N. Y.

The new steel arch bridge over Popolopen Creek, 5 mi. south of West Point, N. Y., was opened to traffic by the Palisades Interstate Park Commission on Saturday, July 15. The competitive designs for this structure were published in *Engineering News* of Oct. 28, 1915, and the companying view shows the completed bridge, which as designed and built for the commission by the Phoenix ridge Co. The piers for the bridge were constructed by ie New York State Highway Department, under the rangement noted further on.

Popolopen Creek is a narrow gorge with steep rocky alls nearly 150 ft. high, extending back from the shore the Hudson about half a mile. The only road in the illey of the Hudson on this side of the river has hitherto ossed the creek by making a sharp turn at the rim of e gorge, descending into the gorge by a narrow and orly guarded roadway on a very steep grade to a bridge ar the water level and ascending by an equally steep ad on the other side. The traditional name of the gorge Hell Hole, and the frequency of accidents there, since e road carries a heavy motor traffic, explains the name.

From an engineering point of view the obvious thing to do was to build a high-level bridge straight across the gorge, but the New York Highway Department is forbidden by law to use its appropriation from the state in the construction of bridge superstructures larger than small culverts. The county, on the other hand, took comparatively little interest in the bridge, since the road of which it forms a part is chiefly of importance as a through north and south line down the Hudson Valley, and the population of the county is mostly west of the highlands that border the Hudson.

It happens that the Palisades Interstate Park Commission, however, under the broad powers granted to it in 1910, has authority to protect the scenic features of the Hudson Highlands and is working toward the completion of a through north and south road on the west side of the river. The Bear Mountain Park and pleasure grounds, under control of the commission, border Popolopen Creek on the south. The commission therefore arranged to furnish the funds for the superstructure of the bridge, and the New York Highway Department built the piers.

While the bridge is commonly spoken of as an arch, structural engineers will recognize that it is actually a cantilever structure. The floor of the bridge is of reinforced concrete, on which eventually an asphalt wearing surface is to be laid. At present, however, the traffic, which is chiefly automobiles, is being carried directly on the concrete, as it was considered that better results in the adhesion of the asphalt to the concrete would be obtained if the latter was subjected to wear for some months before the asphalt was applied.

By the abolition of the dangerous Hell Hole passage there is now a good and safe roadway for automobile traffic from New York City on the west side of the Hudson all the way to West Point. Work is in progress on the section of the road that is to run from West Point to Cornwall along the steep slope of Crow's Nest and Storm King Mountains. When this section is finished, there will be a continuous motor road along the west shore of the Hudson all the way between New York and Albany.

⁂

Constructing Pile Foundation in Hard Gravel

By Smith O. Steere*

Construction of the pier footings for the new Main St. bridge over the Allegheny River at Salamanca, N. Y., involved special difficulties in driving piles from a raft in a swift current into the hard stratum of gravel forming the river bed at the bridge site. Further, an unusual method of securing the foundation in varying heads of water was employed—the use of three-wall coffer-dams.

The 102 piles for each of the four river piers were driven by a piledriving plant installed on a raft. The plant consisted of an upright boiler, single-drum hoisting engine and a 2,000-lb. hammer with 24-ft. leads. The piles for each footing course were driven, beginning at the upstream end of the footing block, before any excavating was done and before the coffer-dams were built. The plans called for 24-ft. lengths of pile below cutoff, the elevation of cutoff being 1½ ft. above the bottom grade of the footing block, or on an average 3½ ft. beneath the river bed. So great was the resistance that the gravel offered to the piles that a penetration of only 20 to 22 ft. below stream bed could be attained for the average pile and then only after much constant pounding accompanied with considerable brooming and shearing off of some of the piles. At the start the progress of piledriving was slow. The penetration of the piles under the first blows of the hammer was not over 3 in. per blow. As the driving progressed the fall of the hammer increased, but the penetration per blow rapidly decreased until it was not over ½ in. for an 18-ft. fall of the hammer. Under these circumstances only about eight piles per day were driven, when the piles were used without protection, owing to the excessive brooming of the point.

In order to expedite the work a special pile shoe to protect the pile points was tried. The shoes proved effective. The penetration per blow of hammer was doubled, and the progress of the work was greatly increased. Steel straps for protecting the pile points were also experimented with, but without any appreciable success; they were soon abandoned.

Later on, while workmen were excavating for the footing courses, evidences of the efficiency of the pile shoes were found. Piles with the shoe attached had pierced large flat stones, stones that otherwise would have made the pile glance out of line. The accompanying photograph, Fig. 2, shows a pile shoe unearthed with the pile sheared off just above the point of attachment of the shoe to the pile after striking a large boulder.

The table gives the subcontractor's distribution of cost for driving 419 piles of 24-ft. length for the foundation courses of the bridge.

ITEMIZED COST OF PILE DRIVING

Freight charges to and from Salamanca	$74.40
Unloading and loading plant and team hire	41.50
Cost of barge (materials, labor and repairs)	81.85
Oil and grease	9.95
Bolts, nails and washers	6.32
Blacksmithing charges	27.65
Repairs to pile-driving plant	17.35
Rope for hammer	37.65
30 tons coal @ $4.50	135.00
Labor, July 27 to Nov. 9	799.35
Superintendence and overhead charges	300.00
Interest on plant investment for 3 mo.	9.00
Depreciation of plant for 3 mo.	15.00
	$1,555.02
Salvage on barge	40.00
Net cost, 419 piles	$1,515.02
Cost per lineal foot, $1,515.02 ÷ 10,056	.15

In order to carry the excavation for the footing courses to grade, three-wall coffer-dams were built of sheeting and bracing around each foundation site of the piers. The dimensions of the outer coffer-dam walls were 68x20 ft., and the spaces between walls were 2 ft.; inside of the inner wall the dimensions were 60x12 ft., or the same as the size of the footing block. The entire area within the inner sheetpile inclosure was filled with upstanding pile butts projecting 3 or 4 ft. above the river bed and 6 to 7 ft. above the saw-off elevation.

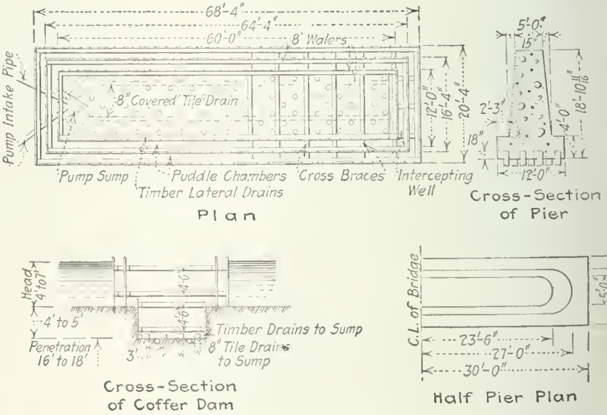


FIG. 1. COFFER-DAM FOR CONCRETING PIER FOUNDATION

The puddle chambers between the three walls of the coffers were filled with a clay-gravel puddle excavated at the south abutment site. The upper ends of all the coffer-dams showed considerable leakage, and these points were strengthened and made more impervious to water by filling cement bags with clay and placing them around the outside.

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*Former Assistant Engineer, New York Highway Commission, for Salamanca Bridge; Montela, Ulster County, New York.

After placing a coffer-dam, the interior was unwatered by using two electrically driven centrifugal pumps with 8-in. intake and 6-in. discharge pipes. These pumps were speeded up to a capacity of 700 gal. per min. each. Except where troublesome local leaks developed, the pumps easily handled the ordinary leakage through the

IG. 2. PILE SHEARED OFF AFTER STRIKING BOULDER

offer walls and the seepage through the porous gravel of e river bed, which was considerable.

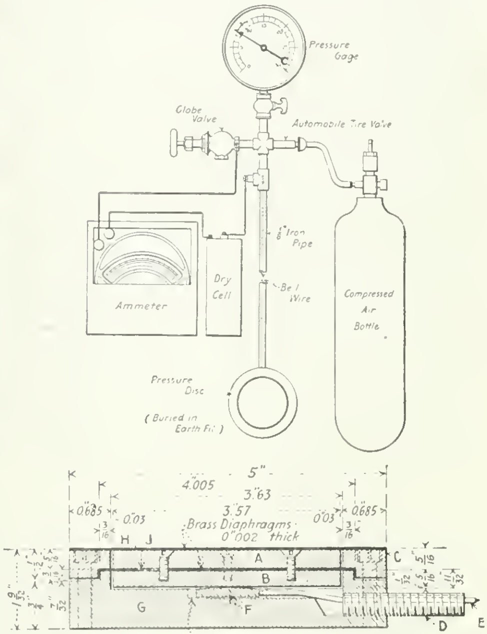
Workmen shoveled the material from the foundation its by lift and wasted it over the edge of the coffer-dam. s the excavating proceeded downward, the sheeting and racing of the inner coffer wall also were driven down, that the bottom of the sheeting was kept 4 or 5 in. elow the floor. The upstanding pile butts were sawed ff near the river bed, as they interfered with the free se of the shovels; later on they were cut off at saw-off rade, 1½ ft. above the bottom grade of the footing block.

The two centrifugal pumps easily handled the water hile excavation was going on, but the problem was how keep the coffer-dam unwatered during the concreting f the foundation course, as the specifications prohibited e laying of concrete in still or running water. Finally, t the writer's suggestion, a plan was tried that proved itisfactory. A narrow intercepting well 2 ft. deep was g across the upper end of the pit and fully planked. his intercepted the seepage and leakage at the upper d of the coffer, where it was the greatest, and delivered through two lines of 8-in. tile drains laid under the floor a triangular sump at the downstream end of the pit. wo additional intercepting side timber drains were aced just beneath the lower wales of the inner wall of e coffer-dam to take care of water coming through the des; this also discharged into the pump sump. The imp had planked sides; its bottom was 2 ft. below the floor of the pit, and its top extended 2 ft. above the top grade of the foundation block. With this arrangement of intercepting well, tile and intercepting lateral drains and sump well, the concrete for the footing blocks was laid without any trouble whatsoever from water. When the concreting for the piers proper was done, the pump sump wells were unplanked and filled with concrete. Fig. 1 shows the plan and section of the drainage system.

⁂

Device To Test Soil Pressure

A. T. Goldbeck and T. B. Smith, of the United States Agricultural Department, have devised an instrument which it is hoped will accurately measure the pressure inside an earth-fill or even inside undisturbed original earth. The authors state that they have attempted to develop an apparatus that will measure such pressure with practically no disturbance of the natural condition of the ground, and in considering it it was deemed advisable to develop the idea of a portable cell of small size capable of indicating at some remote station the value of any pressure coming upon it. The device consists of a small diaphragm cell and a slightly movable top, the movement of which is indicated by electrical contact communicated to the outside of the fill through a wire leading from the inside of the cell through an armored pipe. This armored pipe also conducts compressed air from an outside tank to the interior of the cell, and the pressure of the soil is measured by the reaction of the disk movement against this air pressure. The cell is in some way similar to that used by Professor McDaniel in measuring the pressure of concrete in forms, described in *Engineering News*, May 18, 1916, p. 933.



Vertical Section.

NEW SOIL-PRESSURE TEST APPARATUS

Rock-Tunneling Machine Using Pneumatic-Hammer Tools

A very interesting rock-tunneling machine is at present doing demonstration work in the subway excavation at the Grand Central Terminal, New York City. This machine, which is a recent development from the old Terry, Tench & Proctor machine described in *Engineering News* of Nov. 19, 1908, is designed to chip away the rock by the action of a number of pneumatic hammers fitted with chisels which turn on a longitudinal axis.

The secret of the greater measure of success attained by this machine, which has been developed by Oliver O. App, under the name of the Rock Tunneling Machine Co., 79 East 130th St., New York City, is contained in the fact that there is a distinct relation between the character of the cutting and the action of the hammers. When a chisel is not bearing against the rock, there is no action of the hammer. As soon as the tool contacts firmly with the rock face the hammer operates. Until this coöperation with chisel and hammer was obtained, the hammer type of tunneling machine was bound to remain an experiment.

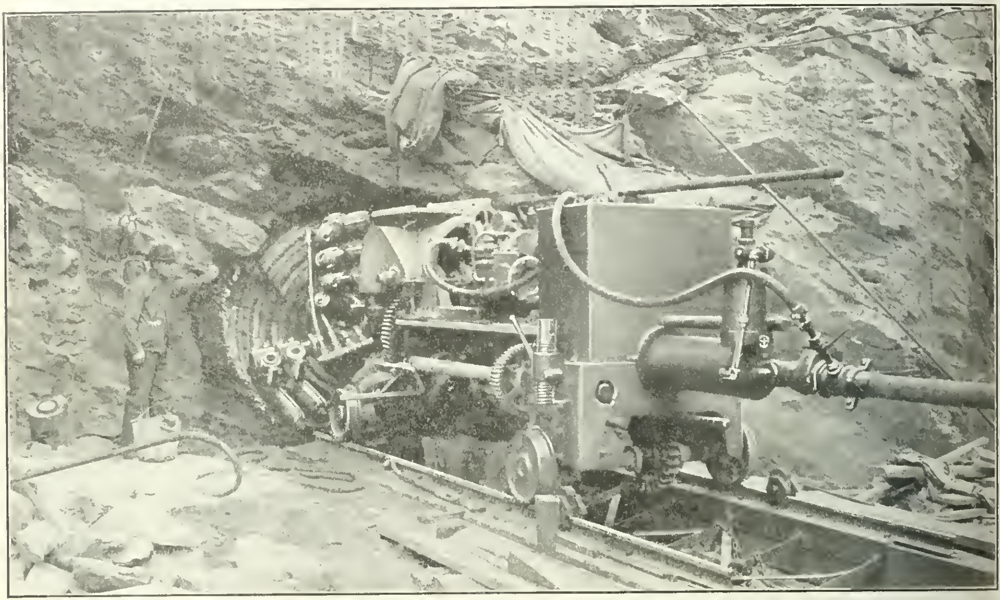
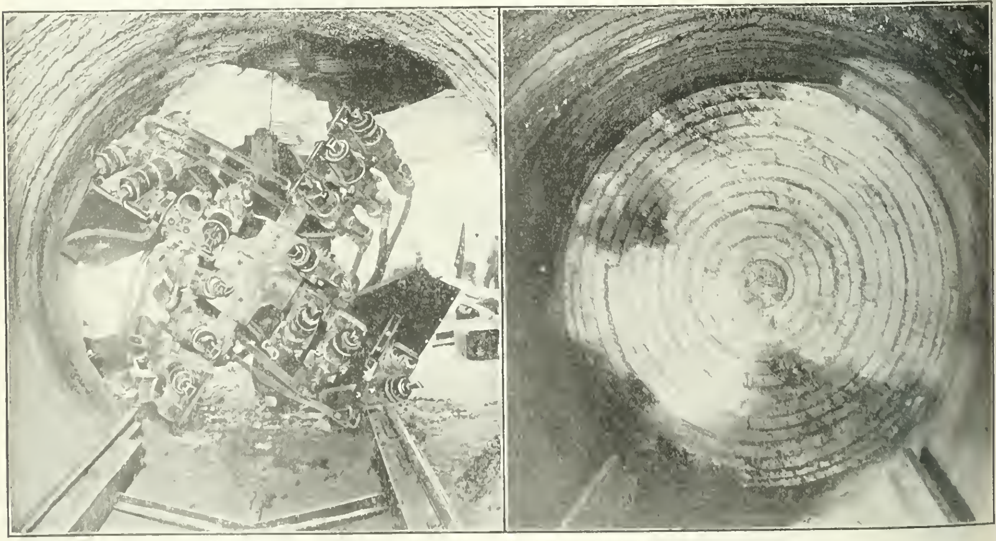


FIG. 1. GENERAL VIEW OF THE APP TUNNELER STARTING HEADING, GRAND CENTRAL TERMINAL, NEW YORK CITY



FIGS. 2 AND 3. VIEW OF CUTTING HEAD OF THE IMPROVED TUNNELER AND THE ROCK FACE

The carriage of the machine consists of a two-wheel main truck at the rear and a two-wheel guide truck at the front. The wheels rest on a light track of standard gage, shown in Figs. 1 and 2. The front and rear halves are separate; the front, carrying the revolving head, is moved forward 1 in. per revolution, by means of two lead screws. The hydraulic feed of the earlier machine has been abandoned. After the front has advanced 2 to 3 ft., the rear is moved up by means of gearing. The main shaft, which carries and rotates the head, is 12 in. in diameter and 14 ft. long and extends the full length of the machine along its axis.

The head, which is the tool carrier, comprises a hub and four arms placed 90° apart. Two arms carry four hammers each; on each of the other two arms are three hammers. The 14 hammers are so arranged that the chisels cut in concentric circles, producing the face illustrated in Fig. 3.

The power to rotate the head and to manipulate the machine is furnished by a compressed-air engine located on the forward part of the carriage.

When it becomes necessary to move the rear half of the machine forward, the track on which it rests is moved bodily by means of jacks. This method will be improved in future machines.

THE HEAD CARRIES FOURTEEN HAMMERS

The hammer-and-chisel element has been entirely redesigned. In the old Terry-Proctor machine a 3-in. cylinder, with piston and valves and springs at each end of the cylinder, was tried. Mr. App uses a 4-in. valveless cylinder carrying a 32-lb. hammer 12 in. long. The hammer is reciprocated by the action of compressed air, the distribution of which is effected entirely by the passing of the hammer over ports in the cylinder wall, there being no distributing valves whatever. The hammer strikes a steel chisel-holder, into which the chisel is firmly inserted. It is now proposed to form the tools with longer shanks so that the hammer will strike the tool direct and not the holder.

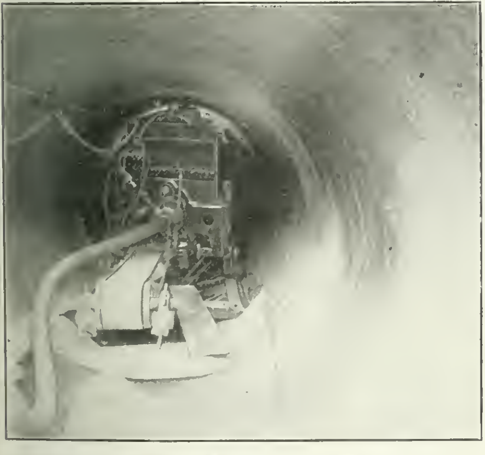


FIG. 4. REAR VIEW OF MACHINE IN TUNNEL, SHOWING AIR LINE AND SPOIL CONVEYOR

In the event of one or more of the tools meeting no resistance—an operating condition that may occur at any moment—the air supply to those particular cylinders is shut off immediately and automatically. Arrangements are provided so that the supply of air to any single hammer is determined solely by its immediate demand, and this control is effected by variation of bearing pressure of the tool against the rock. The harder the rock the more air is supplied automatically. If the rock is soft, less air is supplied; if sufficiently soft, the hammer is inactive and the rock is sheared off by the rotation of the tool. In short, the blow delivered is proportional to the hardness of the rock to be cut.

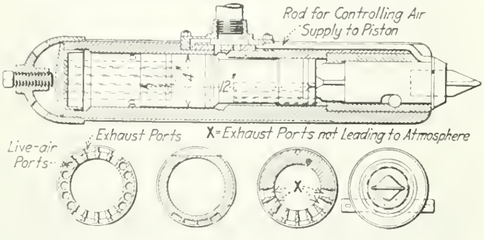

Rod for Controlling Air Supply to Piston
1/2
Exhaust Ports
X=Exhaust Ports not Leading to Atmosphere
Live-air Ports
X

FIG. 5. LATEST DESIGN OF 32-LB. PNEUMATIC HAMMER

Oil enters the cylinders with the air. The chisels now in use are made of 1½-in. square steel. The movement of a chisel is limited to not over ½ in.

Dust in the tunnel is practically eliminated by a spray of air and water over the face of the rock. The broken rock is elevated by two scoops carried by the rotating head and delivered on a belt conveyor (Fig. 1) that discharges into muck cars at the rear.

RECORD OF RUNS

In three 8-hr. shifts in which the total operating time was 13 hr., an advance was made of 8 ft. 10½ in. in the 8-ft. diameter tunnel. The lost time comprised that required to move track forward, to break off core and to insert tools that dropped out. The following is a record of an 8-hr. test and was compiled by H. S. Dow, of the Rapid Transit Construction Co., New York City:

TRIAL RUN ON JUNE 9, 1916

Operating from cut on north side 42nd St. between Park and Lexington Ave.

Time of Start, P.M.	Time of Stop, P.M.	Duration of Run, Min.	Cause of Stop	Time Machine Was Idle, Min.	Total Progress, Ft.	Total Progress, In.	Total Running Time, Hr.	Total Running Time, Min.
5:54	6:03	9	To break off rock ore..	13	..	..	..	..
6:16	6:27	11	To tighten tool	6	..	..	..	..
6:33	6:34	1	To change tools	13	..	..	..	..
6:47	6.53	6	To measure progress...	1	0	4	0	27
6:54	7:01	7	To change tools and move track	17	0	5	0	34
7:18	8:04	46	To change tools and move track	25	0	11	1	20
8:29	8:37	8	To clean out muck......	4	..	..	..	..
8.41	8:46	5	To replace tools and move track	24	1	0	1	33
9:10	9 17	7	To replace tool; lunch..	54	1	2	1	40
10:11	10:21	10	To replace tool	3	..	..	..	..
10:24	10:30	6	To clean out muck.....	1	..	..	..	..
10:31	10.33	2	To break off rock core.	11	..	..	..	..
10.44	11.03	19	To clean out muck and replace tools	40	1	7	2	17
11:43	A M 12.01	18	To tighten tools	3	..	..	..	..
A.M. 12:04	12:11	7	To tighten tools	2	..	..	..	..
12:13	12:24	11	To tighten tools	3	..	..	..	..
12 27	12.35	8	To clean out muck.....	40	1	11	3	1
1:15	1:21	6	To adjust distance	1	..	..	..	..
1:25	1.58	33	To tighten tools	7	2	4	3	40
2:05	2:09	4	To tighten tools	2	..	..	..	..
2.11	2:20	9	To tighten tools	1	..	..	..	..
2:21	2:25	4	End of run.............	..	2	6	3	57

Total time of test, 8 hr 31 min. Average progress, 7.6 in. per hr. for running time of 3 hr. 57 min. Average progress for 8 hr., 3¾ in. per hr.

River Diversion and Flood Control in Missouri

SYNOPSIS—This $4,000,000 job is to reclaim nearly 1,000 sq.mi. of low land. Flood waters now spreading over this district will be diverted to a defined channel, with large detention basins to equalize the flow. The use of electrically operated excavators of great size is a feature of the work. The plan and methods are described fully.

The reclamation of an area of some 500,000 acres of swamp and overflowed land in southwestern Missouri—constituting the Little River drainage district—is being effected by two distinct classes of work: River diversion to prevent the entrance of flood water, and ditches to drain the swamps and take care of the rainfall. The project was described in *Engineering News*, Mar. 18, 1915, and work is now in active progress. The general situation is shown by the plan and profile, Fig. 1.

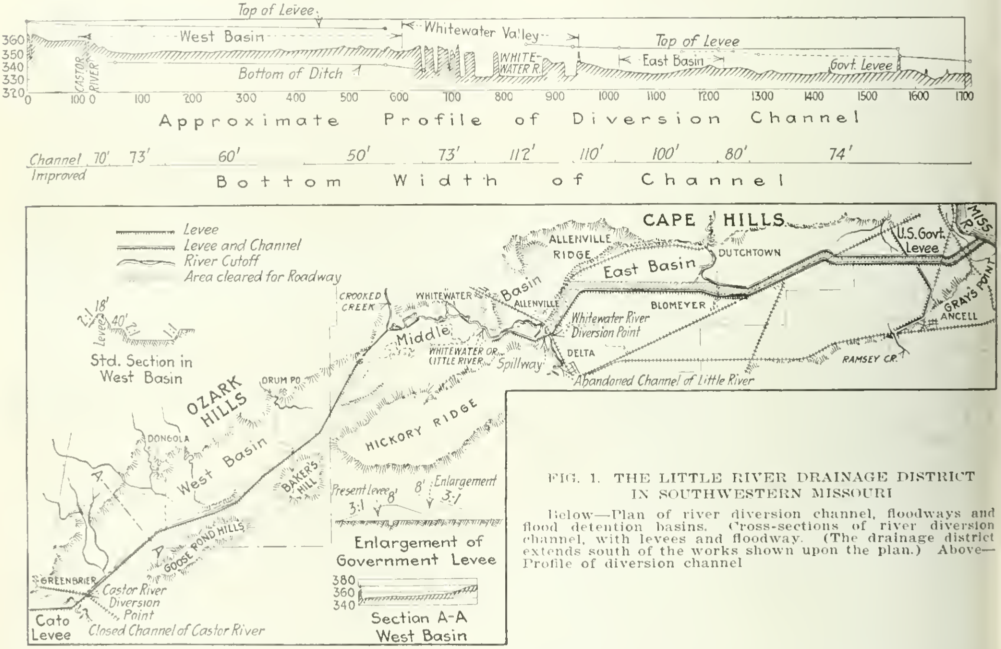


FIG. 1. THE LITTLE RIVER DRAINAGE DISTRICT IN SOUTHWESTERN MISSOURI

Below—Plan of river diversion channel, floodways and flood detention basins. Cross-sections of river diversion channel, with levees and floodway. (The drainage district extends south of the works shown upon the plan.) Above—Profile of diversion channel

The district lies back from the Mississippi River; it has a length of about 90 mi., north and south, and an average width of about 10 mi. The floods come from the Castor River and the Little River (or Whitewater), which flow out of the Ozark hills near the northwestern corner of the district. These streams are of a flashy character, but after leaving the hills the water flows slowly southward through the district by tortuous and ill-defined channels. These streams will be intercepted by a diversion channel along the north boundary of the district and extending eastward to the Mississippi River.

The surface waters will be carried southward by the ditch system, which will extend to the Arkansas line and there discharge into Big Lake, Arkansas. The state boundary is an arbitrary limit to the Little River district. On the Arkansas side, however, the Keystone drainage district has been organized, which is practically an extension of the other. Its works will deliver the combined waters from the two districts into the St. Francis River at Marked Tree, Ark.; this in turn discharges into the Mississippi above Helena, Ark.

The Little River drainage district has its headquarters at Cape Girardeau, Mo. William A. O'Brien is Chief Engineer; N. C. Frissell, Assistant Chief Engineer; B. F. Burns, Office Engineer. The river-diversion work is divided between two resident engineers—L. D. Sheppard and Harry V. Newcomb. The drainage-ditch system is divided among three resident engineers—Blair Boyle, Howard Henderson and E. S. Blaine, with William Mulholland as Locating Engineer. Isham Randolph (Chicago) is consulting engineer for the district. John A. Ockerson (St. Louis), A. E. Morgan (Dayton, Ohio) and Daniel W. Mead (Madison, Wis.) are consulting engineers for the bondholders.

The contract for the whole of the river-diversion work has been let to the Floesch Construction Co., of Rochester, N. Y., at $1,260,000. S. T. Neely is General Manager for the company. The drainage-ditch work is divided among several contractors at an aggregate price of $2,706,000. The total amount of excavation will be

8,600,000 cu.yd. for the river diversion and 34,230,000 cu.yd. for the drainage ditches. The former work is expected to be completed by October, 1917, and the latter by January, 1918.

RIVER DIVERSION FOR FLOOD CONTROL

The method of eliminating the flood water from the district is to carry the two rivers eastward across the north end of the district in a channel extending to the Mississippi River, as previously mentioned. Beginning near Greenbrier (Fig. 1), the channel of the Castor River will be improved for 2.5 mi. to the point of diversion, beyond which a channel and levee will extend 12.3 mi. to Crooked Creek. High ground here makes a levee unnecessary, but the channel of this river and then of the Little (or Whitewater) River will be improved and straightened for 5.5 mi. to near Allenville. There the channel and levee work will recommence, extending hence to the river, 15 mi. (as shown by the plan in Fig. 1). The total length of the diversion channel is 32.5 mi.

Typical sections are shown in Fig. 1. The main-channel section has a bottom width of 50 to 112 ft. (as shown eneath the profile in Fig. 1), with slopes of 1:1 on he open side and 2:1 on the side adjacent to the levee. There is a 40-ft. berm on this latter side. The levee is ft. wide, with an 8-ft. crown and side slopes of 3:1. t has a central muck ditch 8 ft. deep and 6 ft. wide, which insures thorough bonding with the ground beneath. For the floodway extending from the East Basin to the iver the smaller levee, along the north side, has an 8-ft. op, with side slopes of 2:1 and a muck ditch of the ze already given.

To provide for the possibility of a flood in the upper asin of the diversion channel being beyond the capacity f the channel, it is proposed to establish a spillway in the levee near Allenville. This would discharge excess water into the abandoned channel of the Little (or Whitewater) River, and the amount would be much less than the bank-full capacity of this channel. The spillway would be a stretch of levee with its crest 5 ft. below the normal crest elevation and having the slopes paved with concrete. Concrete toe walls, perpendicular to the slope, would prevent undercutting or wash.

FLOODWAYS AND DETENTION BASINS

The provision for heavy floods is an interesting feature of the work. The channels could not be made large enough to carry the water of maximum floods, but a strip of land has been obtained along the channel as a floodway. This is cleared and grubbed and will be flooded when the channel capacity is exceeded. On the west end of the work this floodway has a width of about 1,500 ft. and is bounded by rising ground (Fig. 1).

At the east end of the work, the ground is low, and the floodway has to be formed by a second and smaller levee on the far side of the cleared area. As this excludes flood water from the adjacent district on the north, a drainage ditch outside of and parallel with this levee is required to care for surface water for the land north of the floodway. The width of this defined floodway is about 900 ft.

Besides the floodway there will be three flood-detention basins, formed by the levees, having an area of 23 sq.mi. and providing ample capacity to hold the water of a sudden storm on the watershed. These basins will be dry and in large part available for cultivation except during flood periods.

The use of these large basins is a special feature of the headwater-diversion system, and it is believed that the formation of detention basins of such magnitude has not been attempted elsewhere in this country or abroad

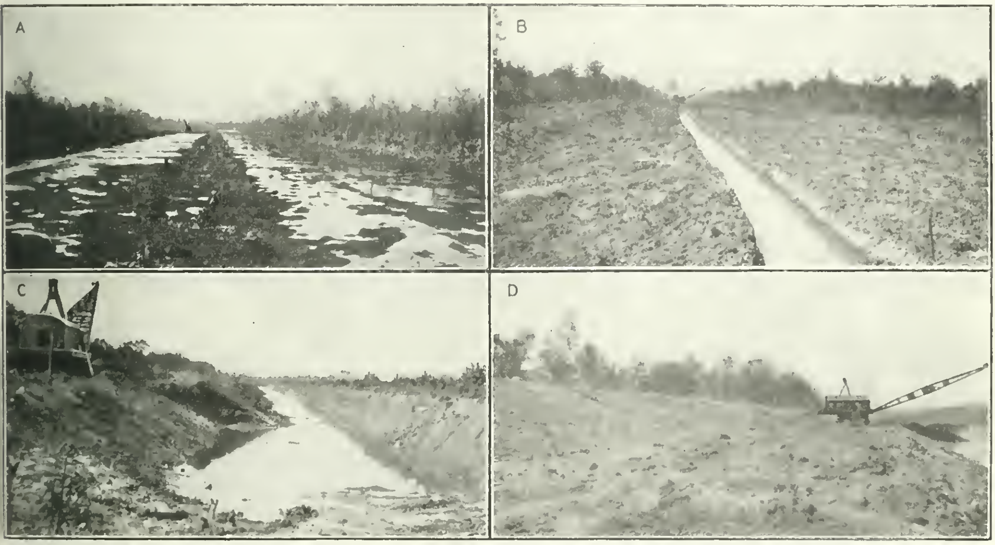


FIG. 2. DIVERSION OF THE LITTLE RIVER, IN MISSOURI

A—Area stripped for the channel and levee. B—Muck ditch for levee. C—Cutting the channel; the excavator has commenced the cut, another (not shown) is completing it to full section. D—Levee and channel; the excavator is on the 40-ft. berm, excavating the channel at the right and putting the material in the levee at the left in connection with land-reclamation works. The capacity of the West Basin is about 3,000,000,000 cu.ft. and 5,000,000,000 cu.ft. at elevations 360 and 365 (see profile, Fig. 1); that of the Middle Basin is nearly 2,000,000,000 cu.ft. at the former elevation. The capacity of the East Basin is 1,500,000,000 cu.ft., of which 418,000,000 cu.ft. is above the Mississippi River flood plane of 1,844, so that this basin provides storage capacity for floods of the hill streams even when the Mississippi is in flood.

LEVEE AND CHANNEL CONSTRUCTION

The site for the levee and channel is cleared of all vegetation. Trees are felled by means of crosscut saws and cut up into 20-ft. lengths. The stumps are either pulled out bodily by a Clyde steam stump-pulling machine, with occasional blasting of large stumps, or they are all blasted, using 40% dynamite, and the pieces are pulled out with horse-operated stump-puller tackle. The cutting is done by small local contracts, and not much of the timber is utilized, as there is not time for its sale and removal in advance of the excavation. The logs and slash are either stacked on the channel site and burned or are stacked outside of the levee line and covered with the stripping. The steam stump puller does its own stacking, but where the material is handled by teams the stacking is done by steam hoists or skidders.

The entire area for the levee and channel is stripped to a depth of 12 in. in advance of the main-channel excavation. On part of the work, where the slow progress of clearing had checked excavation, the stripping and the cutting of the muck ditch for the levee were done by one of the large electric excavators. But these machines could make more money for their owners when cutting the channel, and the best results were obtained where the clearing was kept well in advance, and a special stripping excavator was used between this and the main excavators.

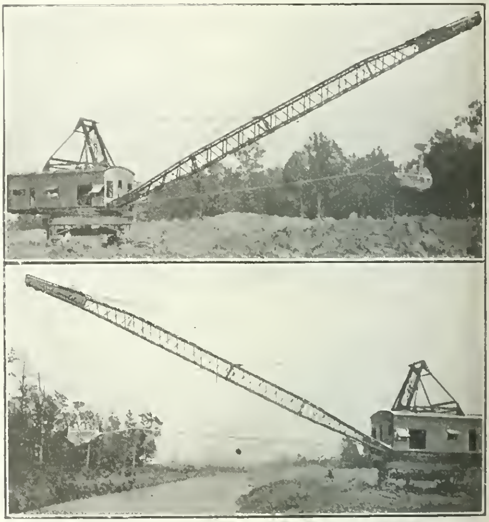
The stripping machines are 80-ton Bucyrus dragline excavators with 70-ft. boom and 1½-yd. bucket. Each is mounted on two pairs of caterpillars. Even the broad base of the caterpillars is not sufficient to support the machines in traveling over the soft ground, full of stump holes. They travel therefore on pads made of layers of heavy planking, the pads being 16x5 ft. in size and handled by the boom. This machine works back and forth, longitudinally of the work, stripping the entire surface, cutting the muck ditch and removing any broken stumps left by the stump puller.

Where all the work is done by the main dragline excavators, the method of procedure is as follows: One of the excavators travels first along the site of the south berm, stripping the surface of the channel and depositing the material in a spoil bank 40 ft. from the north edge of the channel. This bank is about 4 ft. high, well rounded, and drainage openings will be cut through it later to admit surface drainage from the floodway area to the channel.

After stripping the surface for a distance of about 2,000 ft. the machine returns along the center line of the levee, stripping the levee site and making the muck ditch (8 ft. deep and 6 ft. wide). The stripping is thrown upon the stumps and grubbing piled 15 ft. from the south toe of the levee. The material from the muck ditch is placed along the south toe, so as to retain the main fill.

Having finished this work on the stretch of 2,000 ft., the machine then moves to its first position (on the berm) and again travels forward, excavating one-third of the channel prism. The second excavator follows and completes the channel to its full dimensions (Fig. 3). Both machines build the levee with the excavated material. The levee has a maximum height of about 18 ft. and is built in three layers or lifts of 5 to 6 ft.

For the work on the lower part of the river diversion, where the stripping is done by a separate machine, the method of working is slightly different. The stripping from the channel is placed outside of the levee, along the edge of the right-of-way. The stripping from the levee site and the material from the muck ditch are placed along the toe of the levee on the berm or channel side. The main dragline machines then travel along the berm, excavating the channel and building the levee in four lifts. Fig. 2 shows some of the stages of the work.



FIGS. 3 AND 4. ELECTRIC DRAGLINE EXCAVATORS WITH 100-FT. BOOMS AND 4½-YD. BUCKETS

Fig. 3—Dumping on the levee. Fig. 4—Finishing the river-diversion channel

On the upper part of the work, above Allenville, the material is mainly a stiff white clay, which stands very well in the slopes and is easily dressed to the specified slopes both for the channel and the levees. There are some red earth and sandy soil also, while at some points, generally in high ground, the bottom of the cut is in fine sand. The dragline machines, with diagonal cuts, finish the channel very closely to the specified slopes. For finishing the levee the lighter material is used in the top and sides, any large lumps being broken up and leveled by a man with a shovel. The slopes will be seeded with a mixture of white clover, bermuda and herd grass.

The lower section of the work is largely in gumbo soil, which will stand in the slopes of the cut, but when heavily saturated will not stand at the specified slopes for the levee. Here the material is being deposited temporarily as a spoil bank, of lower height and greater width than the levee section. After the material has dried and settled, a dragline excavator will travel along the top of this bank, taking the material from the sides and placing it on the top, giving the required height and slopes.

For the drainage ditch outside the north levee forming the floodway the stripping is done by a steam caterpillar dragline with 1½-yd. bucket. This places the material along the south toe of the levee. A steam dragline excavator with 100-ft. boom and 3½-yd. dipper then excavates the ditch and throws the material into the levee. This has a slope of 2 : 1 on the ditch side and 2¾ : 1 on the floodway side; the flatter slope is due to the material spreading out over the stripping piled along the toe.

Electric Dragline Excavators

The main-channel excavation is done by four Bucyrus electrically operated dragline machines, two on each division. This use of electric power for large excavators is one of the specially interesting features of the work. Two are 165-ton machines, having 100-ft. booms and 3½-yd. buckets, with 200-hp. main motor and 115-hp. swinging motor. Of the remaining two, one has a 100-ft. boom and 4½-yd. bucket, while the other has a 125-ft. boom and 3½-yd. bucket. These latter have 250- and 125-hp. motors for the main operation and swinging movements and weigh 206 tons each. The machines are shown in Fig. 3.

All these machines operate on 3-phase 60-cycle 440-volt alternating current, which is generated at 13,200 volts at the power house of the Cape Girardeau (Mo.) electric light plant, additional turbo-generators being installed for the purpose. The contractor builds his own transmission line along the work, using steel latticed poles. At each excavator there is a transformer outfit. For the machines on one section the outfits are mounted on skids and hauled ahead by a horse-operated windlass and cable as the work progresses. At first the excavator, in moving ahead, picked up its transformer outfit and swung it ahead, but this involved too much loss of time in the work of excavating. On the other section the transformer outfits are on scows floating in the first cut made by the excavators.

Each electric excavator has an operator and an oiler. The former sits at the front and controls all movements by a bank of levers. The latter sees that the machinery s kept in working condition. These men work three 8-hr. shifts. There is no stop for meals, but the oiler (glad to learn how to run the machine) takes a spell while the operator eats his lunch. There are four to ix pitmen to each machine; and they work 12-hr. shifts.

An electric fan near the operator's seat serves to keep he mosquitoes and flies from troubling him. Work proceeds continuously, night and day, for six days a week, nd on Sundays the machines are overhauled and given any necessary repairs.

The main part of the machine revolves on a 24-ft. urntable upon a steel tower about 21 ft. square and 0 ft. high. The total weight is carried by four 4-wheel rucks with 22-in. grooved wheels. The two forward rucks are pin-connected to the tower. The rear trucks re connected by a long transverse equalizing beam, so hat the machine is stable even on irregular track. The machine makes a full swing (loading, dumping and reurn) in 45 to 60 sec.

The trucks ride on two tracks of 30-in. gage, spaced 6 ft. c. to c. Each track is in lengths of 15 ft., which re shifted by the machine. The tracks are of very heavy construction, but soon become distorted vertically, owing to the weight of the machine and the soft soil. Each track has 100-lb. rails on steel base plates on longitudinal timbers 10x12 in. These timbers rest on closely spaced 6x12-in. ties, 8 ft. long, bolted to 4x12-in. longitudinal planks. Ring bolts in the platforms or pads are provided for the attachment of chains in shifting. (*Engineering News*, July 13, 1916.)

The maximum monthly records for these electric dragline excavators are 90,000 and 80,000 cu.yd. for machines with 4- and 3½-yd. buckets respectively. For a 24-hr. run the maximum record is 5,800 yd.

Government Levee

The work crosses the present Government levee, which will be cut for the channel and the remaining portions widened and raised to the full section of the new levees (Fig. 1). This involves also the construction of a diversion channel for Ramsay Creek, outside the Government levee, and with a new levee along its outer side.

This work is being done under subcontract by Bartson & Millard, of Peoria, Ill., using a Monighan steam dragline excavator with 100-ft. boom and 3½-yd. bucket. For the stripping and muck-ditch excavation they use a Lidgerwood dragline machine; this travels on rollers and has a 60-ft. timber boom and a 1-yd. bucket.

The railway bridges across the diversion channels and ditches are built by the railway companies, the structures being needed to meet the requirements of the engineers for the district. The state law compels county authorities to pay for bridges across drainage channels, but one of the counties concerned has claimed that this does not apply to the river-diversion work. This question is now before the Supreme Court of Missouri, and in the meantime the district has built trestles to carry roads across the channel.

Several railway lines traverse the district, so that in most cases the excavators could be assembled at a point of shipment and then be moved a short distance to the work.

Engineering and Inspection

The field party on each of the two river-diversion divisions consists of an instrumentman, rodman, chainman and inspectors. The first three stake out the work in advance and make cross-section measurements of the finished work. Four lines of stakes are set; these mark the center lines of channel and levee and the toes of the levee slopes. Any labor necessary to assist the party is furnished by the contractor.

Cross-section measurements are plotted directly in the field on section-paper tablets, with carbon paper for making a duplicate. Thus any mistake or discrepancy is evident at once. Three shots are taken on each slope and at 5-ft. intervals across the bottom. On one stretch of very wide ditch the bottom was too wet for wading, and there was not enough water for a boat. Here two 100-ft. tapes were tied together and stretched across the cut, while a level rod was suspended in such a way that it could be worked along the tape. The measurements were taken from the water level, as the grade line, so that the sag of the tapes had no effect upon the readings.

Monthly records are made of the expenses on each residency, showing the ratio of engineering expenses to amount of excavation.

Loose-Leaf Filing System for City Surveys

By James M. Owens*

After the great conflagration of 1906, which destroyed practically all of the municipal records in San Francisco, it was found when the scattered forces of the city engineer's office were brought together in a temporary office (in a hay and grain barn) that there remained hardly any official records with which to recommence business. During the period of reconstruction there was not much time available for refinements in the handling of office work. Particularly was this true in the case of the Survey Department. It was quantity rather than quality that the public demanded, and there was neither time nor money available for introducing modern office equipment or methods. During this time the need of a new system in handling this office work was very apparent. A loose-leaf system for field notes promised satisfactory results. As an index for these a 15x20-in. lithographed copy of a map compiled by the city assessor proved convenient.

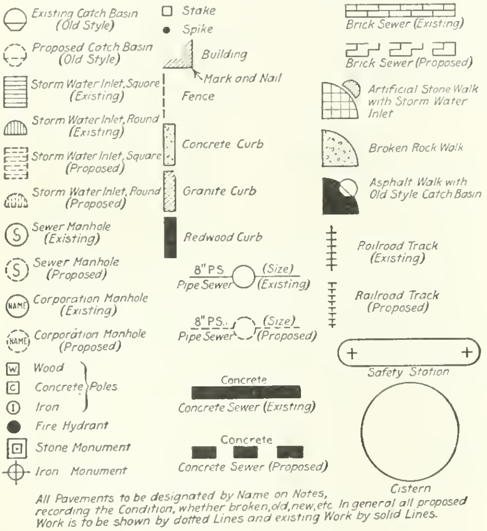

Existing Catch Basin (Old Style)
Proposed Catch Basin (Old Style)
Storm Water Inlet, Square (Existing)
Storm Water Inlet, Round (Existing)
Storm Water Inlet, Square (Proposed)
Storm Water Inlet, Round (Proposed)
Sewer Manhole (Existing)
Sewer Manhole (Proposed)
Corporation Manhole (Existing)
Corporation Manhole (Proposed)
NAME
Wood
Concrete
Iron
Poles
Fire Hydrant
Stone Monument
Iron Monument
Stake
Spike
Building
Mark and Nail
Fence
Concrete Curb
Granite Curb
Redwood Curb
8" P.S. Pipe Sewer (Size) (Existing)
8" P.S. Pipe Sewer (Size) (Proposed)
Concrete
Concrete Sewer (Existing)
Concrete
Concrete Sewer (Proposed)
Brick Sewer (Existing)
Brick Sewer (Proposed)
Artificial Stone Walk with Storm Water Inlet
Broken Rock Walk
Asphalt Walk with Old Style Catch Basin
Railroad Track (Existing)
Railroad Track (Proposed)
Safety Station
Cistern
All Pavements to be designated by Name on Notes, recording the Condition, whether broken, old, new, etc. In general all proposed Work is to be shown by dotted Lines and existing Work by solid Lines.

FIG. 1. CONVENTIONAL SIGNS FOR DIFFERENT CLASSES OF STREET WORK

Briefly, the assessor's idea was to divide the city into some 18 districts, starting with the older 50-vara district. A certain allotment of numbers was allowed for each district. In the partly developed districts an extra set of numbers was made available to cover all possible block extensions. The block numbers on this map were from 1 to 7,200. Under this system each block has a definite number and location, which remains unchanged despite the block extensions that may be made. This gives a very simple method of locating a particular property when the block number is once known. In adapting this system to the needs of our surveying department the following simple scheme of indexing was used:

For single units of street work—say a roadway pavement or crossing—the highest and lowest block number adjoining the work was used; such as 24/48, the survey being filed under 24. For more extended pieces of construction work, covering a series of blocks, the lowest block number adjoining the work and the highest within its scope were used in the same fashion. For property surveys the block number was used. For special projects such as the various tunnels and municipal railroads, separate index cards were made, filed separately and designated by the name of the particular project. This briefly describes our system of filing field notes. This method has been in use here for the last 2 yr., and we have found that it works very satisfactorily.

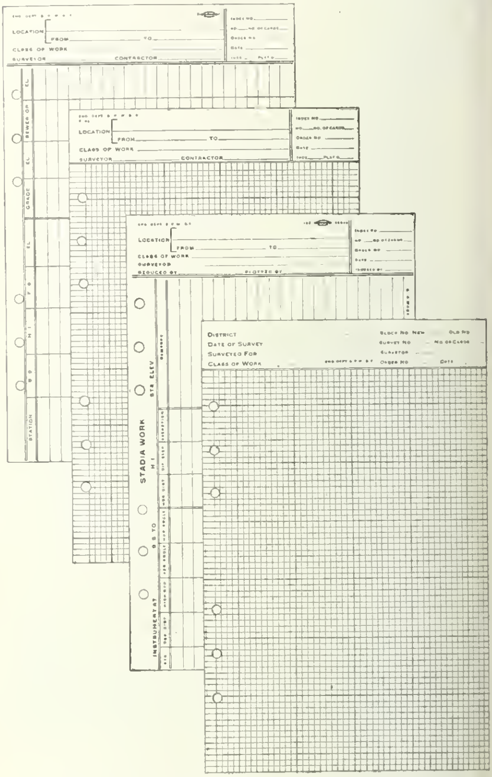


FIG. 2. FOUR LOOSE LEAVES (5x7¾ IN.) FOR RECORDING SURVEYS

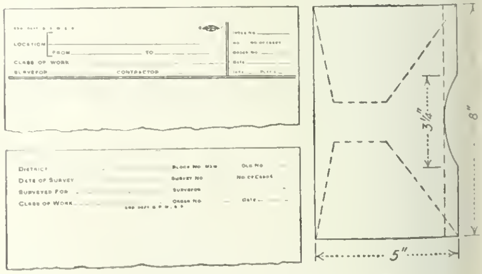


FIG. 3. ENVELOPES FOR STREET (UPPER) AND LOT (LOWER) SURVEYS

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*Assistant City Engineer, in charge of pavement design, San Francisco, Calif.

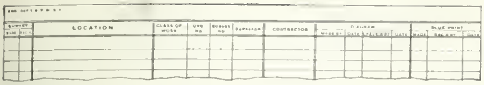

SURVEY
LOCATION
CLASS OF WORK
CONTRACTOR
DIAGRAM
Date
BLUE PRINT

FIG. 4. SURVEY RECORD IS KEPT ON THIS 5x8-IN. CARD

For the sake of comparison it may be well at this time to give an illustration of the working of the old system and the disadvantages incident to its use. Whenever a survey was ordered, it was found necessary to give the surveyor from one to six notebooks as references for his daily work, that he might correlate it with surveys already completed. When this daily assignment of work in the field was completed he turned in his notes all in one book. This work was then assigned to the different draftsmen for the preparation of diagrams. Under this order of things the surveyors would have in the field for an entire day, say from 20 to 40 fieldbooks, containing some 300 or 600 jobs, notwithstanding the fact that for their immediate needs only one job in each book might be required. For the office men who were making up the notes almost as many books were in daily use.

The transition from the old to the new system presented some slight difficulty to the field men for the reason that it is always more or less difficult to get away from the beaten path. They soon learned, however, to appreciate the greater simplicity of the new system.

No claim is made to originality in the use of a loose-leaf system for this class of work. Claim is made only for the special arrangement of the handling and filing of the notes. The following description will give a good idea of the arrangement of our filing system for field surveys, the component parts of which are as follows:

Order books, consisting of a General Order Book and a Municipal Order Book.

A 20x30-in. cardboard assessor's desk map of the city, with plate-glass cover.

Specially designated loose-leaf covers, with stiff backs, consecutively numbered and properly labeled.

Set of field instructions for surveyors.

Sets of conventional signs for the different classes of street work (Fig. 1).

Four different types of loose leaves for recording surveys (Fig. 2), 5x8-in.

Two different types of filing envelopes for surveys (Fig. 3).

Special card for arranging data from the inception to the delivery of diagrams (Fig. 4), 5x8-in.

Assignment-of-work folder (same as top sheet in Fig. 2).

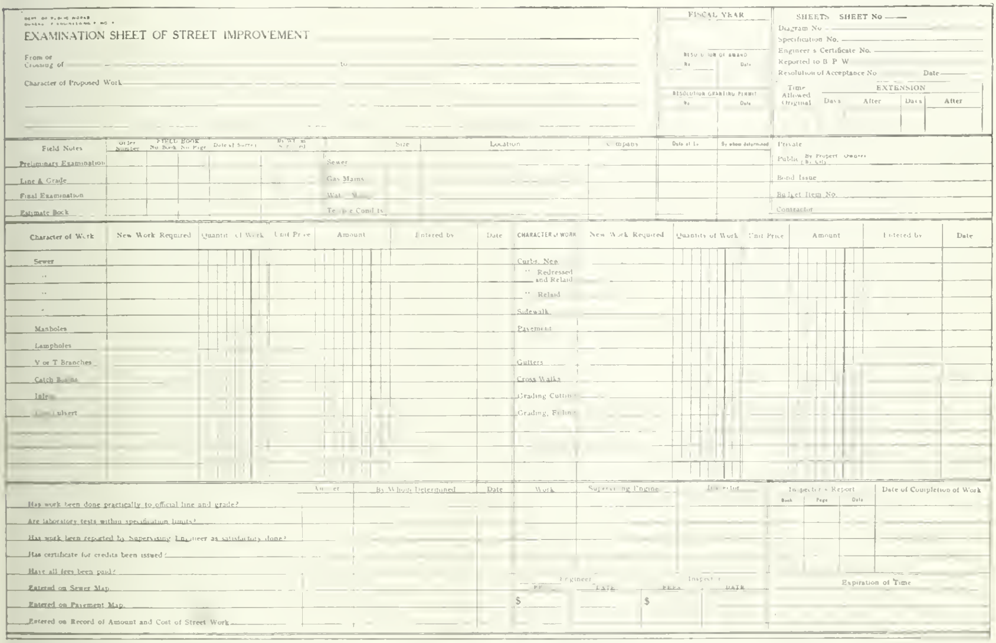
Work-to-be-checked folder (same as top sheet in Fig. 2).

Work-to-be-filed folder (same as top sheet in Fig. 2).

Special celluloid index cards tabbed and numbered in series of 100.

Supplementary celluloid index cards tabbed and numbered in series of 20.

Two special sizes of tracing-cloth sheets for diagrams $9\frac{1}{2}$x15-in. and $9\frac{1}{2}$x12-in. (Fig. 6).


EXAMINATION SHEET OF STREET IMPROVEMENT
From or Crossing of
to
Character of Proposed Work
FISCAL YEAR
SHEETS SHEET No
Diagram No
Specification No.
Engineer's Certificate No.
Reported to B. P. W.
Resolution of Acceptance No
Date
Time Allowed Original
EXTENSION
Days
After
Field Notes
Preliminary Examination
Line & Grade
Final Examination
Estimate Book
Size
Location
Sewer
Gas Mains
Private
Public
Bond Issue
Budget Item No.
Contractor
Character of Work
New Work Required
Quantity of Work
Unit Price
Amount
Entered by
Date
Sewer
Manholes
Lampholes
Y or T Branches
Catch Basins
Inlets
Culvert
Curbs, New
Redressed and Reland
Relaid
Sidewalk
Pavement
Gutters
Cross Walks
Grading Cutting
Grading, Filling
By Whom Determined
Supervising Engineer
Inspector's Report
Date of Completion of Work
Has work been done practically to official line and grade?
Are laboratory tests within specification limits?
Has work been reported by Supervising Engineer as satisfactorily done?
Has certificate for credits been issued?
Have all fees been paid?
Entered on Sewer Map
Entered on Pavement Map
Entered on Record of Amount and Cost of Street Work
Engineer
Inspector
FEES
DATE
$
Expiration of Time

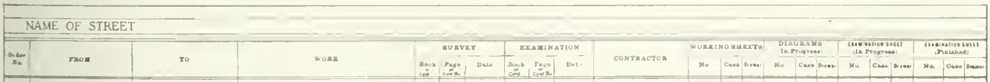

NAME OF STREET
Order No.
FROM
TO
WORK
SURVEY
Book or Card
Page or Card No.
Date
EXAMINATION
CONTRACTOR
WORKING SHEETS
DIAGRAMS (In Progress)
Examination Sheet (In Progress)
Examination Sheet (Finished)
No.
Case
Drawer

FIG. 5. (UPPER) EXAMINATION SHEET ($9\frac{1}{2}$x15 IN.) GIVING FULL DATA ON STREET IMPROVEMENTS. (LOWER) GENERAL INDEX CARD ($9\frac{1}{2}$x11 IN.) OF STREET WORK

Extra sheet for street work (Fig. 5, upper).
General index card street work (Fig. 5, lower).
Standard 5-drawer built-up sections for filing surveys.
Case for filing field diagrams and blueprints of finished work.

Orders for street and lot surveys are of two classes—"General" and "Municipal." These orders are taken from the desk books by the assistant in charge of the preparation of field data, who prepares the necessary information for the surveyors. These are turned over to the assistant in charge of filing for distribution to the different surveyors. These the latter place in their folders, together with sufficient blanks for the work in hand. Upon completing a survey the reference notes and finished notes are turned in and are properly indexed and filed by the assistant in charge of filing.

[A] NOTICE TO CONTRACTORS AND INSPECTORS

All street monuments found along the line of the work must be capped with iron frames.

Frames will be furnished by Engineering Department upon application.

Street monuments shall not be disturbed until permission is given by this office.

[B] CITY AND COUNTY OF SAN FRANCISCO, DEPARTMENT OF PUBLIC WORKS, BUREAU OF ENGINEERING
M. M. O'Shaughnessy, City Engineer
Surveyed for..........................
Date ....
Drawn by........Checked by........
Date.......... Date..........

[C] No. ....
Order No. ....
Survey No. ....
No. of cards..........
Surveyor ....
Private Contract .....
Public Contract ......

FIG. 6. CAPTIONS WHICH ARE ATTACHED TO TRACINGS FOR STREET-WORK DIAGRAMS

In arranging the field notes in the cabinet the following method is used: Block numbers are arranged consecutively. For surveys of property in the same block, with the block number as prime unit, the order of filing is according to the chronological sequence of the surveys (their order number). An index of these surveys is made in the Daily Record Sheet, and given to the assistant in charge of street work, who assigns the different pieces of work to the draftsmen. When any particular job is completed, the draftsman turns over all working data, notes and completed diagrams to this assistant, who places the notes in the "To-Be-Checked" folder, and has the job checked as soon as possible.

When checked the notes are placed in the "To-Be-Filed" folder, and at the end of each day are filed away in the cabinet in their respective envelopes. The completed diagram is then blueprinted; three prints being made, one for the Supervising Engineer, one for the inspector and one for the contractor. The filing envelope, after being made and placed in the cabinet, always remains there and acts as a receipt and check for the number of surveys made.

This is the system for all surveys made; in special cases, where the notes are extended and are required in the field by the construction engineer and his inspectors, photostat copies are made of each survey. When a large job is completed, a set of these notes is filed in a folder, with the rest of the working plans and data, and consequently a complete history of any particular job is always available.

On my recommendation this system was adopted for the division of surveys, the files of which are kept distinct from those of the construction, sewerage-design, water-supply, municipal-railway, tunnels, and other divisions of the Bureau of Engineering, each of which has its separate system. All divisions are under the direction of M. M. O'Shaughnessy, City Engineer.

Some Results of Analyses of Garbage and Waste

The thorough investigation and study of the collection and disposal of municipal waste in the District of Columbia, made by Irwin S. Osborn, Consulting Engineer, Cleveland, Ohio, makes available data on the composition and value of these wastes which will prove useful to others studying the same problems elsewhere. An outline of the methods employed in this investigation was given in *Engineering News*, Aug. 17, 1916. Some of the results of the investigation follow.

GARBAGE STATISTICS

The average per capita per annum production of garbage in the District at the present time amounts to approximately 285 lb. From the studies made it was found that the weight per cubic foot of garbage varies considerably from day to day, depending upon how well the load is packed. Where collectors deliver two or more loads per day, it is found almost invariably that the first load runs heavier per cubic foot than the second load, which is simply placed in the wagon loosely, although in cold weather the unit waste is about the same. The daily average weights per cubic foot run from 44.7 to 51.2 lb.

The per capita production of garbage in the District of Columbia is very high as compared with the per capita productions of other cities. This condition can be accounted for by the fact that there are practically no slums in the city and the majority of people are of the better residential class, who produce a larger percentage of waste than do residents in average cities. At the same time all the garbage is collected, including that from hotels and restaurants, as well as from the floating population, whereas in the majority of cities the garbage from hotels, restaurants, etc., is gathered by private collectors and is not included in the reports. The per capita production varies from year to year, although increasing each year with few exceptions from 1900 to 1915.

PRODUCTION OF RUBBISH

The production of rubbish has increased considerably during the past years, as shown by the records. In 1907 approximately 0.196 cu.yd. was collected per capita per year, and in 1914 the corresponding amount was 0.415 cu.yd. The latter figure, no doubt, is as close to the maximum as can be expected.

In making weight and volume studies it was found that there was considerable variation in weight per cubic yard, the largest occurring during rainy weather. The variation per cubic yard was due either to moisture in composition of the material or the packing of the load by the collector. From the total studies made, the average weight per cubic yard was found to be 201 lb.

The results of analyses (see accompanying Table 2) to determine calorific values, by the United States Bureau of Mines, constitute the first data which are available in regard to the calorific values of various constituents of rubbish. From the analyses made it was found that the amount of ash in cardboard, linoleum and magazines was considerably higher than that found in other items. It was the opinion of the fuel chemist of the Bureau of Mines that the amount of ash in cardboard and linoleum was no doubt due to mineral fillers, and a high ash value

TABLE 1. RESULTS OF MECHANICAL ANALYSES OF RUBBISH IN % OF WEIGHT, 1914-15

Material	Nov.	Dec.	Jan.	Mar.	May	June	July	Aug.
Newspaper	10.4	17.8	19.5	16.1	15.6	17.2	17.0	16.0
Manila paper	6.6	12.7	7.0	9 5	8.7	7.3	12.1	13.4
Cardboard	0.8	9.4	11.7	10.5	9.7	6.9	10.9	12.8
Books, etc.	4.4	3.0	2.4	2.4	3.3	3.2	1.4	5.6
Mixed paper	16.6	4.4	3.1	5.0	4.6	2.8	2.4	2.6
Rags	5.9	3.7	4.5	5.2	7.2	4.3	5.0	5.7
Wood	1.2	7.4	1.4	2.8	2.6	4.1	3.6	4 1
Leather	1.5	0.2	0.4	0.7	1.2	0.2	1.0	1.1
Rubber	0.3	0.3	...	0.3	0.5	...	...	...
Screenings	...	4.6	18.5	13.4	10.4	18.6	12.3	11.1
Tinware	10.2	7.3	11.7	13.6	8.8	6.6	5.6	6.4
Enamelware	0.4	0.4	0.1	0.4	0.3	5.0	...	0.1
Metals	1.8	0.6	0.3	0.8	1.3	1.1	0.8	1 5
Bottles	11.0	8.1	7.7	9.0	7.7	8.3	8.4	7 2
Broken glass	3.8	3.5	4.0	4.7	5.2	4.3	4.8	3.5
Excelsior	...	0.7	0.3	0.8	0.7	0.1	0.7	...
Mattresses, etc.	5 2	1.1	...	...	0.3	...	0.7	0.1
Matting	3.1	0.8	0.1	0.3	1.6	1.5	1.4	...
Linoleum	0.7	...	...	...	0.3	0.1	...	0.1
Straw	...	...	0.4	...	...	...	...	...
Dirt	16.1	14.0	6 9	4.5	10.0	8 4	11.5	8.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

in the rubber resulted from the clay and similar filler, as well as the fabric contained in the rubber. The high ash value of books and magazines was attributed to the sizing of the paper, which would account for its low calorific value.

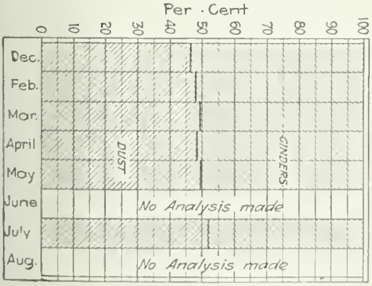
From the results obtained in making calorific tests of the various component parts of the rubbish it is possible to compute the calorific value of the rubbish as collected. The percentages of the various constituents determined by making mechanical analyses, multiplied by the calorific values obtained, give the average calorific value of the rubbish as collected.

In comparing the calorific values with the average constituents found in the rubbish as a whole, taking into account all items determined by mechanical analyses, it was found by computation that the average calorific value in samples as collected, including the noncombustibles, such as metal, dirt, etc., amounted to 5,500 B.t.u. per lb.

Analyses of Ashes

In making the analyses of the ashes it was found that there was no definite relation between the weight of the cinders and the weight per cubic yard of the ashes, although the weights show a slight range per cubic yard. In cases where the maximum weights were found, the ash contained a higher percentage of moisture, the percentage of cinders depending on the residences from which it was collected, as would be expected.

The percentage of cinders produced in the ash was approximately 50%. On comparing the results given in ables of calorific value it was evident that considerable ombustible material was left in the ash. The average f 45 analyses of the screened-out cinders showed the ollowing: Moisture, 2.05%; volatile matter, 3.53; fixed arbon, 51.1; ash, 45.3%. The average B.t.u. per lb. in he samples as received was 7,858; and dried, 7,932. The calorific value of this ash, if recovered each year, would amount to that produced by approximately 24,000 tons of coal. The highest calorific value of ashes was found in the collections from the residential sections, which contained a higher percentage of unburned coal.



PROPORTION OF CINDERS IN ASHES

TABLE 2. RESULTS OF CALORIFIC TESTS ON COMPONENTS OF RUBBISH, BY BUREAU OF MINES*

		Dry Coal					
Component	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.t.u. as Received	B.t.u. Dry Coal
Newspaper	6.2	86.9	10.0	3.1	0.10		8,230
	8.67	87.41	7.84	4.75	0.11	7,485	8,196
Manila paper	5.1	88.9	8.6	2.5	0.25		7,840
	8.99	89.12	8.14	2.73	0.13	7,626	8,379
Mixed paper	5.3	84.8	10.7	4.5	0.15		7,910
	9.07	86.85	9.6	3.55	0.16	6,867	7,552
Books and magazines	4.4	71.2	5.1	23.7	0.35		5,630
	7 24	74.72	4.88	20.4	0.08	5,400	5,821
Cardboard	6.0	80.3	10.4	9.3	0.15		7,430
	8.67	84.39	9.33	6.28	0.16	7,154	7,833
Screenings	8.6	78.1	11.4	10.5	0.30		6 910
	9 97	83.11	9.08	7.81	0.46	6,483	7,201
Wood	6.3	87.6	11.0	1.3	0.10		8,910
	9.55	87.78	10.22	2.0	0.19	7,721	8,536
Excelsior	7.0	88.5	10.4	1.1	0.05		8,580
	9.48	92.76	6.8	0.44	0.19	7,853	8,675
Matting	10 20	82.41	8.08	9.51	0.19	6,266	6,978
Rags	3.7	89.9	8.8	1.3	0.10		7,410
	6.47	94.39	2.45	3.16	0.16	7,312	7,818
Rubber	1.2	...	...	47.6	0.65		6,620
Leather	5.9	72.3	17.7	10.0	0.45		8,530
	10.33	78 64	11.18	10 18	0.45	8,240	9,189
Dirt	2.7	20.2	9.1	70.7	...		4,261
	3 7	22.27	3.87	73.86	...	3,661	3,802
Linoleum	2 1	65.8	6.8	27.4	0.40		8,310
Mattress	6.4	75.4	18.5	6.1	0.25		7,430

*The average calorific value per pound of rubbish as collected, including dirt, metals and other noncombustible material, amounts to 5,500 B.t.u.

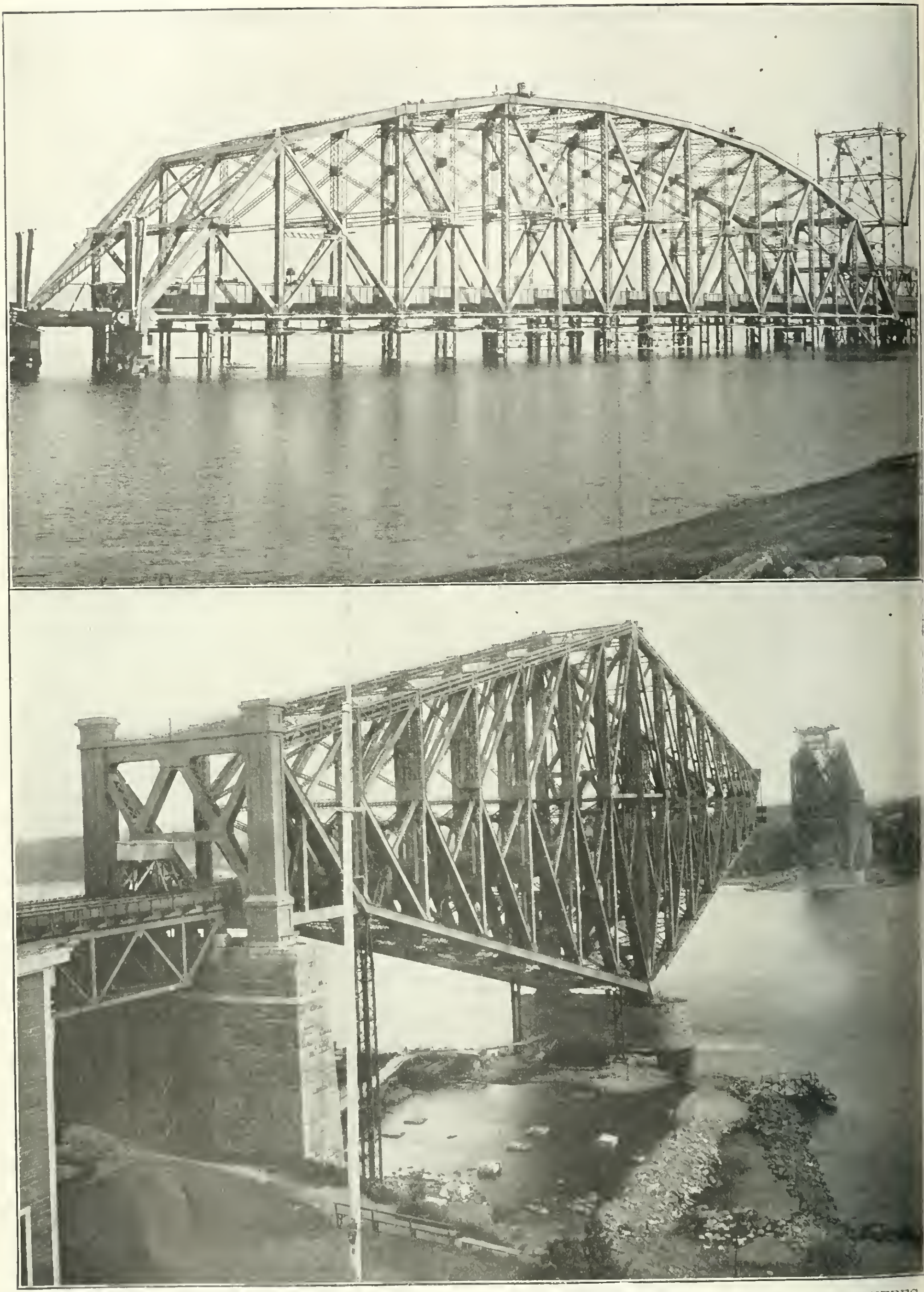
Quebec Bridge in Picture

Four striking views of the Quebec Bridge are presented on two following pages. They immediately recall to all who have followed this, the world's most notable piece of bridge work, some of the outstanding features of design and erection which it is well to review as the day of completion draws near.

One view shows the famous K-truss in the anchor and cantilever arms, the first use of an epoch-making departure in design. With this goes the novelty of a bridge within a bridge to carry the floor, the extensive use of nickel-steel and larger and longer rivets than ever before. A second view shows the 640-ft. suspended span, in itself the longest single-span bridge yet completed.

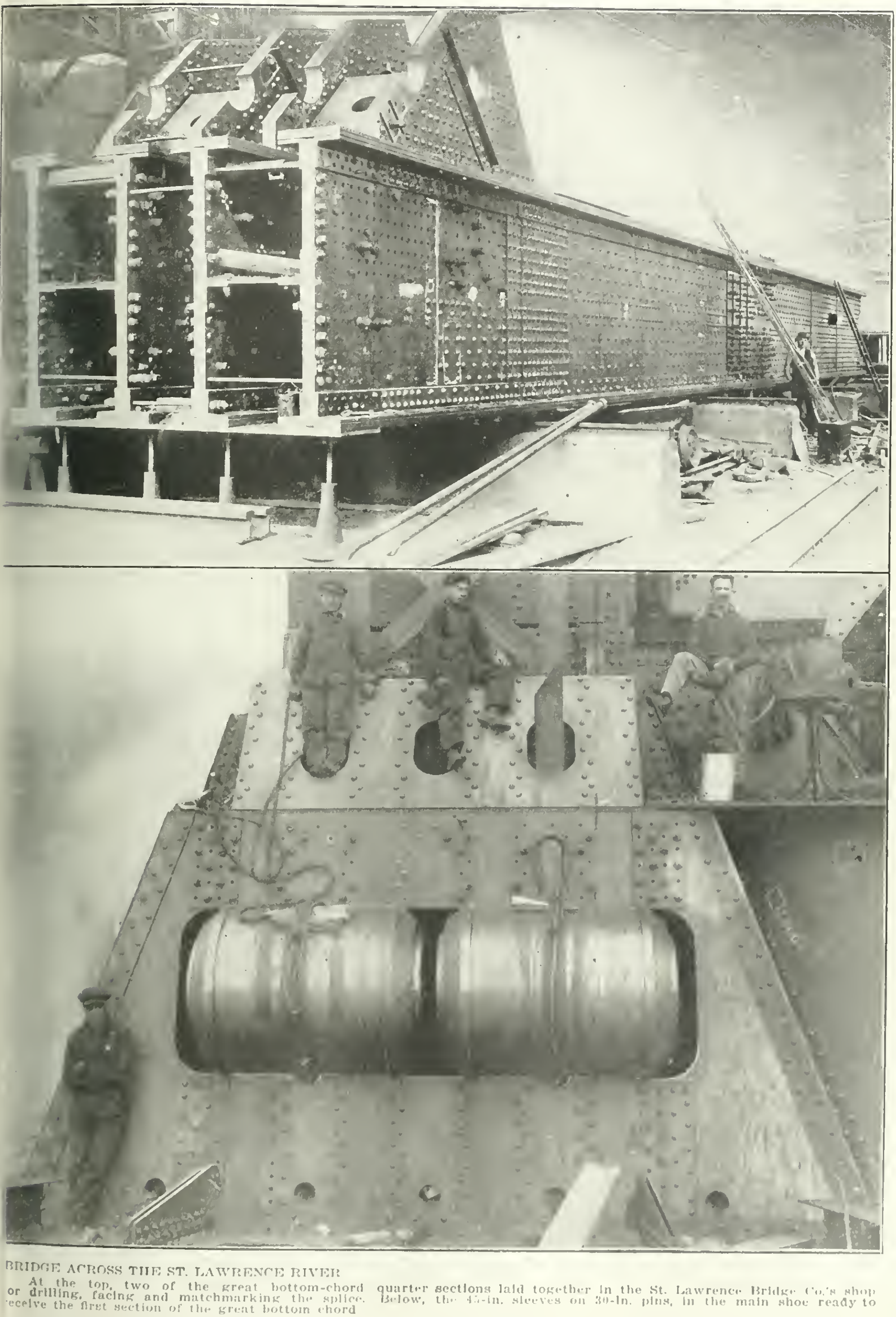
The views of two great bottom-chord sections and a pair of the huge main-shoe multiple pins are reminders not only of a pioneer design but also of the great accuracy to which the builders' shop practice was developed. So determined was the bridge company on this last point that the shop handled nothing on which coarser work was permissible; even the falsework was sublet to get it outside. The benefits of a new shop, new machines and new methods were reflected in the smooth machine-like progress of erection and in elimination of field corrections.

Taken together any collection of such views must emphasize the boldness of the erection schemes, as for the elimination of secondary stresses in bottom chords, the lavish expenditure on construction adjuncts like the 200-ft. traveler, the anchor-arm falsework, the flying bridge, the top-chord jacking links and eye-bar trusses. Yet with all this completeness of preparation, the amount of junk has been kept down to a probable 5,000 tons by studied uses of various pieces—even of the bridge itself—in different parts of the work. And finally any collection of Quebec Bridge pictures must always bring fresh to mind the names of a few men closest connected with the design and erection—Johnson, Duggan, Porter, Mitchell, Fortune; Monsarrat, Modjeski, Schneider.



COMPONENT PARTS OF THE GREAT QUEBEC

At the top, suspended span as erected on falsework near shore at Sillery, ready for transfer to six scows for floating and hoisting; view taken with erection traveler in last position. Below, the bridge seen nearly endwise from camp on north shore about two months ago. North cantilever arm completed; the south arm was finished July 28, 1916

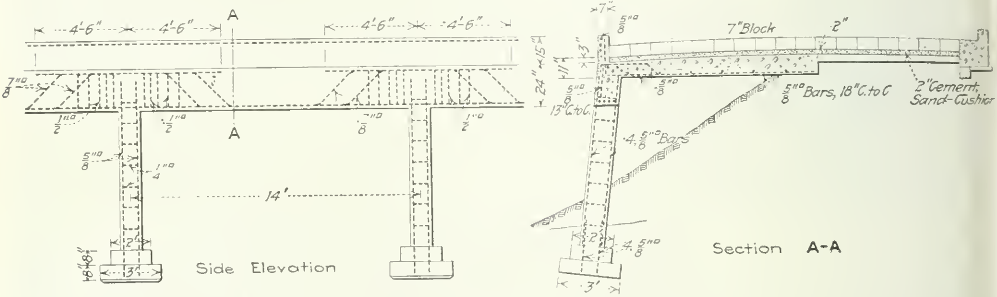


BRIDGE ACROSS THE ST. LAWRENCE RIVER

At the top, two of the great bottom-chord quarter sections laid together in the St. Lawrence Bridge Co.'s shop or drilling, facing and matchmarking the splice. Below, the 45-in. sleeves on 30-in. pins, in the main shoe ready to eceive the first section of the great bottom chord

Concrete Side-Hill Viaduct for a Brick Highway

A side-hill section of the Dunham road, in South Newburgh township, Cuyahoga County, Ohio, gave constant trouble from failure along the line of fill, so that it had to be repaired each season. The trouble was caused by settlement or down-hill slipping of the fill triangle: the original slope was rather steep and the fill not sufficiently stable to support the pavement. The cure finally devised was the construction of a girder-and-slab viaduct carrying the pavement over the fill triangle, supported by columns along the down-hill edge of the road. This viaduct construction has just been completed.



DUNHAM ROAD SIDE-HILL VIADUCT, BUILT AS A CURE FOR SLIPPING FILL

The drawing herewith shows the arrangement and details of the viaduct construction. The columns are spaced 14 ft. on centers longitudinally of the road, and their footings are carried down 2 ft. or more below the surface of the shale, which lies practically at the original undisturbed ground level. A longitudinal girder 14x24 in. extends along the top of the columns. The raised curb of the roadway is formed integral with this girder. An 8-in. reinforced slab spans from this girder across to a bearing on the undisturbed ground near the center of the road. This bearing is made at least 30 in. wide, but locally is considerably wider. The fill is level with the down-hill curb or slightly higher, and then falls off on natural slope. No special means were employed to consolidate the fill under the roadway slab or prevent the formation of voids through settlement. The slab was, however, molded directly on this fill ground and is intended to carry the pavement independently of any support by the filed portion of the subgrade.

D. Moomaw, Road Engineer of Cuyahoga County, conceived the idea of this viaduct construction and made the design. The work extends along a length of about 275 ft. It was built by direct labor by the county road-repair department.

The following table gives the total cost and its principal elements:

COSTS OF DUNHAM ROAD VIADUCT

Excavation, 669 cu.yd.	$484.52	$0.724 per cu.yd.
Concrete, 154 cu.yd.	1,826.68	11.86 per cu.yd.
Pavement, 327 sq.yd.	503.03	1.538 per sq.yd.
Total cost	$2,814.23	

This is subdivided into:

Total labor cost	$1,449.94
Total material	1,056.59
Truck charges	97.50
Carfare	210.20
	$2,814.23

Items of concrete cost:

Reinforcing steel	$378.47
Cement	275.08
Sand	88.79
Slag	195.00
Lumber	21.94
Nails, etc.	1.51
Labor	529.55
Overhead (watchman, carfare off and on job, etc.)	336.34
Total	$1,826.68

A number of other pieces of road in Cuyahoga County are in a condition which it is believed requires this same treatment to effect a cure of cracking by reason of settlement of the subgrade. The general practice in Cuyahoga County roadwork is to place rod reinforcement transverse of the concrete base (or concrete pavement) where there is danger of unequal settlement by reason of (1) variation in depth of fill; (2) transition from old fill to new fill, as in widening an old road on one side and paving it; or (3) longitudinally, at points of change from cut to fill. Under the conditions prevailing on the Dunham road, however, this reinforcement is not adequate to prevent failure of the pavement, and the viaduct construction was resorted to for this reason.

Side-hill viaducts are frequently adopted in European practice on new construction, but their use as a cure for slipping fill is probably original with the Cuyahoga County authorities.

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The Effect of Manganese on the corrosion of steel has recently been investigated by Sir Robert Hadfield and J. Newton Friend, and the results were reported in a paper read at the recent meeting of the Iron and Steel Institute. A number of previous investigators reached the conclusion that it is the manganese in steel, introduced in the process of manufacture that is largely responsible for the rapid rate of corrosion of much of the present-day steel. The most notable statement to this effect was the paper published by Cushman in 1905, when he was connected with the Department of Agriculture. The series of tests carried on by Hadfield and Friend included also the effect of increasing percentages of carbon on the rate of corrosion. It was found that the addition of carbon from 0.0 to 1.63% to pure iron containing less than 0.2% of manganese produced a steadily increasing rate of corrosion as the carbon increased. These tests were made with specimens immersed both in fresh water and in sea water. When the metal was immersed in dilute sulphuric acid, there was a rapid increase in the rate of corrosion as the quantity of carbon increased until a maximum was reached at 0.8% carbon. Tests were then made on similar steels containing 0.7% of manganese The result was a very slightly increased corrosion when the metal was immersed in both fresh and salt water, until the carbon content reached 0.4 to 0.5%. From this point upward the manganese affords a slight protection. When the steel was immersed in dilute sulphuric acid, however, the specimens containing the high percentage of manganese showed an enormously increased corrosion. Steels were then tested in which the manganese content had been increased to 2% and upward. These specimens showed greatly decreased corrodibility in neutral solution, but the corrosion in dilute sulphuric acid was greatly enhanced.

Field-Artillery Service Should Attract Engineers

By Ernest McCullough*

SYNOPSIS—The modern artilleryman is a highly trained soldier whose training combines that of every other arm of military service; the technical work of field artillery appeals particularly to engineers in competition with the engineer corps. The author gives particular attention to the system evolved for laying the fire of a battery.

Much has been written lately in the technical press on the importance of engineer troops in war, and engineers in civil life have been shown the work of engineers in war. Apparently it has been overlooked that the artillery, particularly field artillery, is an arm especially appealing to an engineer.

The modern field artilleryman is trained in every arm of military service. He is drilled in foot movements ike the infantry, the new regulations coördinating the artillery foot drill with infantry drill. He receives the same instruction in equitation and hippology, the riding and care of horses, as that received by the cavalrymen. He is trained in the use of the yellow and red semaphore signal flags and in the use of the white and red flags for signaling with the International Morse ode; in the care and use of field telephones and the are and use of wireless. He learns various other methods for quick communication, and his instruction n this respect is, for all practical purposes, as good as that of men in the signal corps. He becomes skilled n scouting, map reading, road and panoramic sketching. Besides this, he learns to fire the pistol and the field gun. Not only must he know how to fire the gun, but he must know the name of every part of it, and the limbers, caisson, battery wagon, store wagon, forge wagon and harness. He must have also some knowledge of the construction of field fortifications and demolition of structures.

The civil engineer will be interested in the surveying nd the firing problems. The mechanical engineer will be interested in the splendid machines he has to handle. The electrical engineer will be interested in the telephones and the wireless apparatus, the construction ngineer in the camps and equipment. Military work s to the chief-of-staff a science; to the officer in the field with troops it is an art; to the men in the ranks it is trade. The artillery arm has so many trades not trictly military connected with it that the engineers f the country should look carefully into the claims f the artillery before deciding to join the engineers.

Development of Field Artillery

The types of guns used in the Civil War were rigid nd had to be returned to position and "relaid" after every shot, for the recoil sent them back several feet. Barring the universal substitution of breech-loading uns for the old muzzle loaders and an increase in ower, there was little advance in field artillery up to 892. In that year General Langlois, of the French army, wrote a book giving a history of artillery from the earliest times, in which he set forth specifications for the field gun of the future. The French general staff got busy and finally in 1898 produced a gun that could be used for "indirect fire" in a far more perfect way than any previous gun, for indirect laying had long been the subject of experiment. In the new gun the recoil was controlled and the gun did not "kick off" the target, but was held to the previous laying after each shot. Then the breech mechanism and the ammunition were so improved that the gun become a rapid-fire gun, which could deliver ten aimed and twenty unaimed shots per minute.

Field artillery has one work to perform. The training of the officers is practically identical in all the schools, no matter what the language spoken by teachers and students. General Langlois in 1892 presented his specifications, and ordnance officers everywhere turned their attention to the design and manufacture of guns to fill the specifications. The field-artillery officers gave the *matériel* a complete try-out in the field, and the modern gun was thus evolved. Proceeding from the same starting point, equipped with the same knowledge, learning through various channels of the work done by other men and given opportunity to view the completed product as finally adopted by other countries, it is not strange that the light fieldpiece is practically standardized the world over.

In 1898 the United States adopted the 3.2-in. gun (called the "three-point-two"), which embodied some of the features deemed by General Langlois to be essential, and finally in 1902 adopted the 3-in. field gun. The breech mechanism was brought to its present satisfactory state in 1905, so that the American 3-in. field piece is practically the equal of the famous French 75-mm., the *soixante-quinze* idolized by the French nation. The bore of the "75" lacks only 0.05 in. of being as large as the 3-in. gun, which is the caliber of the light field gun of the United States, Great Britain and Russia. The caliber of the Austrian light fieldpiece is 3.01 in. and of the German 3.03 in. The light fieldpiece of the remaining eighteen powers that have armies large enough to be considered as important have a caliber of 75 mm. (2.95 in.). The weight of the projectile differs very little, that of Great Britain being 18 lb., of the United States and Germany 15 lb., and of France 15.96 lb., the weight being less in all the other countries.

Field artillery is classed as horse, light and heavy in all countries other than the United States. Here we have only horse, light field and siege artillery. Actually we have no siege artillery in the United States, the pieces so classed coming under the designation of "heavy field artillery" in other countries. Faulty phraseology and careless diction placed the United States in a rather ridiculous position in this classification, but if the present "preparedness" campaign accomplishes the hoped-for results we may have some siege artillery. Lack of reasonable mobility places artillery in the siege class, and the line is fixed above the 4.7-in. gun and the 6-in. howitzer, these being heavy field artillery and the lightest equipment sometimes classed as siege artillery.

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*Consulting Engineer, Conway Building, Chicago; Lieunant, Field Artillery, Illinois National Guard

A fieldpiece fires at an elevation of less than 20°, a maximum of 15° with the end of the trail on the surface, additional elevation for distant ranges being secured by sinking the trail in a trench. A howitzer fires at elevations of from 20° to 40°, a mortar at from elevations of from 40° to 70°—the elevations referred to being the angle above the horizontal through the axis of the bore.

The howitzer is shorter than the field gun of practically equal mobility, so that the 3-in. field gun and the 3.8-in. field howitzer are paired in infantry divisions of a mobile army as light artillery. The pieces are hauled by six-horse teams and can readily accompany infantry anywhere. Only the commissioned and noncommissioned officers and privates of special details are mounted. The rest of the enlisted men accompany the batteries on foot, mounting on the limbers and caissons and on axle seats of the pieces for rapid movements over short distances.

When every man is mounted, the 3-in. battery becomes horse artillery and accompanies cavalry, having the mobility of that arm. No field howitzers accompany cavalry. The 3-in. field gun fires a 15-lb. projectile, and the 3.8-in. field howitzer fires a 30-lb. projectile.

The 3.8-in. field gun is a heavy fieldpiece hauled by a team of eight horses. For short distances only, the gun is capable of rapid movement—not being so mobile as the lighter piece. It fires a 30-lb. projectile. The field howitzer of equal mobility paired with this gun is the 4.7-in., firing a projectile weighing 60 lb. The reader will notice that in every case the weight of the projectile, consequently the power, of the howitzer is in each case double that of the field gun with which it is paired. The 4.7-in. gun fires a projectile of 60 lb., and the 6-in. howitzer one weighing 120 lb. The 3-in. fieldpiece is the weapon used against infantry and cavalry operations, and the 3.8-in. howitzer gets into action when the attackers intrench. Heavier pieces are brought into service as the protection of the enemy by intrenchment assumes a more permanent form.

LAYING THE FIRE

Modern artillery fires whenever possible from concealed positions and it is with this phase of the subject that the artilleryman has use for his mathematics. When indirect laying became a subject of interest to artillery officers, all the work was trigonometrical and the operations involved partook of the nature of careful triangulation work. They were slow and required some degree of education. It was essential that the ordinary enlisted man be able to understand how to lay a gun properly, so the French artillery appointed a board of officers, who had been for years working on the new *matériel,* to get up a simple system for laying the gun when the target was invisible.

In 1897 they reported in favor of a new graduation of the circle whereby every element in the data pertaining to the delivery of fire became a function of the range. With sights on each piece graduated horizontally in "mils" and with range quadrants on each piece graduated vertically in the same system and with all observing instruments similarly graduated, the idea met with an enthusiastic reception. It is now used the world over by field artillerymen.

A mil is the one-thousandth part of the range, approximately. For the purposes of delivery of fire it is to all intents and purposes exact. The ratio of the radiu of a circle to the circumference is 6.283185; and if the radius is divided into 1,000 equal parts, there will be 6,283.185 such equal divisions on the circumference. The artilleryman divides the circle into 6,400 parts, because this number can be halved or quartered and continually subdivided by 2 to any limit without a fractional remainder. The error involved is small from the standpoin of the mathematician, and from the standpoint of accuracy required in the delivery of fire there is no error at all The sixty-four-hundredths part of a circle is called a mil (millième) because it is the one-thousandth par of the radius, or, for artillery fire, the range. It is an angle whose natural tangent is 0.001.

1 mil = 3.375 min., exactly
0.3 mil = 1 min., approximately
1° = 18 mils, approximately

To convert degrees into mils the writer in reconnaissance work with a common compass subtract mentally 11% from the number of degrees and multiplie by 20 to obtain the mils. Never subtract fractiona degrees; but when fractions occur, take the next highe unit. For example, the number of mils in 90° = (90 — 10) × 20 = 1,600. The number of mils in 45° = (45 — 5) × 20 = 800. The quarter-circle is graduated into 1,600 mils, the eighth-circle into 800, the half-circle into 3,200 mils, etc. Possibly before the nex war the United States may issue to the artillery prismatic compasses with the mil graduation. In fact, there exists no good reason why all officers in the army should not have such compasses, which would have the usual letters designating the cardinal points.

The methods of laying, about to be described, have been supplemented by a method, described recently in an English artillery magazine, in which compasses are used. The United States Army School of Fire for Field Artillery issued a clearly written pamphlet on the subject in January, 1916. Experiments indicate that a transit-compass needle is not materially affected by large masses of metal at distances greater than 50 ft.

The artilleryman in discarding sines, tangents and other functions of an angle went to the astronomer to obtain a term to use for expressing the angle subtended at the point observed, by the platoon front. The term used is "parallax" and is expressed in mils. It is quickly obtained by dividing 20 by the number of thousands of yards in the range, the width of a platoon front—that is, the distance center to center of bores of two adjacent pieces—being 20 yd. Thus if the range is 2,800 yd., the parallax $= \frac{20}{2.8} = 7$, for fractions are disregarded. The work is done mentally in the field, and 20 ÷ 3 = 7 (approximately) would be the result of the brainwork of the observer.

This disregard of fine results troubles an engineer more at first than any other one thing in artillery work. However, all that is required at the first salvo is to bring the "burst" within the range of observation of the field glasses and battery commanders' telescope, after which corrections are applied in accordance with the laws of probabilities, provided no serious errors of range have been introduced. Since 1 mil = 3.375 min., the disregard of 0.4 mil will make a difference of less than 1 yd. in 1,000. This is a far greater degree of accuracy than the best guns possess, accurate though the modern fieldpiece may be.

The mil measures chords of angles for given radii, and at 1,000 yd. an angle of 1 mil subtends a chord of 1 yd.: at 3,000 yd. a chord of 3 yd., etc. If a house standing normal to the line of sight from a battery has a length known to be 60 ft. (20 yd.) and the observer at the telescope measures an angle of 25 mils from the rear to the front corner, the range $= \frac{20 \times 1{,}000}{25 \text{ mils}} =$ 800 yd. Field glasses and telescopes are made for use by artillerymen, having an interior glass diaphragm engraved with vertical and horizontal lines similar in principle to stadia wires. The interval between the lines being known, angular measurements in mils are quickly made or estimated; and when the distance between objects is known, the range may be quickly estimated. This range is set off on the gun and shots fired. The burst is observed through the glasses and corrections made by rounds, or salvos, until the object is bracketed. Such firing is termed "fire for adjustment," and the adjusted fire is termed "fire for effect."

The battery commander sets up his telescope, whenever time permits, on a flank of the battery and at some little distance from the gun on the right, which is known as the right or No. 1 gun. If the gun is in a position where the target can be seen, it has been ustomary to use direct laying, in which the gunners sight on a portion of the target assigned to them. A attery of fieldpieces is a power plant, and the battery ommander is the superintendent of the plant. In order o have it completely under control he may, even gainst visible targets, use indirect laying, in which he gunner sights on an aiming point and sets off a deflection to the target announced by the executive officer. t is exceptional to use direct laying, for every effort s made to conceal the positions of guns, the battery comnander, assisted by observers, giving all necessary data o the men at the guns. It is mainly with indirect ying that mathematics enters into the matter.

Fig. 1 illustrates the geometrical truth that when two arallel straight lines are intersected by a straight line

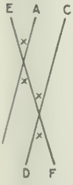

Fig. 1

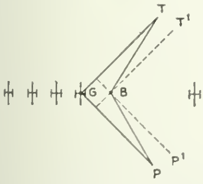

Fig. 2

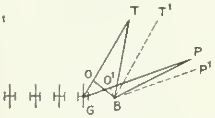

Fig. 3

e alternate angles are equal; thus the angles marked are equal. This principle is used in what is called e "parallel method," a method so simple that any listed man can lay a gun. For the enlisted man the ethod is partly graphical. In Fig. 2 let *T* be the target, the aiming point, *B* the observing station, and *G* the ght gun of a battery. The distance from *B* to *G* will measured, estimated or guessed, if *B* is exactly in e with the guns. If it is a little in front or behind e guns, then the distance is taken to the line *TG*, or is line produced. The range from *G* to *T* is measured, timated or guessed. The offset distance in yards from *B* to the line of fire from the gun to the target is divided by the thousands of yards in the range from the gun to the target, and the angular result in mils is measured from the line *BT* to the line *BT'*.

The telescope is pointed to the aiming point and similar computations and measurements made to the line *BP'*. The angle *T'BP'* is measured and the result given to the gunner on the right piece. He sets his panoramic sight at the angle given, and the trail is moved to the right or left until the vertical wire is on the indicated aiming point. The axis of the gun then lies in the line *GT*. In Fig. 3 the aiming point is in front of the battery. An officer of experience and a man familiar with algebra will not take the time to set auxiliary aiming points on the lines *BT'* and *BP'*, but will compute the angle of deflection by using positive and negative signs in connection with the angles subtended. This is known as the parallax method, formerly used altogether.

The writer will not describe the parallax method further than to say that, the parallax for a platoon front having been obtained, the distance from *B* to *G* is given in terms of platoon fronts and the angle *BTG* is found by multiplying the parallax by this number of platoon fronts, for the parallax is the angle subtended by a chord of 20 yd.

The angle *PGT* is the deflection of the right piece only. If the other guns set off this deflection, with their panoramic sights on the aiming point, the fire would not be directed on the target by all the guns unless the target was quite extended. It is therefore necessary to find the convergence difference in order that each gun will have the necessary deflection to fire directly at the target. Obtain the parallax of the target and give it the positive (+) sign. Similarly obtain the parallax of the aiming point, the sign of which will be positive when the aiming point is in front and negative when the aiming point is in the rear. The parallax of the target is subtracted algebraically from the parallax of the aiming point to obtain the "convergence difference."

Example—The deflection of the right piece is 3,320 mils. The parallax of the target is + 7 and the parallax of the aiming point is —6. The convergence difference = —6 —(+7) = —13. The deflections then become 3,320, 3,307, 3,294 and 3,281, for the convergence difference is applied progressively. These deflections being set off and fire opened, each shot should strike in the same place, provided the range is correct, the data properly computed and the *matériel* is perfect.

Assuming that the front of the target subtends an angle of 60 mils and it is desired to distribute the fire over the whole front, divide the front of the target in mils by the number of guns firing to get the "distribution difference." This for the foregoing example is $\frac{60}{4} = 15$ mils. Adding progressively, the deflections become 3,320, 3,322, 3,324 and 3,326. The distribution difference is always additive. The algebraic sum of the convergence difference and the distribution difference is the "deflection difference."

Having obtained the deflection and the deflection difference, and the panoramic sight of each gun being set on the aiming point, the battery commander can by changes in deflection, or deflection difference, open and close the "sheaf of fire" so as to distribute or concentrate the fire of the guns at will. The cannoneers do not see the target and cannot know the effect of the shots. The observers on high points communicate by telephone, flag or other signal system the result of each shot to the battery commander, who alters his data as required. The battery commander is presumably seated on the upper end of a very light ladder in rear of the battery, the better to observe the fire and direct his power plant. He is a good target for sharpshooters, but then someone has to take some risk in battle.

The path of the projectile is a parabola, and the battery in action may easily be likened to several fire engines at work with the chief of the fire department in the place of the battery commander. The stream of water has a path of travel of the same form as that of the projectile. The parabola for all practical purposes of the field artilleryman is rigid—that is, the range is the shortest distance from the muzzle of the gun to the target, whether it is horizontal or inclined. The errors liable to arise because of this assumption are well within the limit of errors that may be caused by inferior *matériel* or errors in the data. The first shots never hit a target, except by accident, but they get so close as to make the target feel very uncomfortable and anxious to seek cover. Corrections are rapidly made, and the data are set off on the sights so that the following shots get closer to the target.

In the example given, the captain may have observed that the front had not been estimated correctly and it was necessary to narrow the fire. His command may be "Close by 10"; then the gunner on the first piece makes no change, the gunner on the second subtracts 10 mils and his deflection becomes 3,312, the third gunner subtracts 20 and his deflection becomes 3,304, the fourth gunner subtracts 30 and his deflection becomes 3,296. The deflections are set off on the sights and the trails are swung or the traversing gear operated to bring the vertical mark again on the aiming point, when the guns will be pointed properly to place their fire where wanted.

If the command had been "Open by 10," each gunner except the first would have added 10 mils multiplied by the number of his piece counting from the first piece.

If the captain observed that all the shots were falling, say, 40 mils to the right, he would command "Add 40," and each gunner, including the gunner on No. 1 piece, adds 40 mils and brings his aiming point on the vertical mark. Observing that the fire is falling 40 mils to the left the officer commands "Subtract 40," whereupon every gunner subtracts 40 mils from his deflection.

These data are kept on small cards by chiefs of section, the sergeants. The chiefs of platoon, the lieutenants, cannot use paper and pencil, but must do all work mentally. Nevertheless they must remember the data. It is thought speed is sacrificed if time is taken to write down data.

The angle of site is the angle of slope of the range in mils. It is set off when the range is set off, in order that the axis of the bore will lie in the trajectory of the projectile. The corrector reading is the number of mils set off on the fuse setter to insure the fuse burning until the shrapnel reaches the proper point on the trajectory. The fuse setter is an attachment on the rear of the caisson, consisting of a movable ring graduated for range. The range being ordered, it is set off on the fuse setter and the corrector correction applied. When the corrector reading is 30 and the range is correct, the shrapnel will burst at a height of 3 mils above the groun at the end of its flight. When shots are "over" o "short," slight changes are made in the corrector settin or in the angle of site, or both, together with change in range until the shots reach their mark.

Masking the Fire

It is necessary to fire over a mask, for concealment which is known as "defilade." Dismounted defilade i when a man standing at the gun can just see over th mask and observe the target. In mounted defilade mounted man at the gun can just see the target over th mask. The gun is perfectly concealed with a "flash defilade when the flash of the gun is concealed. defilade of 4 yd. is sufficient to conceal the flash of gun by day. A flashless powder is now made. On fairly uniform reverse slope a flash defilade may b quickly obtained by posting a dismounted man in th position of dismounted defilade and in his rear a mounte man where mounted defilade will be obtained. The gun are then posted in rear of the mounted man at a slightl greater distance than that separating him from the dis mounted man.

It is necessary to know whether the shot will clear th mask. Let y = height of mask in yards, x = distanc from gun to mask, and $R - x$ = range from mask t target in hundreds of yards. Then $x = \frac{4y}{(R - x)}$.

Example—The range from mask to target is 2,000 yd height of mask 15 yd.; $x = \frac{4 \times 15}{20} = 3$ (300 yd.).

By consulting a range table it will be found that th angle of elevation for a range of 2,000 yd. is 52.4 mil and the angle of site to the top of the mask is $\frac{15}{3}$ = 50 mils, so the shot will clear the top with a sma margin. The margin is so small that the mask is poor one, for it is unnecessarily high. The entire distanc from the target to the mask is dead land and perfectl safe. The guns should be close enough to the mask t afford perfect concealment and yet be able to depress th muzzles and cover a considerable length of the advanc from the target, which is usually occupied by troop This particular mask should be not over 12 yd. high. T fix the proper height of mask, use the formula $S = 3$ $(K - 1)$, in which S = angle of site in mils and K = range in thousands of yards.

Let the range from the gun to the target be 2,300 yd. then $30 \times (2.3 - 1) = 39$ mils, which upon referenc to a range table is the angle of departure for a rang of 1,350 yd., so that the danger zone from the firs position of the target will be 950 yd. and the enem will have to approach within 1,150 yd. of the mask befor the gunfire fails to reach them. At this range th infantry can handle the enemy with machine guns an rifles. With a lower mask, say of 5 yd., the danger zon may be greatly widened.

Readers who may have become interested in the wor of field artillery through the reading of this sketch shoul procure "Notes on Field Artillery," by Capt. Oliver l Spaulding, Jr., or "Elements of Modern Field Artiller United States Service," by Maj. Harry G. Bishop, o both books. The authors were lecturers on the subjec at the Army Service Schools, Fort Leavenworth, Kan and the books contain the substance of their lecture

Old Iron Bridge Damaged by Electric Car

The damage done to a bridge truss by the derailment of an electric car is shown by Fig. 1. The track is close to the truss, so that the blow was almost longitudinal, and the car evidently struck the truss post with its roof and body. The accident occurred recently on the middle span of the Galena Ave. bridge over the Rock River at Dixon, Ill.

The post is the second from the south end of the east truss of the middle span. The channels and lacing bars are bent and buckled, showing the toughness of the metal, but the rivets are tight and only one of the lacing bars seems to have broken, the fracture occurring at the rivet hole. The post is about 8x12¼ in., being composed of two 8-in. channels. For temporary repairs a two-pile braced bent was placed under the panel point, and blocking was wedged up against the foot of the post, while a timber post was placed upon this support and wedged up against the top chord. The bridge carries two tracks, but one track (and half the roadway on the damaged span) is now closed to traffic. The damaged post was cut away by torches and a new post put in place, the repairs being made by the American Bridge Co.

The Galena Ave. bridge is peculiar in that, while it was built 30 years ago for wagon traffic, it now carries a double-track electric railway for both city and interurban cars. The railway line is single track, but presumably a track in the middle of the bridge roadway would have interfered with street traffic, which is an important consideration as this is the only highway bridge across the river at Dixon. It was built in 1885 by the Milwaukee Bridge and Iron Works, of Milwaukee, Wis.

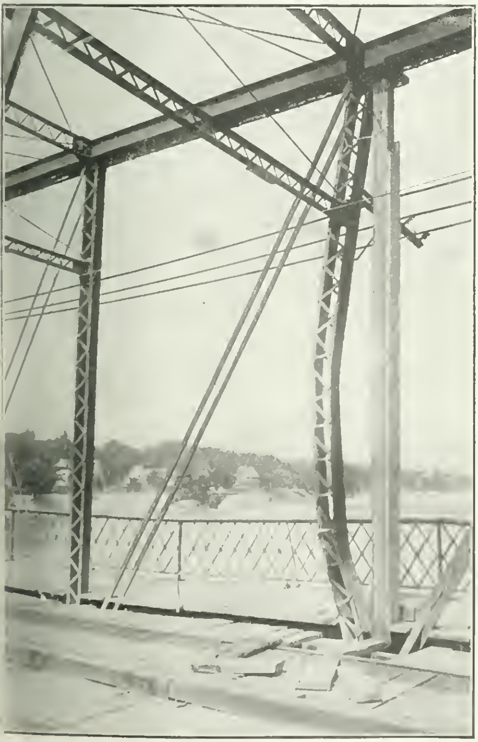

FIG. 1. DAMAGED TRUSS POST OF THE GALENA ST. BRIDGE AT DIXON, ILL.

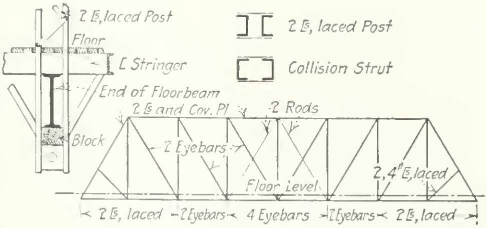

FIG. 2. GENERAL DESIGN OF TRUSS SPANS OF THE GALENA ST. BRIDGE AT DIXON, ILL.

The bridge consists of five through-truss spans of 175 ft. The design is shown in Fig. 2. The end posts and top chord are composed of two channels and a cover plate, with lacing on the under side. The end posts have 11¼-in. channels and 16-in. plates. The bottom chord for two panels at each end is composed of two channels with top lacing; the next panel has two eye-bars, and the two middle panels have four eye-bars each.

The truss posts are pairs of channels with flanges outward, and laced, as shown: First post, 6-in. channels, 11½ in. over backs of channels; second post, 8x12½ in.; third post, 7x12 in.; middle post, 5x11 in. At the bottom of the post a saddle is riveted between the channels to carry the end of the floor-beam, and through this saddle passes the pin connection for the diagonals.

The collision struts are 4x10 in., with two 4-in. channels having the flanges inward. The diagonals are pairs of eye-bars, about 3½x1$\frac{1}{16}$ in., 3x1⅛ in. and 2½x⅝ in. in the three panels. The counters in the two center panels are about 1-in. rods, with turnbuckles. At each panel point there are a top strut and sway bracing. The metal of the trusses seems to be in good condition and is well painted.

The bridge originally had wooden floor-beams and stringers. When the electric railway was laid across it, about 12 years ago (according to our information), the floor system was rebuilt. There are now plate-girder floor-beams on which are 13 lines of channel stringers with wooden spiking strips. The two channels under each rail are placed back to back and have riveted supports for a timber stringer between them. Each sidewalk has four lines of channels. The flooring is of transverse planks. There are no curb or wheel-guard timbers. The longitudinals in the view are to keep traffic to one side of the roadway of the damaged span. The rails are of tram-head section.

It is stated that, when the changes were made, calculations showed that the bridge was strong enough to carry the increased loads. Under the ordinance permitting the railway to use the bridge the company was charged with the duty of putting and maintaining the bridge in proper condition.

The railway company states that while the bridge has two tracks (for the traffic reasons noted above) there is a rule by which cars are not allowed to pass on the bridge.

Field and Office

6,000-Ton Rock Slab Pinned in Place To Save Bridge

By W. H. Warnecke*

An almost separated mass of rock weighing about 6,000 tons, on the face of a steep cliff overhanging the West Shore R.R., was recently pinned to the sound rock of the cliff by steel pins as a precaution against its sliding and wrecking a railroad bridge. The following paragraphs describe the work done to secure the slab.

The cliff in question (Fig. 1) is located immediately south of the Highland Falls station on the West Shore R.R., now called the River Division of the New York Central R.R. The rock is granite of an inferior grade, with nearly vertical stratification. The partly separated mass is about 200 ft. long, with an average height of 100 ft., and from 5 to 8 ft. thick. It starts from about midway between the upper and lower chords of the bridge shown in Fig. 1, the greater portion of the mass being wholly above the bridge.

The bridge seen in the figure is one of two built in close proximity to each other in this locality, both of the bridges being placed close to the precipitous faces of the rock cliffs forming the shore. These bridges are peculiar in that they were constructed to carry the tracks over transverse clefts in the rock bottom of the Hudson River, which it was found impossible safely to fill on account of the steep slope of the rock toward the center of the river. Considering the conditions, it was clear that any attempt to remove the loosened mass of rock would prove extremely dangerous to traffic. Therefore, a scheme for supporting the slab was adopted. Ten holes, 11¼ in. in diameter and from 11 to 20 ft. apart, were drilled from 11 ft. to 15 ft. into the rock at an angle of 60° with the vertical at the level of the upper chord of the bridge shown in Fig. 1. A gas-driven core drill (Dobbins, Class H-G) was used in drilling the holes. The drilling outfit is shown in Fig. 3, mounted on the platform built on the upper chord of the bridge. This view also shows a completed hole with a piece of casing projecting from it, and near-by is a piece of the core removed from the hole. Owing to the rough face of the rock, it was necessary to facilitate the starting of the drill by building a wooden box 24 in. square, the box being made fast to the rock by means of angles and expansion bolts, and cementing in place in the center of the box a 12-in. nipple 12 in. long. This nipple assisted in keeping in place the steel shot used for cutting the rock. The starting of the drill was thereby simplified and its penetration into the rock greatly augmented. The seam between slab and cliff was successfully passed, though some shot was lost.

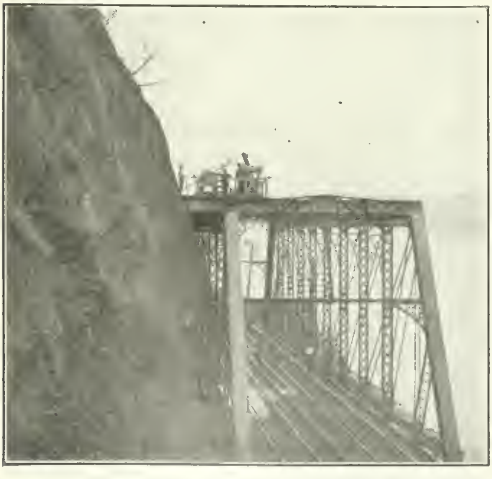

FIG. 1. CLIFF WITH HANGING ROCK, HIGHLAND FALLS N. Y.

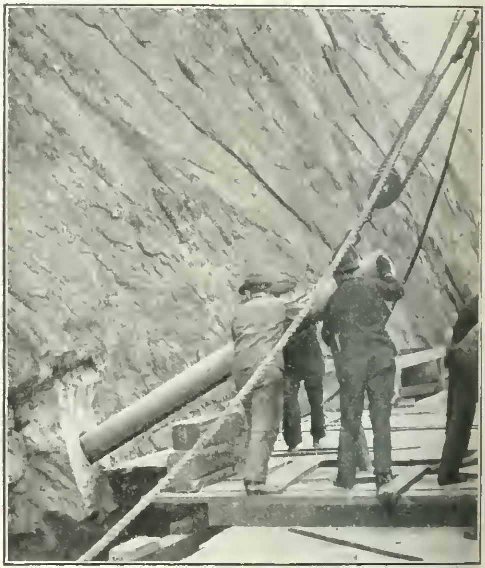

FIG. 2. PINNING THE ROCK DOWN WITH 10-IN. STEEL PINS

Upon the completion of the drilling of the holes, 10-in. solid steel pins, made in various lengths to suit the respective lengths of holes, were put in place, to serve as support for the hanging rock. Fig. 2 shows the operation of placing one of these pins. One end of the pin was raised to the level of the hole at the face of the rock, and the other end was then raised until it had the same inclination as the hole. In this position it was a comparatively easy matter to slide the pin into place. A small derrick resembling a gin pole was used.

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*Engineering Department, New York Central Railroad, Poughkeepsie, N. Y.

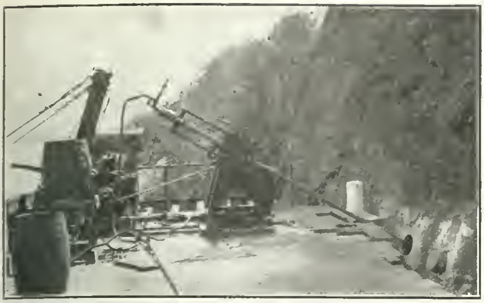


FIG. 3. CORE-DRILL OUTFIT ON BRIDGE, DRILLING HOLES FOR THE PINS

The space surrounding the pins was filled with rich cement grout by means of a $\frac{3}{4}$-in. pipe with a hopper on one end, the pipe being long enough to reach to the bottom of the deepest hole. The pins were cut 1 in. longer than the length of the respective holes, causing them to project 1 in. beyond the face of the rock. These projections were treated with coal-tar pitch and covered with a rich cement mortar applied to woven-wire mesh fastened to $\frac{1}{2}$-in. steel bars of U shape. These bars are held in place in a horizontal position at the centers of the pins by expansion bolts inserted into the rock 3 in. on either side of each pin. The surface of the mortar is also covered with hot coal-tar pitch.

For auxiliary support the foot of the loose slab was underpinned with timber struts. A shelf was cut into sound rock a little above the floor level of the bridge. Yellow-pine struts, 12x12 in. in section and 3 ft. apart, were then inserted under the projecting slab and held in place by expansion bolts set into solid rock. The work was carried out by close coöperation between the Engineering Department and Maintenance-of-Way Department; G. W. Kittredge, Chief Engineer; J. W. Pfau, Engineer of Construction; R. E. Dougherty, District Engineer; George W. Vaughan, Engineer Maintenance-of-Way; and H. C. Thompson, Division Engineer.

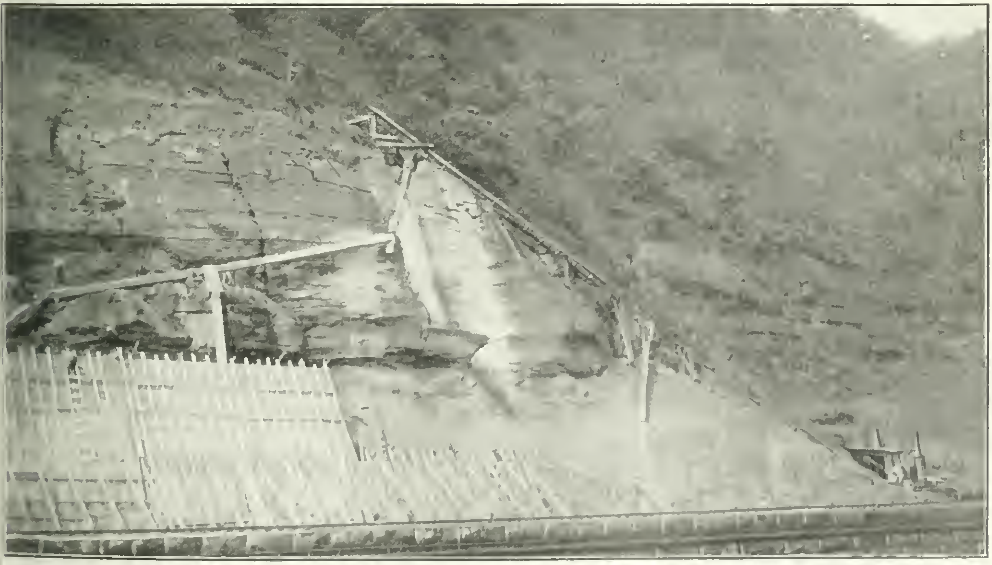
⁂

Keeping a Cliff from Falling on Railway Tracks

A good-sized job of geological dentistry is being performed by the Pittsburgh division forces of the "Panhandle" railroad (Pittsburgh, Cincinnati, Chicago & St. Louis Ry.) in plugging up the cavities in the face of Mount Washington, across the Monongahela River from Pittsburgh. The weathering of this cliff has been a constant source of trouble and maintenance expense ever since the toe of the slope was cut away to make room for the two tracks of the Pennsylvania low-grade freight line detouring around the heart of Pittsburgh.

Immediately above the track level there is a stratum of hard clay, varying from 15 to 30 ft. in thickness, underlying the ledge rock. As the clay sloughs away under the action of the elements, it becomes necessary to provide support for the overhanging mass of rock above it. In the past nine years over 800 ft. of wall has been built for this purpose, and the present season's work will add 300 ft. to this. Similar support is also to be furnished some rock ledges farther up the cliff.

The work is being done by company forces and requires the placing of a sloping concrete wall from firm rock below the track level to the under side of the rock mass above. It was planned to handle the work from a portable tower, but as this could not be obtained in time an inclined skidway was built up the side of the hill. Concrete is hoisted in a wooden car, sliding on skids, and dumped into a hopper at top, from which it is chuted to place.



SUPPORTING THE OVERHANG OF MT. WASHINGTON BY CONCRETE TOE-WALL

The work is being done by the Panhandle railway. Forms are in place for the wall, and a spout from a distributing hopper supplies the concrete

Cutting Clay Tunnel Face with Special Knife

Since the ingenious application of a modified drawshave or drawknife to cutting clay in tunnel work in the St. Clair River tunnel at Port Huron, Mich., over twenty years ago, this tool has been standard for use in similar operations in the clay ground of the lake plains. Two tunnels now in course of construction at Cleveland are excellent illustrations of the use of the drawknife. In the course of the work a change has been made in the tool, and at present both the simple and the improved form are in use on the same job. The drawknife as generally used up to the change of design is as shown in Fig. 1. The steel of the blade is about $1\frac{3}{4} \times \frac{1}{4}$ in., bent hot to the roughly semicircular shape indicated in the sketch and turned at the ends to form eyes. Sawed-off spade handles are inserted in these eyes. The lower edge of the knife is ground on its inner face to a sharp edge and is reground here as it becomes dull, until the blade finally becomes so narrow that it is too weak to use. In new condition the failure is apt to be in the handles; but as the blade wears narrower, breaks in the steel are likely to occur. Great muscular effort is required to use such a knife with full efficiency. Two men usually work on one knife, with a third giving a hand in entering the blade and later receiving the slab of clay cut down. Some suggestions were made for a U-shaped bar handle in place of the two straight handles, this bar handle to be made of strong pipe, which would not only give more convenient hold but also eliminate breakage of handles. The final design of John W. Dolman, engineer in the City Water Department is shown by Fig. 2. At first a handle length (offset length) of 18 in. was thought best; but it developed at once that this was too long for most effective manipulation, and it was shortened to 12 in., as indicated in Fig. 2. Fig. 1, redrawn from a sketch made from life, illustrates the typical manner of using the drawknife as practiced in the Cleveland tunnel work. This sketch was made in the West Side lake tunnel—the same in which the disastrous accident of July 21, 1916, occurred, but in the land heading. In this heading, knives of both types shown in Fig. 2 are used side by side, although the old style is the regular equipment. The experience here has amply demonstrated the greater robustness and generally greater serviceability of the new knife.

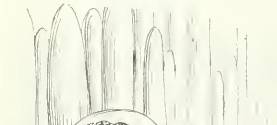


FIG. 1. HOW THE DRAWKNIFE IS USED ON A CLAY TUNNEL FACE

In the Central Ave. tunnel being driven under the Cuyahoga River for a water-main connection from the east to the west side, a job now completed, these knives were also used.

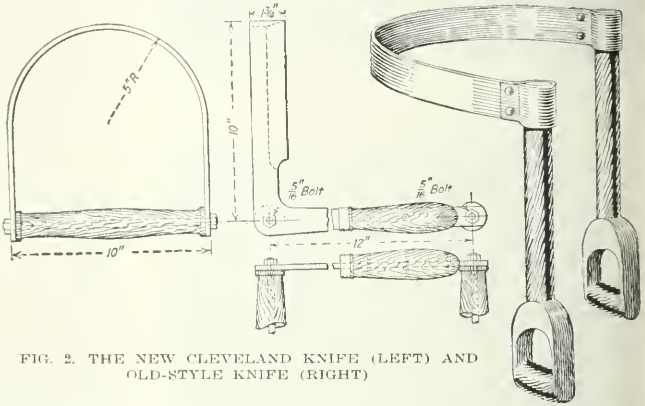


FIG. 2. THE NEW CLEVELAND KNIFE (LEFT) AND OLD-STYLE KNIFE (RIGHT)

The lake tunnel is under Gustav C. Van Duzen as Superintendent, while the river tunnel is handled by Charles Vandevelde. John W. Dolman is in charge for the Water Department, under the direction of C. P. Jaeger, formerly engineer and now commissioner.

⁂

Sandbag Dam Saved by Canvas Cover

Emergency work was necessary to save the water-supply of Charleston, S. C., at the time the Goose Creek dam was breached by flood, as reported in *Engineering News* of Aug. 3. The ocean tide comes up to the dam with 6-ft. rise, and there was risk of salt water backing up into the reservoir. Fig. 1, showing the breach on Sunday, July 16, 1916, the day after the washout, suggests how readily this might have occurred. Closure of the breach succeeded in three days, although the gap was 100 ft. wide and over 13 ft. deep.

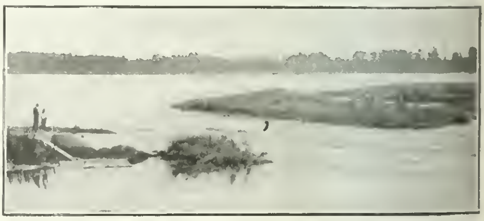


FIG. 1. BREACH OF GOOSE CREEK DAM
West wall of west spillway at right

The embankment (the grassy surface seen in Fig. 1) was cut through late Saturday, July 15, by water overflowing about 14 in. deep. Material and tools could not be assembled on the ground for two days, however. On

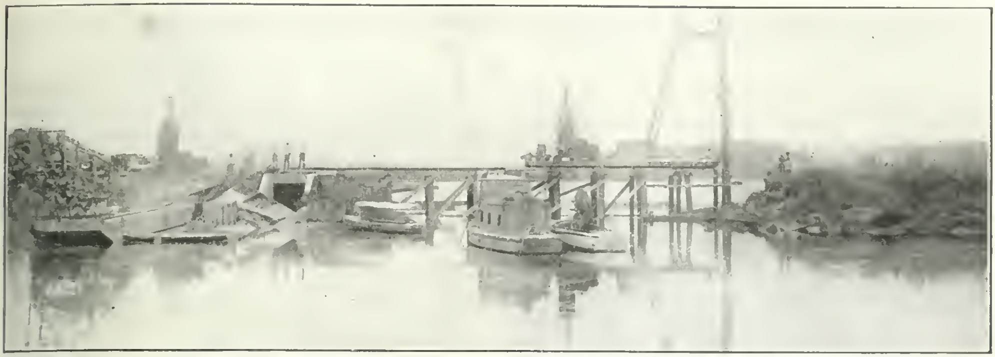


FIG. 2. SANDBAG EMERGENCY DAM (IN REAR) AND PILEDRIVING FOR CRIB COFFER-DAM OF PERMANENT CLOSURE

Tuesday morning work was begun on throwing a sandbag dam across the break; operations were in charge of W. R. Bonsal, vice-president of the Seaboard Air Line, working with a railway wrecking crew. The sandbag dam was completed early the next morning.

Low tide setting in soon afterward, the overflow over the bags began to disintegrate the temporary structure, and it was apparent that some means of protection had to be found. The expedient was tried of covering the worst places with canvas, weighted down on the upstream side and lapped over the dam. This proved successful, and the whole dam was then covered similarly.

This temporary dam was about 25 ft. wide on the bottom, 6 ft. wide on top and 120 ft. long. Water flowed over it 6 in. deep at the maximum.

Following the successful emergency closure of the breach, permanent repairs are being made. Heavy piling was driven all the way across the breach and into the embankment on both sides. Three rows of piles were set, the two upper rows about 8 ft. apart with piles spaced 8 ft. on centers. On the upstream side a line of 1-in. sheetpiling was driven, and the space above and below the sheetpile wall was filled with clay bags. In Fig. 2 (this as well as Fig. 1 is from J. W. Ledoux, of Philadelphia) the pile wall is shown practically completed, with the sandbag dam back of it still overflowing. This view was taken Saturday, July 22.

A fire engine obtained from the City of Charleston then served as means for making hydraulic excavation of clay from high clay banks near the breach and sluicing this clay into the pile dam closure. The dam as a whole, 2,300 ft. long, will be provided with larger spillways.

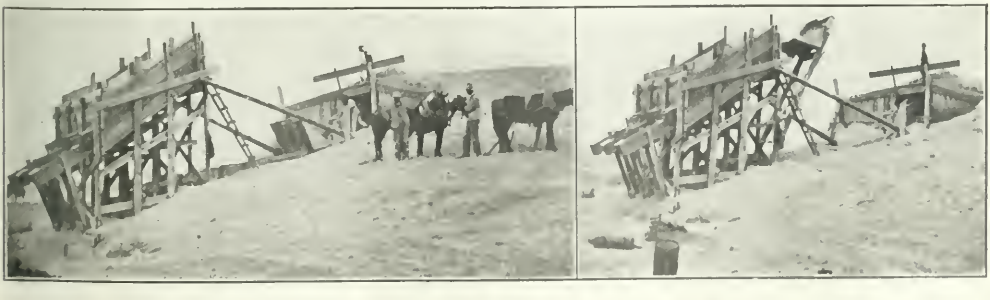
Home-Made Horse-Operated Wagon Loader

The accompanying views show a rather crude wagon-loading device, but at the same time an improvement over the cruder methods often met with at small gravel pits. It is in use in New Mexico, where horse power is cheap. The designer is A. E. Saint Morris, County Highway Director of Valencia County.

The gravel loader consists of an elevated bin, holding approximately 6 to 8 cu.yd., with an inclined floor and three unloading spouts extended over the wagon way. An elevating hopper is provided to raise the gravel to the bin from a pit in the rear. This device is made entirely of wood. The arms are round poles braced with planks. The hinges are merely round iron pins through the poles, and the bearings are holes bored in the square timber supports. The motive power for raising the loaded hopper is two two-horse teams.

The hopper is loaded from a platform on the edge of the gravel pit, which is provided with an opening and chute discharging into the hopper, when in its lowest position. Gravel is brought to the platform by fresno scrapers. The same two teams are used for the fresnos.

The operating force at the pit consists of only the three men shown in the view. One man shovels the gravel from the platform to the elevating hopper. The other two handle the teams. There is no waiting of wagons to load. The teamster does his own loading by opening the gates of the bin chutes. With teams at $3.50 to $4 per day, the cost at the plant shown is about 20c. per cu.yd. for excavating and loading the gravel in the wagons.



HOME-MADE WAGON LOADER, VALENCIA COUNTY, NEW MEXICO

Special Methods in Building Concrete Footing Walls

The construction of concrete foundations for buildings is the line of work followed almost exclusively by the contracting firm of F. Johnson & Co., of Chicago, which subcontracts this work from general mason contractors. In making this a specialty various methods have been introduced to increase the efficiency and economy of operation, and employees are encouraged to offer suggestions in the way of further improvement.

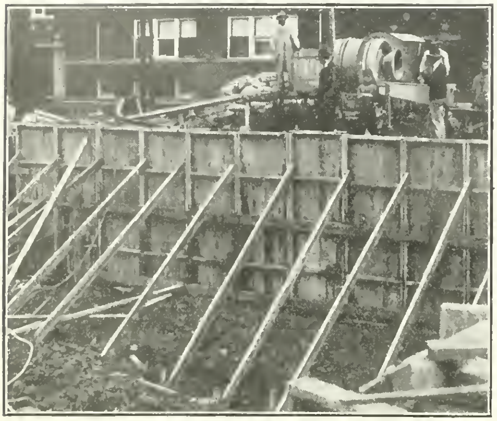


FIG. 1. SECTIONAL WOOD FORMS FOR CONCRETE FOUNDATION WALLS 9 FT. HIGH

Among the important methods are: The use of large motor trucks for rapid delivery of materials, simple sectional wood forms that can be used many times and require very little lumber or bracing, placing the concrete with a minimum amount of handling, and the use of nonfreezing compounds in winter in such a way as to insure good quality of concrete placed during cold weather. The company owns a large number of motor trucks for distributing materials to the various jobs. It has also ten concrete mixers, all built by the Standard Scale and Supply Co., of Chicago. These mixers are of the low-charging portable type which can be moved as the work progresses and thus enable a large part of the concrete to be spouted directly into the forms.

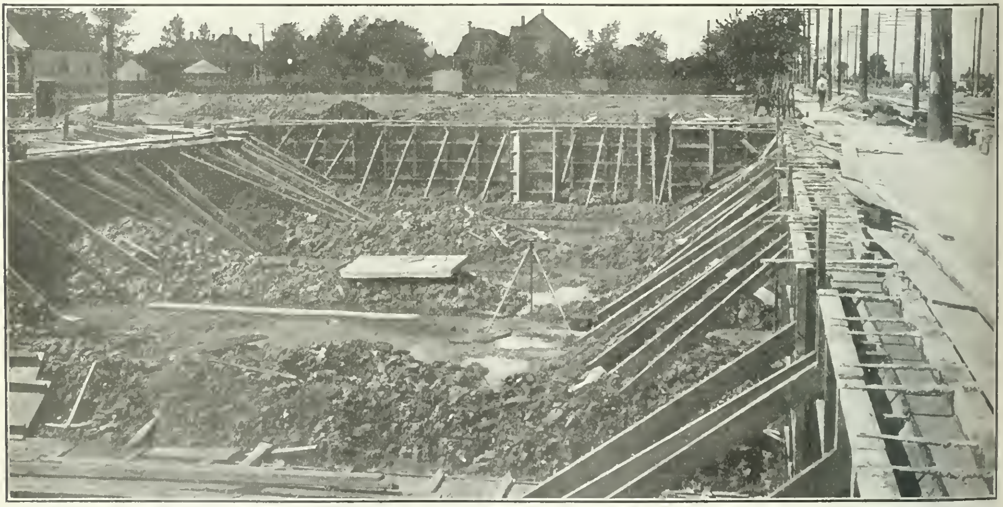


FIG. 2. TOP TIES AND SIDE BRACING OF FORMS FOR FOUNDATION WALLS

Sectional wood forms are used for practically all basement walls 9 ft. or less in depth. These forms vary from 3 ft. 6 in. to 4 ft. 6 in. in width, and from 4 ft. to 9 ft. in length, depending upon the requirements of the foundation. For basements requiring a greater depth of forms than 9 ft. it has been found preferable to construct special forms of loose lumber.

When using the built-up sectional forms, the concrete footings are first put in. The forms for the outside of the wall are then set up, but before erecting a form section, strips of No. 28 hoop steel are nailed at the bottom of the frame. These are about 1 in. wide and of sufficient length to nail to the outside of the frame of the outer form, extend across the wall and permit nailing to the inside of the frame of the inner form. When the inner forms are set up, by placing wood wall gages between the side forms at the bottom, drawing the steel hoops taut and nailing them on the inside of the frame of the inner form, the lower parts of the forms are securely held on the footing. At intermediate points between the bottom and top of the forms wood wall gages, or spacing pieces, are inserted and the forms wired together, the wires extending around the lateral braces of the forms.

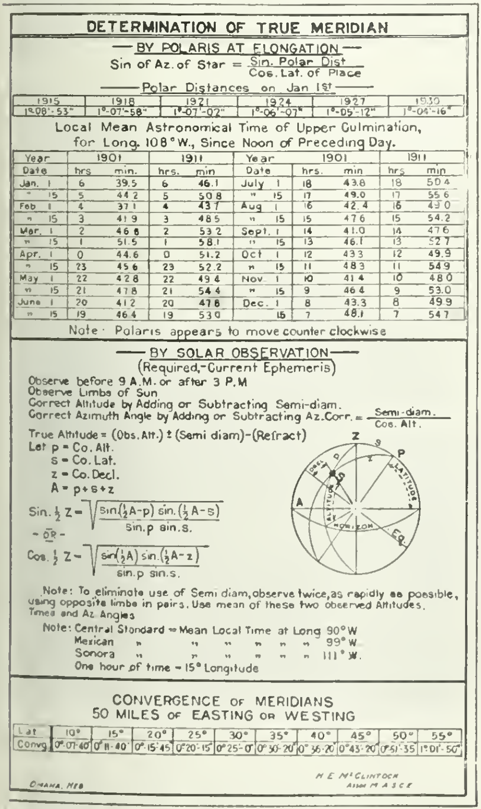
At the intersection of forms the sections are tied together by diagonal wiring. Adjacent forms are nailed together through the side frames, the nails used for this purpose being of such length that when driven to the heads the points protrude a considerable distance on the opposite side. This method of nailing affords great holding strength and permits driving back the nails without injury to the frames when it is desired to remove the forms. At the top the forms are held by U-bars of hoop steel nailed to the outer sides of the forms on either side, similar to the method of holding the forms at the bottom.

With these sectional or movable forms properly set up, and with sufficient wall gages and wired ties nailed at the intersections and secured with the steel hoop bands at top and bottom, the entire construction is very rigid and only a small amount of bracing on the sides is required to steady the forms against shock. Fig. 1 shows the movable forms 9 ft. high, with the bracing. On the ground is the concrete mixing plant. Fig. 2 shows the forms, and the steel holding bands at the top may be seen plainly. These views indicate the small quantity of side bracing required.

The work of erecting forms and placing concrete begin practically at the same time, and on many foundations of moderate size a skilled crew can erect all forms for the basement walls in a few hours.

Fieldbook Sheet for Azimuth

A fieldbook sheet of data for finding true north, used by H. E. McClintock, Assistant Engineer, Union Pacific R.R., Omaha, Neb., is reproduced herewith. The upper table gives the necessary data for observing on Polaris at elongation. The table of time of upper culmination can be used for any year because the small difference for 10 yr., only about 7″, permits of accurate interpolation. Eastern elongation is (within a few minutes of time) 6 hr. before, and Western elongation 6 hr. after upper culmination.


DETERMINATION OF TRUE MERIDIAN

—BY POLARIS AT ELONGATION—

$$\text{Sin of Az. of Star} = \frac{\text{Sin. Polar Dist}}{\text{Cos. Lat. of Place}}$$

—Polar Distances on Jan 1st—

1915	1918	1921	1924	1927	1930
1°-08′-53″	1°-07′-58″	1°-07′-02″	1°-06′-07″	1°-05′-12″	1°-04′-16″

Local Mean Astronomical Time of Upper Culmination, for Long. 108° W., Since Noon of Preceding Day.

Year	1901		1911		Year	1901		1911	
Date	hrs	min.	hrs.	min	Date	hrs.	min	hrs	min
Jan. 1	6	39.5	6	46.1	July 1	18	43.8	18	50.4
" 15	5	44.2	5	50.8	" 15	17	49.0	17	55.6
Feb 1	4	37.1	4	43.7	Aug 1	16	42.4	16	49.0
" 15	3	41.9	3	48.5	" 15	15	47.6	15	54.2
Mar. 1	2	46.8	2	53.2	Sept. 1	14	41.0	14	47.6
" 15	1	51.5	1	58.1	" 15	13	46.1	13	52.7
Apr. 1	0	44.6	0	51.2	Oct 1	12	43.3	12	49.9
" 15	23	45.6	23	52.2	" 15	11	48.3	11	54.9
May 1	22	42.8	22	49.4	Nov 1	10	41.4	10	48.0
" 15	21	47.8	21	54.4	" 15	9	46.4	9	53.0
June 1	20	41.2	20	47.8	Dec. 1	8	43.3	8	49.9
" 15	19	46.4	19	53.0	15	7	48.1	7	54.7

Note · Polaris appears to move counter clockwise

—BY SOLAR OBSERVATION—

(Required,-Current Ephemeris)

Observe before 9 A.M. or after 3 P.M

Observe Limbs of Sun

Correct Altitude by Adding or Subtracting Semi-diam.

$$\text{Correct Azimuth Angle by Adding or Subtracting Az. Corr.} = \frac{\text{Semi-diam.}}{\text{Cos. Alt.}}$$

True Altitude = (Obs. Alt.) ± (Semi diam) − (Refract)

Let p = Co. Alt.

s = Co. Lat.

z = Co. Decl.

A = p + s + z

$$\text{Sin.}\tfrac{1}{2}Z = \sqrt{\frac{\sin(\frac{1}{2}A-p)\,\sin.(\frac{1}{2}A-s)}{\sin.p\ \sin.s.}}$$

– OR –

$$\text{Cos.}\tfrac{1}{2}Z = \sqrt{\frac{\sin(\frac{1}{2}A)\,\sin.(\frac{1}{2}A-z)}{\sin.p\ \sin.s.}}$$

Note: To eliminate use of Semi diam, observe twice, as rapidly as possible, using opposite limbs in pairs. Use mean of these two observed Altitudes, Times and Az Angles

Note: Central Standard = Mean Local Time at Long 90° W

Mexican " " " " " " 99° W

Sonora " " " " " " 111° W.

One hour of time = 15° Longitude

CONVERGENCE OF MERIDIANS
50 MILES OF EASTING OR WESTING

Lat	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°
Convg	0°-07′-40″	0°-11′-40″	0°-15′-45″	0°-20′-15″	0°-25′-0″	0°-30′-20″	0°-36′-20″	0°-43′-20″	0°-51′-35″	1°-01′-50″

OMAHA, NEB

H E McCLINTOCK
ASSN M A S C E

FIELDBOOK SHEET FOR AZIMUTH REDUCED ABOUT ONE-FOURTH

In ordinary field practice observations on Polaris are usually the most convenient, and are the most accurate, for azimuth determinations. When conditions make it impossible to observe on Polaris, however, the sun may have to be used.

The following notes of observations illustrate the use of the sheet:

Notes for determination of the true meridian at Devil's Slide, Utah. Lat. 41° 01′. Used Mountain standard time, which equals mean local time for Long. 105° W.

BY POLARIS AT ELONGATION—MORNING OF APR. 25, 1916

Upper culmination (by interpolation) is 23 hr. 31 min. .... = 11:31 a.m.
Western time is 3° faster than mean local for Long. 108° .... 12 min.
Western standard time of upper culmination 11:43 a.m.
Eastern elongation is 6 hr. earlier, or............ 5:43 a.m.

The star appeared to cease eastward motion at about 5:35 a.m. Turned angle to right of 128° 01′ to semaphore disk.

Polar distance (by interpolation) is 1° 08½′

Log sin 1° 08½′ = 8.296524
Log sin Lat. 41° 04′ = 9.877340
Log sin az. = 8.419184
az. = 1° 30′ = N 1° 30′ E
128° 01′
129° 31′

180° — 129° 31′ = 50° 29′ or bearing of S 50° 29′ E to sem. disk

BY DIRECT SOLAR OBSERVATION—APR. 27, 1916

1. Observed on lower left limb

Western standard time 7:10 a.m. — SH 17° 38′ — Hor. Angle Rt. 42° 51′ to sem. disk

2. Observed on upper right limb

Western standard time 7:14 a.m. — SH 18° 53′ — Hor. Angle Rt. 41° 39′ to sem. disk

3. Average of (1) and (2) to center of sun

Western standard time 7:12 a.m. — SH 18° 15½′ — Hor. Angle Rt. 42° 15′ to sem. disk

Solution of (1)

Refraction for alt. 18° = 0° 03′ Semidiam. = 0° 16′
True alt. = 17° 38′ + 0° 16′ — 0° 03′ = 17° 51′

$$\text{Az. correction} = \frac{0^\circ\ 16'}{\text{Cos}\ 17^\circ\ 51'} = \frac{16}{0.95186} = 0^\circ\ 17'$$

Correct az. angle = 42° 51′ — 0° 17′ = 42° 34′

Western standard time is mean local time for Long. 105° W. or 7 hr. slower than Greenwich time; 7:10 a.m. + 7 hr. = 2:10 p.m. Greenwich time of observation.

Declination at Greenwich, noon of Apr. 27, 1916 .... = North 13° 49′ 05″
Hourly change of 47.8″ × $2\frac{1}{6}$ hr............ = 0° 01′ 43″
Correct declination .... = 13° 50′ 48″
say 13° 51′

p = 90° — 17° 51′ = 72° 09′
s = 90° — 41° 04′ = 48° 56′
z = 90° — 13° 51′ = 76° 09′
A = 197° 14′ ½A = 98° 37′
½A-p = 98° 37′ — 72° 09′ = 26° 28′
½A-s = 98° 37′ — 48° 56′ = 49° 41′

Using first formula:

Log sin 26° 28′.... = 9.649020 Log sin 72° 09′..... = 9.978574
Log sin 49° 41′.... 9.882229 Log sin 48° 56′..... 9.877340
19.531249 9.855914
9.855914
2)19.675335
Log sin ½z..... = 9.837668 ½z = 43° 29′ z = 86° 58′

Center of sun at time of observation bears N 86° 58′ E
Corrected az. angle.................... 42° 34′

Az. of sem. disk from north....... = 129° 32′ — S 50° 28′ E

Checks Polaris observation within 0° 01′.

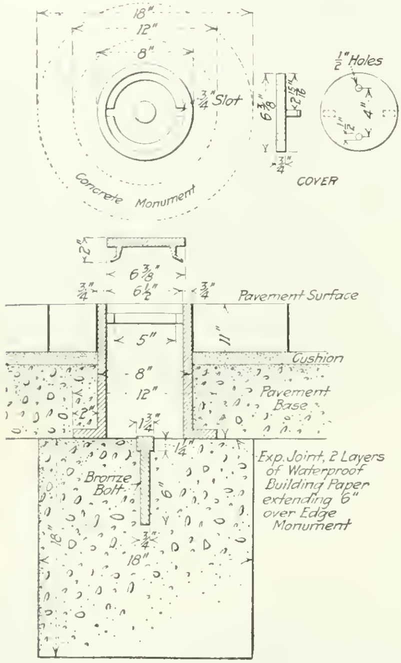
Solution of (2) gives S 50° 29½′ E and solution of (3) gives an average of S 50° 28¾′ E.

Using S 50° 29′ E as correct, an angular tie gives course of track tangent just east of the Devil's Slide as S 48° 30′ E.

The table of Convergence of Meridians is useful in checking transit work on long lines. For instance in Lat. 10° N. a line making 25 mi. of Westing (or Easting) would have an error of 18′10″ in its corrected course.

NOTES

City Survey Monument, Houston, Tex.—On account of the peculiar susceptibility to climatic changes of the black waxy soil of the Gulf coast country, a monument separate and distinct from the pavement is needed. In periods of drought cracks develop in the ground as wide as 2 in., and extending several feet deep and hundreds of feet long. When the rains come the adjacent soil softens and settles, carrying the pavement with it. On some of the older paved streets in Houston the base has cracked on both sides along lines approximately parallel to and 4 ft. from the curbs extending from one end of the pavement to the other, with the curbs and pavement showing settlement in places as much as 6 in. from the original grade. By constructing a monument independent of the pavement, separating them by two layers of waterproof building paper, the paving base is free to move in response to temperature changes or earth settlements with the least probability of monument being disturbed. Access to the bronze bolt imbedded in the monument marking the alignment or elevation is provided by a casting fixed in the pavement, which is in no way connected with the monument.—J. C. McVea, Office Engineer, Engineering Department, City of Houston, Tex.



DETAIL OF STANDARD CITY MONUMENT, HOUSTON, TEX.

Mowing by Machine at an Angle of 45° was accomplished on the canal banks of the Salt River project, according to A. J. Halton, Irrigation Manager, in the "Reclamation Record." The first machine to be purchased required a certain amount of alteration before the cutting bar could be dropped down for cutting at angles of 30 to 45°. This was in 1914. In 1915 the mowing-machine field was surveyed carefully, and three new machines were bought. Experience with these has established the following facts:

1. It is necessary to have a good teamster skillful in adjusting his machine so it will cut under various and difficult conditions. A quiet, steady team is also essential.
2. It is practicable to use mowing machines on canal banks where the slope does not exceed 45°.
3. Machines cannot be operated on banks where there is trash or heavy brush.
4. Leveling the banks when the ditches are being cleaned greatly increases the efficiency of the machine.
5. Mowing should be done in the early part of the season when the grass and weeds are tender and standing straight. If the work is delayed until late in the season, the weeds fall and make the work more difficult.
6. One mowing machine working under normal conditions will do the work of from 8 to 14 men using scythes, thus effecting a saving of from $10 to $20 per day.
7. With careful driving, machines can be operated in difficult places.

Approximate Expression for Tangent—An algebraic expression claimed to give a very close approximation to the value of the tangent of any angle is presented by George Paaswell, 2726 Creston Ave., New York. The expression is $x\frac{12 - x^2}{12 - 5x^2}$, in which x is in radian measure (360° = 6.2832). It is said to be only 0.2% in error at 45° and 0.7% at 60° An advantage of the expression, due to its simplicity, is that it can be memorized and used in an emergency when no function tables are handy. It can also be used in algebraic expressions involving transcendental functions where a direct solution in algebraic form is required in order to enable the mathematical work to proceed.

Burning a Wedged Sledge out of a stone crusher by means of an oxyacetylene cutting torch was recently reported at Middletown, N. Y., by the "American Machinist." A workman dropped a 20-lb. sledge into a running crusher in the municipal stone plant. The only alternative to this scheme of removal was to dismantle the machine and platform, which would have required a day or more. The torch freed the crusher in 1½ hr.

Specifying the Progress on Construction Work is a feature of contracts for the Calumet intercepting sewer at Chicago, which work is being built under the direction of the Sanitary District of Chicago. The contractor agrees that the progress shall be such that a certain percentage (in value) of the whole work will be completed by specified dates during the period of the contract. The percentages and dates are listed in the contract. Similar practice is followed on the work of the Little River Drainage District in Missouri. Here the total yardage record for each month necessary for the completion of the work within the contract time has been estimated by the engineer, and when individual contractors fail to make the required monthly progress they are notified of the extent of their deficiency, and are thus warned to speed up the work.

Pipelaying with a Portable Derrick was the method used in installing a sanitary outlet sewer at Butte, Mont. Excavation for this trench proceeded rapidly—the daily maximum being 537½ ft. on Oct. 17, 1914—until the deeper part (shown in the view) was reached. This deep part had to be sheeted, and the groundwater proved troublesome. Here 30 or 35 ft. was a good day's advance. In the shallow trench a tripod with single block and tackle was used for handling and lowering the pipe. The portable derrick was employed at the deeper trench, where saving of labor was an important item.

DERRICK LAYING PIPE AT DEEPER SECTION OF SANITARY OUTLET SEWER ON B ST., BUTTE

Editorials

Mechanical Tunneling in Rock

For many years there have been sanguine inventors who believed they could design a rock-tunneling machine that would cut away rock by mechanical action at a lower cost than the same rock can be excavated in the ordinary manner with explosives. None of these inventors have yet succeeded in placing a commercial machine upon the market. The prospects of the future in this direction must be judged in part with reference to the performances of the past.

The most recent tunneling machine, described in this issue, gives evidence of a high grade of designing ability. This machine is now cutting a short rock tunnel for subway purposes and in doing this it has proved itself able to bore an 8-ft. hole in the hard New York gneiss at the rate of about 9 ft. in 24 hr.—a mechanical feat of no small consequence.

A machine can show advantage over the drilling and blasting method chiefly in two ways: First, in making faster progress or lower cost—the two are likely to go together; second, in making tunneling safer. This second point is of considerable importance and heretofore has been more or less neglected in the consideration of the subject. Fissured rock produces a great amount of overbreakage in tunneling and it is responsible at the same time for most of the dangers which affect the work of driving tunnels in rock.

It frequently happens that a stratum of rock is so traversed by jointing planes and seams as to be in effect a pile of separate stone blocks. Driving a tunnel through such rock by drilling and blasting inevitably means disturbing the material for some distance from the excavation line. Many a tunnel worker has been killed by rock falling as a result of the loosening due to the action of the explosive. On the other hand a boring or trepanning operation in the same rock may easily succeed in producing a smooth hole with undisturbed walls, the separate blocks of the material arching together in mutual support rather than falling away from each other.

In the short experimental tunnel now being driven, for example, the conditions are such as to make it seem quite probable that in proceeding by the usual method of blasting a distinct danger from loose rock would have been created and possibly much timbering would have been required to hold the roof. The hole produced by the unneling machine, on the contrary, barely shows even uperficial indications of the presence of jointing planes and fissures.

But while this consideration may frequently enter as a factor in the choice of tunneling methods, speed and cost will be determinative in the great majority of cases. Time, and development by successive trial, alone can show whether such speeds and such low costs can be attained as to making a tunneling machine a formidable rival of the ock drill and the dynamite cartridge.

It is very interesting to note that the new tunneling machine, like most of its predecessors, operates by chipping action. Percussion tools of some kind seem to have been the chief reliance of tunneling-machine inventors. Far back in the history of the subject, however, trial was made of a rotary cutting machine, and later devices of the same type have been applied to softer material such as hardpan and hard clay. An analogy may be found also in the field of coal-cutting machines, where the material dealt with is something that might be considered a soft rock, and where pure cutting action has been found the successful solution.

The question presents itself, whether rotary cutting action may not in the end prove to be the effective solution of the rock tunneling problem, in hard rock as well as soft rock. The possibility of transmitting unlimited amounts of power to the point of use through electric transmission, and the enormous advance made in recent years in tool steel, create new possibilities in this direction as compared with the situation existing a generation ago.

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Rail Troubles Not Yet Ended

If a sure cure has been discovered for the transverse-fissure disease of steel rails, as announced by Dr. P. H. Dudley of the New York Central Railroad in a circular just issued, it will mean a great deal for the safety of railway travel. The strange malady has each year caused hundreds of rail breakages, and wreck upon wreck. Though all the engineering and scientific resources of the railway world have been brought to bear on the problem, the cause and prevention of transverse fissures remained a mystery. Dr. Dudley now says that the cause is an internal crack produced by strains from the gagging press in straightening the rail, and that such cracks occur only in rails which have a nonductile core formed by "delayed transformations." The cure, he says, is reheating the blooms.

The hard-core hypothesis was employed previously by others in a different way. For example, J. E. Howard, of the Interstate Commerce Commission, has practically proved the peening deformation in the rail head to be so great that a nonductile or a weak core, if it exists, is bound to rupture. And such a rupture, of course, is bound to grow outward under repetition of stress. Thus, if we once have the bad core, the case is dangerous, gagging or no gagging. Dr. Dudley's statement that he finds the imprint of the gag on the core in such breaks tends to put a large amount of the blame on the straightening process.

We are left in the dark for the present as to how reheating the blooms will prevent the formation of a bad core; or, for that matter, how a hard core is formed at all, when we know with certainty that the interior of the rail head cools slowly and therefore can anneal fairly well. Mr. Howard and those who follow similar lines of thought seem to blame the bad core on two factors, (1) segregation, and (2) stretching in the rolls, made worse by shrinkage strains. Dr. Dudley, in failing to mention segregation, practically absolves this ancient bugbear of blame. But in contrast, it is well to recall, another railway pays several dollars per ton for special tests to limit segregation in the head.

At a time when Dr. Dudley's cure for transverse fissures may produce the optimistic belief that rail troubles are now over, along comes the Interstate Commerce Commission with a startling accident report. This deals with a derailment at York Road, on the Western Maryland, last January. A rail broke from serious interior defects—extensive longitudinal seaming in the top-of-ingot rail, due to insufficient cropping. The startling feature is that this break occurred after ten years of service of the rail.

Heretofore the comforting thought has been entertained that defects in a rail will show up soon after the rail is laid in track. We have always felt that after a rail has gone through several years of service it has proved itself to be a good rail. Now we learn that such is not the case. A rail may be dangerous, highly dangerous, and yet not betray its condition until it has nearly reached the end of its natural life.

This rail was smashed up completely for an 11-ft. length; only 56 pieces were recovered. Allowing fully for the hammering effect of the train after a first breach was made in the rail, it yet seems that most of the 11-ft. section must have been in almost an explosive condition—ready to go suddenly upon a slight disturbance. On an optimistic basis one might consider that the condition was a good one: that the rail held until worn out, like the one-hoss shay, and then let go all together. But in reality the condition was bad indeed, and the mystery is why the rail held so long.

The York Road accident thus tells us that the next generation will still have to wrestle with the problem of rail defects. It will inherit from us the troubles being created for it today by present-day lack of skill in steel-making and rail rolling. Even if we were to lay nothing but perfect rails in the track from today on, our railways would not become wholly safe against accidents due to the breaking of defective rails until another decade has elapsed.

New York's Harbor Troubles

With considerable flourish of trumpets it was announced just a year ago that the City of New York had appointed a commission of engineers to investigate and report on the terminal problem in New York harbor, to study the various railroad and steamship terminals and their relation to business centers, in short to prepare a comprehensive scheme for the development of the harbor as would befit what it is fast coming to be—the greatest port in the world. The announcement was no dream of a publicity agent or commercial boomer; it was a carefully considered statement of a branch of the city government. It included not only the names of the eminent engineers selected to serve on the commission but an ambitious budget which involved two years' work and a quarter of a million expenditure.

Probably many of our readers are wondering if this commission is not about ready to issue at least a preliminary report which would give some idea of the proposed solution of the greatest problem before forward-looking American transportation experts—the coördination of New York harbor. Any such expectations are doomed to disappointment; the New York harbor commission has never existed for the simple reason that the Board of Estimate has never provided any money on which it could exist.

Meanwhile the numerous antagonistic interests controlling and using the port go on their dissociated way. The State of New Jersey is complaining to the Interstate Commerce Commission that it is not treated as it should be in the dividing up of the New York harbor business. The railroad, the city, the state and the yellow press have hard work agreeing on the west side freight approaches. The Federal Congress turns down the necessary Hell Gate deepening as a part of the River and Harbor Bill but nearly forgets to eliminate it from its hiding place in the Naval Bill, where it was placed in the hope that a mere half-million would be overlooked in our three-hundred million naval budget.

Taking it by and large there are times when one doubts the infallible wisdom of the founders of the republic and wonders whether a few years—say about one generation—of absolutism wouldn't settle satisfactorily a few of our most annoying problems.

Activated-Sludge Progress

Activated-sludge plants from ocean to ocean and from the lakes to the gulf will be in operation within a few months if present plans are carried out. Milwaukee and Cleveland have had in use for some months working-scale units which are the beginnings of proposed large installations. Baltimore has adapted some of its Imhoff tanks to the activated-sludge process for working-test purposes. The Brooklyn sewer engineers are giving close study to the new process, as is also the staff of the Lawrence Experiment Station. Tests at several different plants in Chicago are being made by the Sanitary District and by packing-house companies. The Illinois State Water Survey experiments at Urbana are being continued in a comprehensive and promising way. A plant is being built if not already in use at Houston, Tex. Plans for a plant in New Jersey have been approved by the State Department of Health. An engineer has recommended Riensch-Wurl screens and activated-sludge tanks for Lima, Ohio. Most recent of all, the authorities of Hermosa Beach, Calif., have decided to build an activated-sludge plant.

In England, progress was checked at an early stage by the war, but the process has been studied at Manchester, Salford, Sheffield and perhaps other places. *The Surveyor* of July 28 states that "Worcester is the only place in England where the most modern system of sewage disposal on a large scale can be seen at work." At Worcester half the sewage of the city was being treated by Jones & Attwood, of Stourbridge, under a provisional contract providing for a year's test, three months only of which had been carried out. About 950,000 U. S. gal. of sewage are being treated daily under this contract, which provides that the effluent shall not contain more than four parts per 100,000 of suspended matter and shall be nonputrefactive. The poorest of five weekly samples showed only 3.8 parts of suspended matter and the next highest one only 1.2 parts. None of the samples gave evidence of putrefaction.

The attention that has been given to this most interesting process of sewage treatment by many leading sewage engineers, chemists and bacteriologists, the number and widespread distribution of the experimental and practical tests to which the process is being subjected, and the fact that municipalities here and there are putting in trial units and even plants for the whole city may well lead any engineer or city with a sewage-treatment problem in land to give most careful consideration to the activated-ludge process. Should its highest promises be realized it will fall little if any short of revolutionizing sewage disposal. As yet, there is need for caution. Many details f design and of operation remain to be worked out or, where already worked out, chosen from after further xperience.

Although land area required and construction cost are low the cost of operation under varying conditions has not yet been conclusively determined. The process promises to be very flexible and adaptable to meet local conditions but until more working data are accumulated and interpreted those who have had little or no experience with the process will do well to go slowly and thoroughly —following in this the example of those who have had the most experience. It is highly desirable that trial units r plants readily convertible to other processes be installed freely in various parts of the country and that their eration be studied closely by trained observers in order o accumulate and interpret many and varied data as apidly as is consistent with thorough work.

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Dangers in Solid Rock

Revision of the proverbial phrase "firm as bedrock" eems advisable in the light of events showing that the arth's rock strata may fail either below the surface, as n the Scranton subsidences, or at the surface, as in the emarkable Highland Falls case described on another age. Seams, cavities and whatnot create dangers that ake rock often more treacherous than running earth. hat immense cliffside slab which hung over the ridge at Highland Falls furnished a striking illustration. appily, ingenious resourcefulness devised a complete rotection.

Similar dangers threatened the operation of the Swiss oetschberg tunnel railway, opened just three years ago. s recently described by one of the engineers of the line, e south approach, from Brigue along the steep mountain des of the Rhone valley, had a prodigious amount of ouble with loose and sliding rock masses. Masonry un- erpinning supports solved the difficulty in some locations. ften, however, the safest way was the simplest: swinging e railway line into the inside of the mountain for a ort distance by a bypass tunnel. Pinning a loose ass to place, however, has not been done either there or sewhere. The railway engineers who did the Highland alls work have a clear title to originality.

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No Water Power Legislation in 1916

The adoption of an acceptable water-power bill by the ederal Congress during the present session now appears actically impossible, according to reports from Washing- n of a complete deadlock between the House and Senate nference committees on measures accepted by their re- ective bodies. Apparently there is uncompromising op- sition on two main ideas dominating the attitudes of e "conservationists" and "utilizationists" who control e respective committees. One is the annual Federal charge for the waterpower rights; the other is special legislative permission for each dam to be built across a navigable stream. With complete disagreement holding up legislation there can be no power development on public lands except under revocable permits of the Secretaries of the Interior and Agriculture; and there can be no dams at all on important waterways.

Strangely enough the major conflict is on what to engineers will seem a very minor matter, in practice if not in principle—the annual Federal charge. Such required payments as have been embodied heretofore in the revocable permits have been trifling sums intended to cover the administrative cost of supervision. It is probable that they would remain so under Acts of Congress rather than run the risk of unconstitutionality as a revenue producer. They might perhaps be arranged in a sliding scale aimed to penalize high rates to consumers and unduly delayed development—witness the well remembered agreement between the Secretaries of the Interior and Agriculture and the International Power Co., for the development of 112,000 hp. on the Pend d'Oreille River in Washington, wherein the minimum tax was 5c. per horsepower-year and the possible average from $1 to $5.

Such a deadlock as now exists in Congress is lamentable, unstatesmanlike, unpatriotic. Failure to lay down some sort of a program that will seem to induce capital to enter the hydro-electric industry is bad; but to the engineer even worse is the failure to prescribe some definite terms under which dams may be built so that the feasibility of the many pending projects can be determined or dismissed.

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When a Water-Works Surplus Changes to a Deficit

Under ordinary methods of municipal accounting and financing as a city pays off its water-works bonds the profits increase year by year until important extensions of the works require a large new bond issue. Thereupon the surplus gives place to a deficit. Such a deficit faces New York City within a year or two on account of the immense outlay for the Catskill water-supply, the first unit of which is nearing completion. The case, together with comments on meeting the deficit, is interestingly put by William Williams, Commissioner of Water-Supply of New York City, in his report for the year 1915, just published:

> The estimated value of the city's present water-supply system, exclusive of the new Catskill system, was at the end of 1915 $227,000,000, against which there remained outstanding at that date a debt of only $91,000,000. The interest and sinking fund charges against this debt during 1915 amounted to $4,770,000, while the cost of operating and maintaining this system, including taxes, was $4,541,606. Since the revenues for 1915 exceeded $13,000,000, the income account for that year showed a surplus of nearly $4,000,000. Thus the city appeared to be in a very comfortable position as regards the financial side of its water-supply business.
>
> What is commonly known as the Catskill system is being constructed out of corporate stock (bonds). Down to Dec 31, 1915, $129,175,000 of corporate stock had been issued for this purpose. Further issues will be required before this system is completed, but the interest and sinking-fund charges on the amount issued down to Dec. 31, 1915, reach $7,500,000. As soon as the operation and maintenance of the new system come under this department, as will probably be the case by Apr. 1, 1917, the department's income account from its water-supply business will cease to show a surplus of any kind, and, on the contrary, will show an annual deficit ranging between $2,500,000 and $3,000,000, unless a means can be found materially to increase the water revenues. When this happens there will be a rude awakening for many who have come

> to regard New York's water-supply as a source of financial profit. At that time fewer people will be heard to demand that water shall be as "free as air," and more will come to view it as a most valuable commodity, to be used with care and not wasted, as now so much of it is. At that time, also, the department's efforts to bring about the abolishment of the unintelligent and discriminatory frontage rate system and the installation of meters on all services, so that all water used shall be paid for at a proper rate and that none shall escape (as many now do escape) their fair share of its cost, will be more generally appreciated than they are at the present time.

This situation suggests many points, only a few of which can be discussed here. First, it may be noted that New York, like most other cities, furnishes a large amount of water to city departments and to public or semipublic institutions for which the water department gets no credit. According to Mr. Williams this free water in New York, at current local meter rates, amounts to $2,000,000 a year. This sum might very properly be added to the present yearly surplus. It should just as properly be deducted from the deficit Mr. Williams foresees. Second, if the water consumers of New York have been paying not only for the water they have used but also for that used by city departments and various institutions they have either been overcharged or else there would have been accumulated by this a large surplus fund to offset a part of the Catskill water debt. Third, the Catskill supply, with its higher pressure and better quality, is going to be worth more to the consumers than the water they are now getting. Fourth, a portion of the Catskill supply is to meet increase in consumption due to growth of population and industry, which of course should foot the bills; but another portion of the supply and corresponding outlay is due to provision for the future, which makes a sudden and high jump in capital charges with no immediate effect on water revenue.

A large part of this jump, in a commercial utility's financing, would be made a burden on the future consumers for whose benefit the excess capacity has been secured. This would be done in some cases by capitalizing the deficit, as a cost of developing the business, with provision for later amortization. In the case of a municipality the same result might be secured by issuing bonds to cover that part of the deficit properly attributed to the cost of excess capacity.

Finally, coming back to the concluding part of the quotation from Mr. Williams' report, the present system of charging for water in New York City is not only antiquated but was never justifiable and is notoriously unjust. The frontage charge alone goes far toward explaining why increased water consumption does not mean a proportionate increase in revenue.

Letters to the Editor

Masonry Arch Makes a Cheap Highway Bridge

Sir—Apropos of the editorial on "Concrete and Stone Masonry for Bridges," in your issue of July 20, I send a photograph of a simple highway bridge built in this town a few months ago.

Here, cement and broken stone are obtainable at a little more than average prices, because of freight rates. In this case there was plenty of stone available, and local masons not particularly skilled in laying bridge masonry. After getting a rather high bid from a contractor, we decided to do the work by force account, utilizing home talent and spending the money chiefly in the town.

The span is 28 ft., rise of arch 5½ ft., springing lines 5 ft. above the base. Foundations are of concrete rubble, built behind shallow wooden sheetpiles on gravel bed. The abutments, below the spring lines, are 6 ft. thick. Strong cement mortar was liberally used throughout the work. The arch between stone facing is made of concrete, reinforced with expanded metal. It is intended to carry any possible load up to a locomotive.

The concrete is probably more expensive for us than stone. Indeed we built a second bridge, using the same centers across the same brook, all of stone, the cost of the two bridges being less than $500 more than the contract bid for one.

The photograph was taken before the clean-up of the ground. While the coursing of the masonry may seem a little crude, it must be noted that not one passer-by in ten thousand ever sees more than the parapets on their inside.

The selectmen were persuaded to incur a little greater first cost in order to have a bridge needing no charge for maintenance, and one equal to any traction engine or other future load. Once for all they were rid of worry about capacity of bridge, repainting (had they chosen a plate-girder), replanking floor or renewing pavement, etc.

CHEAP AND ATTRACTIVE MASONRY HIGHWAY BRIDGE

ROBERT FLETCHER,
Director, Thayer School of Civil Engineering,
Dartmouth College.

Hanover, N. H., Aug. 11, 1916.

Creeping and Heaving of Concrete Road Slabs

Sir—In the editorial on the creeping and heaving of concrete road slabs, June 22, 1916, p. 1193, you attach great importance to proper construction of the subgrade—something beneath the concrete and not an integral part thereof—which suggests that it may not be irrelevant to refer to the success achieved by putting something on top of concrete—for example, an asphaltic concrete wearing surface.

If we separate highways in which concrete has been used into two classes, those consisting entirely of concrete and those protected by a wearing surface, we find that in the latter type concrete has given little trouble, whereas unsatisfactory results are far more common in the case of roads constructed entirely of concrete.

According to Frank W. Sampson's communication, published in *Engineering News,* July 20, p. 134, the creeping and heaving of concrete occur when the slab becomes saturated, followed by drying. In discussing the subject recently with Henry H. Quimby, Chief Engineer of the Department of City Transit, Philadelphia, I found hat his opinion coincides with the view expressed by Mr. Sampson. Mr. Quimby also believes that a water-shedding wearing surface would remedy the difficulty and provide further desirable protection against sudden and extreme changes in temperature. I find that others who have made concrete the subject of careful study for years hare Mr. Quimby's convictions as to the efficacy of a wearing surface.

The proposition involves of course the matter of cost. find on this point that Northeast Boulevard, Philadelphia; streets in Newton, Kan.; a section of the Belair oad, just out of Baltimore; and a road in Monroe Couny, Mich., all of them having a 4- or 5-in. concrete base nd a 2-in. asphaltic concrete wearing surface, cost less er square yard than the present price of cement conrete roads.

To the best of my knowledge the concrete on these horoughfares neither creeps nor heaves. Do we require n country roads a better type of pavement than Philadelphia put down on Northeast Boulevard for about $1.25 er sq.yd.? Has enthusiasm on the subject of good roads aused the pendulum of high cost to swing from the metropolis to the country?

E. A. Trego,
Barber Asphalt Paving Co.
Philadelphia, Aug. 8, 1916.

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Curves for Irrigation-Ditch Velocity and Discharge

Sir—In the article by L. R. Douglass, on "Curves for rrigation-Ditch Velocity and Discharge," in *Engineering ews* for July 13, 1916, p. 72, the author has evidently ndertaken a very difficult task if he is attempting to determine accurately the "maximum velocities and disharges" for an old ditch from computations based upon multiplicity of cross-sections. Where a canal is in peration, the simplest and most accurate way to find he maximum capacity is to turn into it as much water as thought safe and take a few current-meter measurements. However, conditions were doubtless such as to ender the method of procedure adopted necessary and urther discussion will be limited to the diagrams proposed by Mr. Douglass for the solution of the hydraulic problems involved.

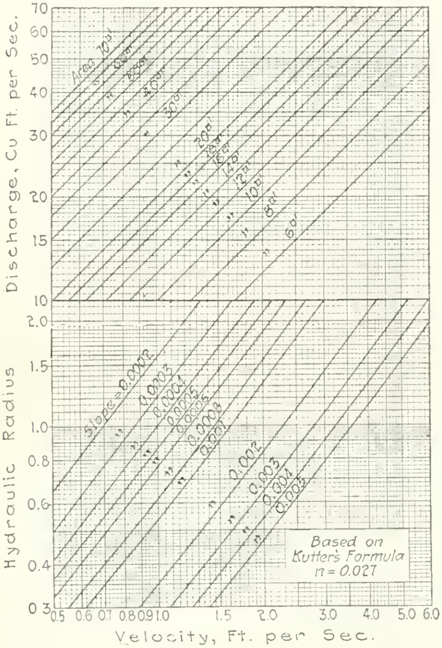
The statement made by the author that his diagrams are designed to eliminate the "long and tedious" computations by Kutter's formula indicates a lack of familiarity with published data upon the subject. There are probably more curves in existence for the solution of Kutter's formula than for any other one formula. In "Working Data for Irrigation Engineers," by Moritz, a series of curves is given for the complete solution of such problems as the one presented. Having the dimensions of the sections, the slope and Kutter's *n* given, the area, the hydraulic radius, the velocity and the discharge are determined from Moritz's diagrams without computation. The curves cover a wide range of canal sections and give velocities for all the commonly used values of *n*. As no diagram is given for $n = 0.027$, it is necessary to interpolate between $n = 0.025$ and $n = 0.030$. A value of $n = 0.027$ is rarely encountered, and ordinarily the interpolation method serves every purpose; but in cases like the one cited, where a great number of computations involving an unusual value of *n* are to be made, special diagrams may be required. It is desired to call attention to some points in connection with the curves submitted by Mr. Douglass.

The diagram, Fig. 1 (p. 72), is less accurate and less convenient than the slide rule and is of little value. The upper and right-hand scales in Fig. 2 (p. 72) likewise perform a simple operation that ordinarily could be performed more easily on the slide rule, but these scales may be used to advantage in connection with the other scales to obtain both the velocity and the discharge from a single entry. This may be done by entering the diagram with the slope and the hydraulic radius, as directed, to find the velocity, thence passing around the velocity curve to intersect the horizontal through the area, and thence vertically to the discharge. This point was not brought out clearly in the article.

It should also be noted that there is a small theoretical error in the construction of Fig. 2. In order for the set of velocity curves to exactly fit both of the two sets of coördinates it would be necessary for the velocity to vary as some simple power of the slope. This is not strictly true, but it is probable that within the limits of the diagram the error is negligible. The diagram has, however, one serious defect. The velocity curves for almost their entire length are nearly parallel to one or the other of the coördinate systems. This makes it difficult to read the diagram accurately. To eliminate this difficulty the curves should be plotted on logarithmic cross-section paper. In this case the velocity curves would be nearly straight lines and would intersect the coördinate lines at practically a constant angle. Also, the curves being approximately straight, fewer computed points are necessary for plotting. Logarithmic curves give a greater range of values on a small area with an equal percentage of accuracy over the whole diagram.

Granting that the number of computations to be made using $n = 0.027$ is sufficient to make the work of interpolating between existing curves or tables greater than the work of constructing a special diagram, the arrangement shown in the accompanying diagram is suggested. The two sets of curves are separated for clearness and to remove all doubt as to accuracy. It will be noticed that the diagrams cover the same range as is covered by the original curves and that the angle of intersection is good throughout.

Only a sufficient number of lines to illustrate the principle are shown in the figure; other lines can be added at will. The lines in the lower diagram are very nearly straight and are plotted from velocities taken from "Hydraulic and Excavation Tables," published by the United States Reclamation Service. The area lines in the upper diagram are straight lines inclined 45°; and since area is equal to discharge when the velocity is 1, they are readily drawn. The straight lines and favorable intersections do not result from the rearrangement, but are due to the logarithmic cross-sections. If the velocities are plotted as in the original diagram, they will be very similar to the slope lines shown here.



CURVES FOR FINDING VELOCITY AND DISCHARGE OF OPEN CHANNELS

JULIAN HINDS,
Asst. Engr., United States Reclamation Service.
Denver, Colo., July 26, 1916.

⁂

Comment on Civil Engineers' Flood-Control Report

Sir—Since the submission of the "Progress Report on Floods and Flood Control" by the committee of fifteen appointed by the American Society of Civil Engineers, there has been a great deal of commenting and criticism on the report by sundry engineers. The criticisms that have been offered, of an adverse sort, have been little more than verbal quibbling over matters of phraseology; and the discussions generally have related to relatively inconsequential features of the major problem.

But critics and commentators have all missed the kernel of the matter, which is, that it is not possible to formulate a report that shall meet the implied demands of these critics, and cover in a comprehensive way what is embodied in the title of the report, as applicable to the entire territory of the United States.

The difficulties in the way of such a comprehensive report as the critics by implication demand, cropped out very soon after the committee began its labors. Colonel Townsend, chairman of the committee, as an initial step, and after consulting the members of the committee, divided the body into sub-committees by geographical distribution, and requested partial reports from the sub-committees to serve as a basis of a general report. In response to that request came but one report from a sub-committee as such, that on the Ohio River. Several other reports were submitted by individual members.

But each report received was an elaborate treatment of *one individual river*, with no reference to any other river; and in the nature of the case this is what must have been expected.

Glancing over a map of the United States and noting all of its drainage systems, it is seen that there is a large number of rivers of sufficient size and importance to engage the attention of engineers; and every one of these rivers is strictly individualized, requiring a special treatment to fit its individual characteristics, upon a plan and by methods that are not applicable to other rivers; and on some of the lar er rivers different portions of the same stream are strongly individualized, differing radically one portion from another, and requiring radically different treatment.

A general report to cover all of these rivers with entire justice must resolve itself into an agglomeration of reports on all the individual streams. Any report that shall embody basic principles that are applicable to all of the rivers in this heterogeneous assemblage of highly differentiated units, must perforce be a meager covering, consisting of the few and obvious principles that are common to all.

An analogous case would be to demand of a committee of the medical faculty of the whole country a general report that should cover the treatment of all the diseases in the category of therapeutics.

T. G. DABNEY,
Clarksdale, Miss. Member of Committee.

⁂

Electrolytic Sewage Tests at Elmhurst and Decatur

Sir—Those interested in sewage-treating processes have doubtless read the statement relative to the electro-chemical treating plant at Elmhurst, Borough of Queens, New York City, in your issue of July 13.

The writer visited the Elmhurst plant a year ago, and while he found details to be criticized from an engineering standpoint, the results that were being obtained indicated great possibilities and the process showed merits worthy of very careful consideration.

The equipment had been installed in a plant designed for another process and the whole installation was not what the process required for best results. Prices paid for electricity and lime were excessive, and the plant was treating 750,000 gal. per day at a labor cost sufficient to handle several million gallons.

The following results, however, were evident: The treatment was made quickly and without odor or nuisance. The effluent was bright and clear and created no objectionable effects below the plant. The sludge was in a condition to be pressed while fresh, and the cakes were easily handled and remained practically inodorous.

It has been my privilege within the past two months to design and see put into operation a demonstration plant wherein this process is used under more favorable conditions. The plant is located in the City of Decatur, Ill., and has a capacity for handling 1,000,000 gal. of sewage per 24 hr.

The sewage is drawn from the main sewer of the city, a 7-ft. brick sewer that carries some three to four million gallons of very strong city sewage, including the trade waste of a large slaughter and packing house, a gas plant, a starch manufacturing plant and a zinc-plating works. The starch works alone furnishes practically a million gallons of waste that is particularly difficult to treat, as it is strongly impregnated with sulphurous acid and is not susceptible to biological treatment.

The plant is located within six blocks of the business center and is housed in a neat frame structure 18x70 ft. in plan. In this is installed a motor-driven pump to lift the sewage some 18 ft. into a feed box, a 1,000,000-gal. electrolytic treating machine with its motors and special generating sets, switch boards and other equipment; a motor-driven sludge pump, and (for demonstration purposes only) a crude-oil engine for generating electricity, thereby giving a complete self-contained plant.

Outside the building is a settling tank 18x60 ft. in the bottom of which are placed four conical hopper-bottom pits. The tank is lined with lumber and has a total depth of 16 ft. to the bottom of the pits, the hoppers extending from the bottom to within 6 ft. of the flow line. The tank is not covered, and sludge pipes are provided extending to the bottom of each hopper through which sludge is constantly drawn off by the pump, and forced through a Johnson filter press located beneath a shed outside the building.

Over a portion of the building is a second story in which are the lime solution and storage tanks. Outside and independent of the building are two small sheds, one for storage of lime, the other a laboratory for the use of the chemists, the entire plant, treating 1,000,000 gal. of sewage daily, occupying about half an acre of land.

The sewage is drawn from the main sewer through an opening in the bottom so that the plant gets its full share of the heavier suspended particles that are carried along the bottom of the sewer. It passes into a pump pit in which a screen is placed to remove all coarse trash that will not pass through ½-in. circular openings. A 5-in. centrifugal pump lifts the sewage from this pit into a feed box containing a weir and overflow, arranged to control the quantity of sewage fed to the machine. Owing to the odors produced by the starch wastes, this box is sealed tightly in a separate room with only a glass gage showing in the operating room to indicate the height of flow over the weir. By-pass pipes are provided, one in the feed box, one in the entrance trough where the treated sewage enters the settling tank, and a second at the outlet end of the tank. These all connect with a tile drain that carries the water back to the main sewer and discharges it below the inlet. A surface outlet is provided through which the treated effluent may enter an open ditch, and after traveling some 300 ft. down a valley enters a branch sewer through which it flows back to the main sewer. The character of the sewage treated compares favorably in appearance to that coming from the Chicago stockyards and is more concentrated than the sewage used in the experiments at Milwaukee.

The plant was operated for some two weeks in order to make adjustments and such changes as were found necessary to meet the requirements of the sewage, and was then turned over to chemists representing the city of Decatur and the Electrolytic Sanitation Co., of Chicago (which installed the plant), for a determination of the results.

To all appearances the plant is doing all that was expected of it. Odors are destroyed, the sludge settles readily into the hoppers and presses into a cake that is easily unloaded from the press, and the effluent on leaving the tank is bright, clear and practically odorless. The cost has not yet been fully determined, but indications are that it will compare most favorably with any of the other known processes, especially when the amount and character of waste from the starch works are taken into consideration.

W. S. SHIELDS,
Consulting Engineer.

1201 Hartford Building, Chicago, Aug. 7, 1916.

Not So Dry in Payta

Sir—In looking up some information on rainfall, I found in your issue of Apr. 19, 1900, p. 249, a note on the "Rainless Region" near Payta, Peru.

I spent three years, 1912-14, in Peru—about two-thirds of the time near Payta. Less than 100 mi. southeast of Payta, I recorded over 5 cm. in one night, and on Mar. 1, 1915, I encountered the prettiest little rainstorm one could wish for at Payta and about 100 km. west of there. It put out of commission the only irrigation canal in that vicinity for four months, on account of the caving in of the banks.

The note in question also stated that the average time between showers is seven years. You would be stretching the truth if you said that the present average duration between showers is seven months. During the time I was there I never saw more than three months between showers.

Several inches of rain falls there during the year, and especially during the rainy season of December, January and February.

WALTER S. WHEELER.

30 East 42nd St., New York City, Aug. 9, 1916.

[If 16 years ago we gave Payta an unwarranted reputation for rainlessness and if we are thereby in any measure responsible for the failure of the irrigation canal, we are sorry.—Editor.]

NOTES AND QUERIES

The Surveys for the Proposed Colorado River Dam, described on p. 306 of "Engineering News" of last week, are referred to a base line 780 ft. long instead of a 200-ft. base, as noted in the article. The mouth of Diamond Cañon is about 800 ft. wide.

In a News Note on p. 766 of "Engineering News," Apr. 20, 1916, it was stated that W. C. Abbott, of the Smithsonian Institution, was coöperating with a weather observer in Houston, Tex., in research work which would make possible long-range weather forecasts. The Institution informs us that no such coöperation exists.

Structural Design of a Peaked Reinforced-Concrete Roof

By J. Norman Jensen*

In the construction of the New Bancroft Hotel in Saginaw, Mich., reinforced concrete was used throughout. There were no unusual structural features in the main portion of the building, but the banquet hall, about 40x70 ft. in plan and one story high, presented a somewhat novel type of roof construction.

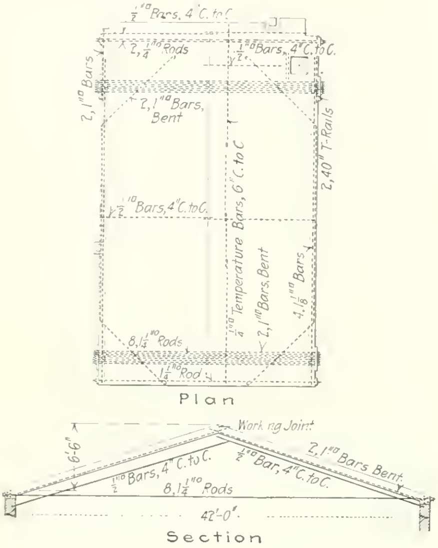


FIG. 1. DETAILS OF PEAKED CONCRETE ROOF AT HOTEL AT SAGINAW, MICH.

The architectural requirements of this portion of the building were that a peaked roof should be used, an arched ceiling should extend the greater portion of the hall, and that any girders or tie-rods should only be used in the extreme ends of the ceiling where they could be concealed. It was also desired that this roof should be of the same type of construction as the rest of the building.

As the span, 40 ft., was rather excessive for an economical roof slab, and as any level slab would necessitate increasing the height of the exterior walls owing to the arched ceiling, it was decided to design a peaked-roof slab to span from wall to wall. The method of design and computations for this roof are given below.

To find the load per lineal foot of slab, on a 20-ft. span (see Fig. 2):

		Lb.
Live.. ..	$25 \times 21 =$	525
9-in. slab	$112 \times 21 =$	2,352
Roofing	$3 \times 21 =$	63
Ceiling	$10 \times 20 =$	200
Total...	..	3,140

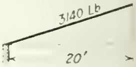


FIG. 2

Using the notation for reinforced concrete as adopted by the Joint Committee, $M = \frac{1}{8} \times 3{,}140 \times 20 \times 12 = 94{,}200$. With $f_c = 700$, $f_s = 18{,}000$, $K = 113$, $p = 0.0072$, $d = \sqrt{\frac{94{,}200}{12 \times 113}} = 8.35$ in. 9-in. slab used. $A = 12 \times 8.35 \times 0.0072 = 0.72$ sq.in. per ft. of width. ½-in. square bars, 4 in. c. to c. were used. Temperature bars were placed in the top portion of the slab as shown on the roof plan and section in Fig. 1. In order to insure that each half of the roof should act as independent slabs, a construction joint was left in the peak of the roof.

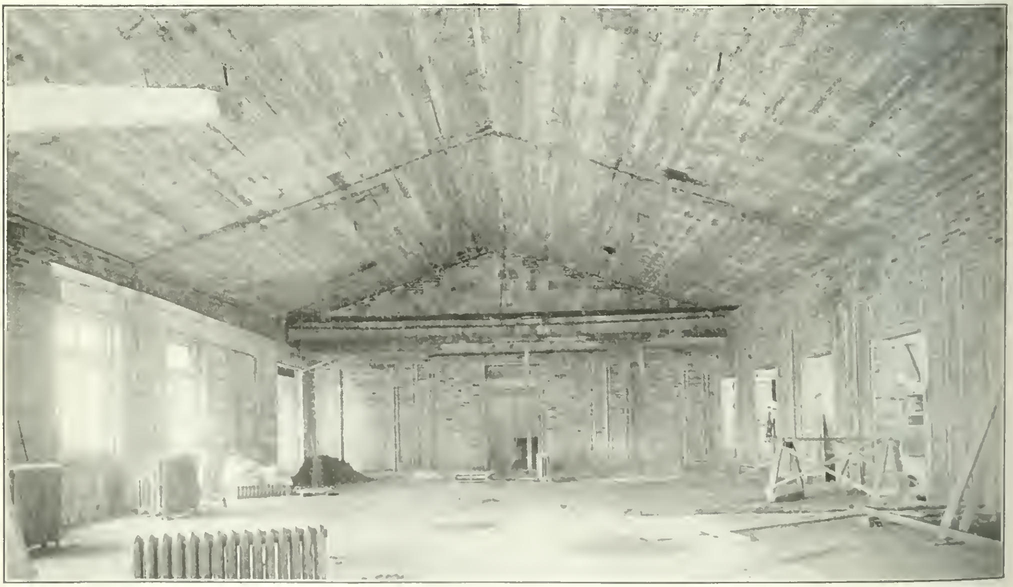


FIG. 3. VIEW OF UNDER SIDE OF ROOF BEFORE ARCHED CEILING WAS PLACED

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*2504 North Sawyer Ave., Chicago, Ill.

Having designed the slab, the next step was to design th roof considering it as a simple truss, in which the to chord was the concrete slab, and the bottom chord th tie-rods at each end of th hall. On this basis the th ist per lineal foot of slab $= \frac{3,140 \times 22}{2 \times 6.7} = 5,150$ lb., a tension per lineal foot f lab $= \frac{3,140 \times 21}{2 \times 6.7} =$ 4, 0 lb.

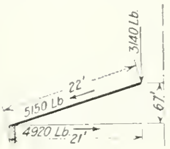


FIG. 4

ince the walls were not designed to take the thrust r the roof slab, it was necessary to consider the roof as a lateral girder, of a depth equal to the distance r the peak of the roof to the wall, of a width equal o e total thickness of the slab, and of a span equal to e distance between the two sets of main tie-rods. this assumption, total load of lateral girder = 54 × 150 = 278,000 lb. $M = \frac{1}{8} \times 278,000 \times 54 \times 12$ 2,500,000. Since $b = 9$ in. and $d = 21$ ft., solving , $K = \frac{22,500,000}{9(21 \times 12)^2} = 40$. $f_c = 350$, $f_s = 16,000$, 0.0027. $A = 9 \times 21 \times 12 \times 0.0027 = 6.15$ sq.in. 1⅛-in. and two 1-in. square bars were supplied in set of tie-rods.

$= \frac{278,000}{2 \times 9 \times 21 \times 12 \times 0.91} = 68$ lb. As the unit was a little higher than is allowable on plain con- the two 1-in. square bars were bent up as shown e plan to provide additional shear reinforcement. ch set of main tie-rods carries about 32 lin.ft. of Total tension in rods = 32 × 4,920 = 157,000 Area required $= \frac{157,000}{16,000} = 9.82$ sq.in. Eight n. round rods, with upset ends and turnbuckles were led.

bring the load from the top chord into the tie- bearing plates were necessary. Using 400 lb. as e llowable unit bearing stress on the 1:2:4 concrete bearing area required $= \frac{157,000}{400} = 392$ sq.in. wo 40-lb. T-rails shown gave a larger bearing area required.

analysis will not be quite complete without an igation as to the combined compression due to the compression of the slab acting as a top chord, lso the compression due to flexure in its action ordinary slab.

		Lb.
Direct compression	$\frac{5,150}{9 \times 12}$	48
Flexural compression		700
Total		748

s total value is not excessive for the concrete used. iew of the completed roof is shown in Fig. 3. The ls at one end of the building can be seen. These ad not been fireproofed at the time of the taking picture, but were afterward wrapped with wire and plastered with cement mortar. The writer bted to the architects, Schmidt, Garden & Martin, ago, for the information concerning this unusual

New York State Barge Canal in Partial Operation

The New York State Barge Canal has been under construction for over ten years. It extends from the Hudson at Waterford to Tonawanda on the Niagara River with side canals from Three Rivers up to Lake Ontario at Oswego, from Waterford to Lake Champlain and from Cayuga and Seneca Lakes to the main canal near Montezuma. Progress toward completion has been considerably slower than was at first anticipated but apparently the end is now in sight. The *Barge Canal Bulletin* gives the following statement of the sections of the canal which are under operation during this summer.

From the eastern terminus at Waterford the new Erie is now open as far as Jacksonburg. Throughout this extent the new channel lies chiefly in the Mohawk River. The short portions of land-line in this stretch have no towing-path and of course the river sections have none. Accordingly all towage must be by tugs, unless the canal boat has its own power. Through this new section the State does the towing, an appropriation having been made therefor by the last Legislature. At Jacksonburg the old canal is entered and must be followed until Newark is reached. Here again the new channel is in use, extending as far west as Pittsford.

With the exception of the new line to the south of Rochester, most of the Barge Canal west of Newark consists of a widening and deepening of the old channel. The Barge Canal scheme does not contemplate the use of animal power for towage and therefore no towing paths are provided. However, along most of this enlarged channel in the western part of the state the old towing path has been retained, and raised or lined if necessary. This has been done for the purpose of maintaining navigation during the period of construction, in accordance with the mandate in the Barge Canal Law. The section between Newark and Wayneport is an exception to this rule and here tugs are necessary. The state is providing towage here this year, the same as in the Mohawk River channel. From Wayneport west, however, the boatmen must provide their own power.

The old line through Rochester is employed this year, since the new alignment, which circles the city on the south, cannot be utilized until certain deferred work on it has been completed and also until there has been built in the Genesee River the dam which will provide both the pool on which boats may cross the river and also the spur and harbor, by means of which the city may be reached from the new canal. From the point where the old and new lines meet, near Greece, west to Tonawanda, the new canal, which is almost entirely the enlarged old canal, is open to traffic. A towing-path borders this channel and animal power may be used. A quarter-mile stretch from Tonawanda to the Niagara River is still to be built to complete the Barge Canal, but this year boats will follow the old waterway to Buffalo.

The new Champlain and Oswego canals are open this year throughout their entire lengths. Each branch is largely a river canalization, on which tugs or power-boats are needed. The State is not providing the towage here. The Oswego canal as it exists this year includes two sections which eventually will not belong to it. One is the canalized Seneca River from Three River Point to Mud Lock, near the foot of Onondaga Lake, which is really a part of the Erie Canal, and the other is the old Oswego Canal from Mud Lock to the junction with the old Erie in Syracuse.

Only the eastern portion of the Cayuga and Seneca Canal was opened at first this year. The old channel from the Erie junction into Cayuga Lake was used. In the section opened later the route extends through the new canal from Cayuga Lake to Seneca Lake, but the full depth of 12 ft. has not yet been provided at all places. From the outlet, at the northeastern extremity of Seneca Lake, to Geneva, the course follows the old canal, which extends some two miles and a half around the foot of the lake.

The sections of Barge Canal which are being used this year are not the only portions which are ready for operation. There are certain parts (and they embrace most of the sections not already in use) which can be thrown open as soon as a few uncompleted pieces of work are finished. The new channel between Sylvan Beach, at the eastern end of Oneida Lake, and Newark is thus ready for operation, with the exception of three short stretches. One of these lies between Clyde and Lyons, another is situated near Montezuma, and the third extends from Three River Point to Onondaga Lake and is now in use, serving as a part of the Oswego Canal

Sinking a Shaft by Dredging Through Springs and Gas

Clay, quicksand and gas-carrying strata gave much trouble in sinking a shaft for the new Central Ave. water-main tunnel under the Cuyahoga River in Cleveland recently. The sinking was effectively stopped at a little over 100 ft. depth below surface. However, since a satisfactory level for the tunnel was found above this point, the tunnel work was able to proceed and has just been completed with entire success.

The difficulties were met in sinking the east shaft of the tunnel, which is located on Stone's Levee on the line of Central Ave. The west shaft, on the opposite side of the river, was sunk later and did not go to such depth, thereby avoiding similar trouble in all probability.

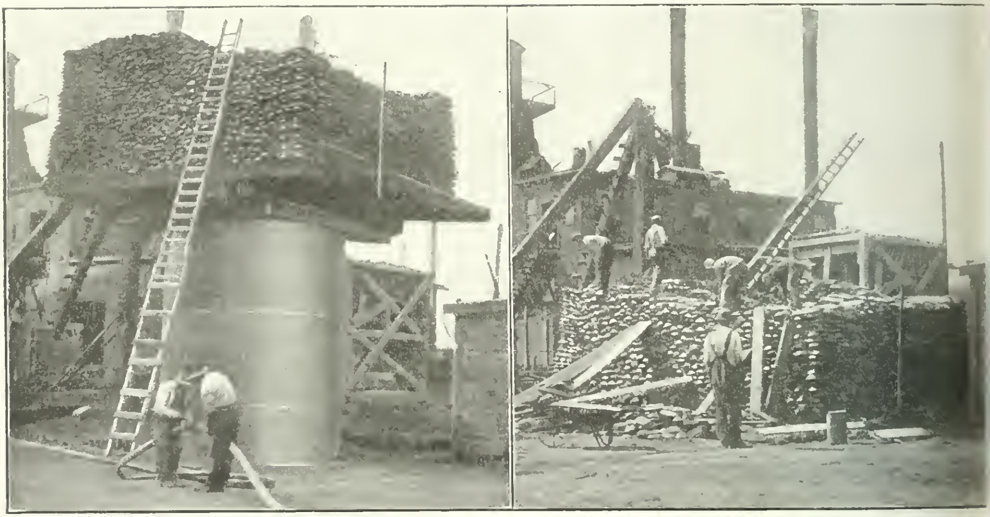
The shafts were originally designed to go down to 121 ft. below river level, this being just below the designed level of the tunnel. The east shaft was started inside an 18-ft. square pit within sheeting driven 16 ft. deep. The steel shell, 13 ft. in diameter, was built together in 16-ft. lengths that were erected successively as the shaft was sunk. At the start the cutting-edge section was turned upside down and concreted with beveled inner edge; then turned over and the next section connected on, and sinking started. Each section as it was joined on was lined with the 12-in. concrete lining.

Digging was done with an Owen bucket having specially wide teeth. The material in the upper strata was dry, hard clay for the most part, but lower down numerous sand seams were encountered. Only one shift was worked, a day shift, and probably in consequence of this there was frequent trouble from the cylinder hanging the next day, due to the clay squeezing and gripping the shell.

About 40 ft. down, a 16-in. log was encountered lying straight across the cutting edge. There was no way of handling this from above. A diver cut it through with an air drill and put a chain around the log, by which was hoisted out.

At 76-ft. depth quicksand and gas were struck, a doubts at once arose as to whether the sinking should continued or the shaft bottom sealed. There was seve days' delay in trying to reach a conclusion as to the b procedure, and then the decision was to go on with sinking. Excavating continued, but it developed t the shaft had frozen in place during the stoppage. week's work did not start it. Meantime pig-iron lo ing was being put on, which finally reached the amou of 300 tons. Then the shaft suddenly dropped 17 in a few seconds, forcing a large amount of material the bottom up into the shaft. (See accompanying view However, the drop did no damage, but on the contra cut off the gas and the quicksand.

When 100-ft. depth was reached, there was no m steel shell available, and it was decided to go down or 30 ft. farther by excavating and underpinning. Sh ing was driven, inclined outward over a ring of timb This sheeting was a 6-ft. length. A similar length driven below it; and below this a third, as the digg by pick and shovel went down.



SUDDEN DROP OF SHAFT UNDER 300 TONS PIG-IRON LOADING

The two views were taken a few minutes apart; the drop took only a few seconds, however

At 113 ft. the bottom blew up with a large inrush natural gas and water, there being apparently a gas-car ing spring of some size. Conditions looked so threat ing that the shaft was promptly filled with water by hose to stop further disturbance of the bottom.

A pipe was put down from the surface to a depth 130 ft. to find hard strata. This pipe indicated t reasonably hard ground would be found at 130 ft., wh was some feet lower than originally expected. Howe on studying the record of the strata penetrated it decided to raise the elevation of the tunnel about 30 to El. —76. The attempts to carry the shaft down dee were therefore abandoned, and the shaft was bottom

To seal the shaft, 5 ft. of concrete was deposited the bottom through 100 ft. of water. The concrete h course was lowered down through the water in a oom-opening bucket. On pumping out the shaft the concrete was found to be unsatisfactory, gas having ied a bad porous spot in it. To remedy this condi- a 3-ft. funnel was placed over the gas pocket and ft. course of concrete was deposited around the fun- lowering the concrete through 10 or 15 ft. of water. eupon a hole was discovered just outside the funnel, igh which gas discharged. This hole was calked with m and another 4-ft. depth concreted, making the depth of concrete about 13 ft.

ie water and gas inflow were now under control, ot for what came through the funnel and was piped ie surface. Operations then started on the tunnel, ng the final finishing and grouting of the shaft bot- for a subsequent time.

e west shaft, started later than the other, was some- behind and was in the neighborhood of 70 ft. down the decision was reached in the case of the east to locate the tunnel with flow line at El. —76. this reason the west shaft was stopped at —75. ughout its sinking no difficulties were encountered, he shaft went down without sticking. Within 6 in. e bottom, however, a strong cold spring broke in. as in the case of the east shaft, gave trouble by ig the concrete seal porous and leaky, but it was olled by catching the spring in a funnel and con- g the bottom, and at the completion of the tunnel ing the bottom under pressure.

work was done under the direction of C. P. Jaeger, iissioner of Water, with John W. Dolman in charge rations. It was carried on by force account. Charles evelde was superintendent.

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A phalt Pavement Costs with Municipal Plant

By John W. Cunningham*

City of Spokane, Wash., has for the past six years and operated a municipal asphalt-paving plant. the primary use of this plant is for repair and enance work and the policy of the city has not been ainate entirely the contract system of doing paving, iber of jobs have been done by the city forces, and igh cost records have been kept. This work has in l shown a substantial saving under contract work. also given the city engineering department under n Macartney, City Engineer, a close idea of the cost haltic pavements under local conditions and a more basis for engineering estimates of street-improve- vork.

municipal plant has also been a means of reducing st of paving through selling the asphaltic mixture, t stuff," to contractors at nearly a cost price. The tic mixture is delivered to the contractors' wagons plant. Under this method the contractor is relieved ing the most expensive and least flexible part of his ient, which enables smaller contractors having less id expense to bid upon work and has, in the case of ie, resulted in a substantial reduction in costs.

Department of Public Works of Spokane has d as standard an asphaltic concrete pavement con- g closely to the Topeka specifications and known locally as "Spokane bituminous." A considerable amount of this pavement has been laid with very satisfactory results, either as a topping upon a coarser mixed asphaltic base or upon a concrete base.

The accompanying detailed costs are for the "Spokane bituminous" pavement laid by the city forces. The first tabulation is for pavements of 5-in. total thickness, made up of a 2-in. asphaltic concrete top on a 3-in. asphaltic base and requiring two spreadings, rakings and rollings. The second tabulation is for 2 in. of asphaltic concrete laid upon a concrete base, the cost of base not included. It will be noticed that the costs, $0.88 and $0.41 respectively, show a rough relation to the thickness. Another piece of pavement upon which costs are available is 3 in. thick, laid upon a concrete base. The cost of laying this was $0.62 per sq.yd., or about 50% more than for the 2-in. pavement.

In all asphaltic pavements the most expensive single item will usually be the asphaltic cement. Since the other materials and the plant and labor costs will vary but slightly with a change in the mixture, a general rule may be stated that the coarser the mixture the less asphalt will be required and hence the less the total cost. Under similar conditions a fine mix, such as a sheet asphalt, would be more expensive than the "Spokane bituminous" pavement, and the coarser mixed asphaltic concretes would be less expensive.

TABLE 1. COST OF A 5-IN. ASPHALTIC PAVEMENT (2-IN. ASPHALTIC CONCRETE TOP ON A 3-IN. ASPHALTIC CONCRETE BASE), CITY OF SPOKANE, WASH.*

Plant Cost		
Asphalt top, 233.34 tons @ $18-$22	$4,309.15	$0.1605
Asphalt base, 177.92 tons @ $18-$22	3,274.15	.1220
Aggregate top, 1,779 cu.yd. @ $1.25	2,223.75	.0828
Aggregate base, 2,324 cu.yd. @ $1.25	2,905.00	.1082
Fuel, power and supplies at plant	1,120.00	.0417
Labor	2,462.70	.0917
Total cost out of plant	$16,294.75	$0.6069
Haul by teams and motor trucks, length of haul not available	2,563.50	.0955
Street Cost		
Labor, laying pavement	2,744.30	.1022
Total of plant cost, haul and street cost	$21,602.55	$0.8046
Plus 10% overhead and depreciation		.0805
Grand total cost per sq.yd.		$0.8851

*Average of two jobs; total yardage, 26,847.

TABLE 2. COST OF 2-IN. ASPHALTIC CONCRETE TOP LAID ON A CONCRETE BASE BY THE CITY OF SPOKANE, WASH.*

Plant Cost		
Asphalt, 401.012 tons @ $16-$16.50	$6,491.50	$0.1418
Sand, 2,594 cu.yd. @ $1	2,594.00	.0567
Rock, 777 cu.yd. @ $1.30-$1.45	1,105.95	.0242
Coal, 79.95 tons @ $6	479.70	.0105
Power	189.95	.0041
Labor	1,708.71	.0373
Total cost out of plant	$12,569.81	$0.2746
Haul from 1.25 to 2.10 mi. Both motor trucks and wagons used, costs not segregated. With wagons, snap teams were used on heavy grades. Average cost per ton-mile was $0.232	1,836.03	.0401
Street Cost		
Paint, 12.25 bbl. @ $7.50	$91.90	$0.0020
Wood, 13.25 cords @ $6	79.50	.0017
Coal, 7.95 tons @ $6	47.70	.0010
Top sand, 19 cu.yd. @ $1.375	26.15	.0006
Labor	2,436.93	.0532
Total cost of laying on street	$2,682.18	$0.0585
Total of plant cost, haul and laying per sq.yd.		$0.3732
Plus 10% overhead and depreciation		.0373
Grand total cost per sq.yd.		$0.4105

*Average of three jobs; total yardage, 45,802.

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Fire-Resisting Materials for use in constructing the deck structures of excursion and passenger steamers are to be investigated by the Bureau of Standards. The Bureau has issued a circular inviting manufacturers of such materials to submit samples for investigation and test

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*sulting Engineer, Portland, Ore.

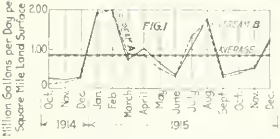
Mass Diagram for Power and Water-Supply Computations

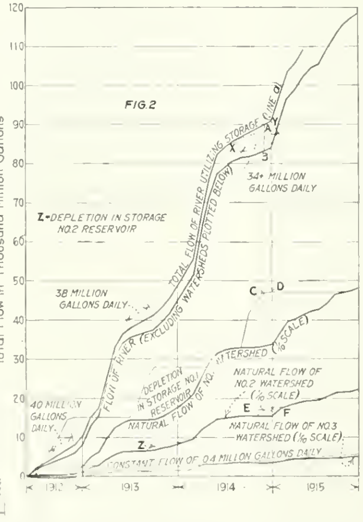
By W. L. Butcher*

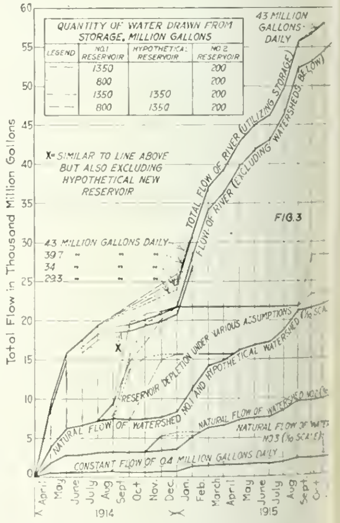
The following notes describe the extension of the "mass" diagram to water-supply and power problems of a somewhat more complex nature than is usual with this graphical device. The simple mass diagram for the study of storage and water-supply, known as the "Rippl" diagram from the name of its originator, is too familiar to require lengthy explanation. The original method consisted in the construction of a mass curve showing the summation day by day, or month by month, of the net accumulated quantity of water resulting from the difference between the runoff and an assumed draft during the period. From such a diagram a graphical study of the required storage to maintain on an assumed draft, the length of time storage will be drawn upon and other factors may be determined.

This method was simplified by John R. Freeman, who in studies for the New York water-supply[1] adopted the idea of plotting the accumulated runoff directly and without first assuming and deducting a certain draft. This not only lessens the preliminary work, but widens the scope of the diagram. It usually occurs in water-supply problems that the storage reservoir is located at the point where the runoff is calculated, and the previously mentioned devices have been applied to this condition.

The following explains the extension of the idea to include another class of problems where it is desired to obtain the conditions of flow that may be maintained at some point downstream, due to storage reservoirs at the headwaters or at other points. Such problems arise in water-power and pollution considerations and in the matter of log-driving and other cases. A mode of treatment of these latter problems is given in Water-Supply Paper 198 of the United States Geological Survey, as developed by Walter H. Sawyer; but the procedure described later, while very simple, does not seem to have been previously used and is believed to be somewhat simpler than the method already mentioned and of wider application.







FIGS. 1 TO 3. DEVELOPMENT OF MASS DIAGRAM FOR WATER-SUPPLY AND POWER COMPUTATION

Fig. 1—Diagram showing close agreement in runoff of land of two adjacent streams. Fig. 2—General mass curve f determination of critical period; reservoirs No. 1 and No. 2 have capacities of 1,350 and 200 million gallons respectivel Fig. 3—Mass diagram for studying in detail the effect of storage

This scheme consists, in brief, in the construction o number of mass diagrams on a single sheet, each stor reservoir and its watershed being treated as an isola case, but the sum of all of them, including the remaini portions of the watershed tributary at the point wh conditions are to be studied, amounting to the total wat shed under consideration.

The starting point for the calculation is chosen a time when from an inspection of the runoff records i seen that the reservoirs will be full and overflowing. T accumulated amounts of runoff at the end of each da or monthly period are then determined for each of separate portions into which the watershed has b divided, and the results are plotted as mentioned, o single sheet.

The method may perhaps be best understood from h on by an explanation of the steps taken in an actual stu The situation was as follows: On a stream having ab 100 sq.mi. of watershed it was desired to ascertain maximum flow that could be maintained during summer months of a dry year. On the stream at wid separated points there were two storage reservoirs t could be regulated to suit conditions. Another reserv was used as a source of water-supply for a town on watershed; and it was assumed that, except when records indicated that this reservoir would be overflow a constant quantity equal to the average water consu tion would be contributed from this source.

One year's record of runoff of the stream was in ex ence, also complete information as to the area of wa surface and storage conditions. From this informat it was possible to calculate the yield of 1 sq.mi. of surface, which was compared with the yield per squ mile of land during the same period of a stream near concerning which records of runoff covering a great m years were in existence.

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*With Metcalf & Eddy, 14 Beacon St., Boston, Mass.

[1] Report on New York Water-Supply, 1900.

The agreement in the runoff per square mile of land surface was remarkably close during the year in which comparable records were available, and the stream having a long-term record was adopted as indicating results that might be obtained on the stream under consideration during similar periods.

In this connection, while having no particular bearing on the matter of mass diagrams, it is interesting to notice what close agreement the runoffs from certain streams may bear to each other when as many as possible of the uncertain factors are removed. Such a result is shown in Fig. 1, which needs no comment except to say that the unusual divergence at low flows was examined and found to be due, in whole or in part, to errors in meter measurements of one of the streams at very low flows. One sees so many examples of the opposite result that the foregoing has a double interest.

Having then the long-time record in hand, it was found that there were three or four consecutive dry years during which the condition of the reservoirs could not be definitely known, without treating the period as a unit. So, for the purpose of determining the critical period, the runoff for each separate reservoir and for the remaining portion of the watershed was determined and summed up beginning with June, 1912, and running through 1915. A perusal of the runoff records left no doubt that all reservoirs would be full and the whole watershed acting as a unit on June 1, 1912. The runoff for each reservoir was determined in the usual way, by calculating the yield of the land surface and water surface and adding together for each month.

After the monthly yield from the beginning was added up, the results were plotted on a small scale for the purpose of getting a general idea of the situation and to make it possible to pick out the critical period to be afterward treated in more detail. This operation is shown in Fig. 2. On account of the small area of watershed tributary to each reservoir in comparison with the remaining portion these latter figures are plotted on a $\frac{1}{10}$ scale.

Beginning now at the left-hand corner, the separate ordinates at the end of each month are summed up and plotted directly above, forming a new curve representing the combined flow of all the separate portions. This is represented by line *A*. As already explained, the flow from Reservoir No. 3 is not the natural flow of the watershed, but is regulated to give a continuous flow of 100,000 gal. daily except when overflowing, and a "rate" line governing this condition is drawn on Reservoir No. 3 curve, according to well-known mass-curve methods, before the summing up is started.

As the season of low flows approaches, the line representing the total flow tends to become more and more nearly horizontal, representing a lower and lower rate of flow. When this condition occurs, an arbitrary line is drawn from a summit, as at *X*, having an inclination that represents a rate which it is assumed may be maintained by the use of the available storage. The vertical distance then at any point between the curve showing the flow of the river, without the subsidiary watersheds, and the line just mentioned as having been drawn measures the additional accumulated flow that must be obtained from the subsidiary watersheds in order that the assumed rate may be maintained. In the example under consideration the additional accumulated flow necessary at the section *AB* amounts to 6,800 million gallons. The natural accumulated flow from Reservoirs Nos. 1, 2 and 3 amounts to 5,250 million gallons, as measured by their respective ordinates, leaving 1,550 million gallons additional to be supplied from storage, as shown by the new curve of runoff from Reservoir No. 1 and Reservoir No. 2, plotted at *C* and *E*.

If the assumed maximum rate of flow that can be maintained is too high, the rate must be reduced by drawing a more nearly horizontal line, until the necessary accumulated flow just exhausts the storage available, as shown at *D* and *F*.

When the rate of flow from the river, without subsidiary watersheds and storage, becomes greater than the maximum flow that has been maintained with the aid of storage during the previous month, which fact is indicated by a convergence of the two lines indicating total flows, the supply from the subsidiary watersheds is cut off, as shown by the horizontal lines, and the reservoirs begin to fill. While the reservoirs are filling, the sum of the ordinates to the lines representing the accumulated flow of the subsidiary watersheds remains a constant quantity except as slightly affected in this particular case by the flow from Reservoir No. 3. This results in the two curves of total flows remaining parallel until the reservoirs are full, when they begin to diverge owing to overflows from the reservoirs. Practically, it can generally be determined by inspection at what point the greatest depletion in storage will take place. The maximum storage lines can then be drawn, the ordinates summed up, added to the flow of the main river and a maximum flow line extended backward to a point of tangency with the curve of natural flow, as *X-Y*. The rate that this line represents can then be calculated, no preliminary trials being necessary.

This small-scale diagram having been completed, it is observed that the minimum conditions occur during the late fall of 1915. With this information in hand, a new curve on a larger scale is plotted beginning Apr. 1, 1914, when, according to Fig. 2, all reservoirs will be overflowing. This curve is shown in Fig. 3 and is on a large enough scale to make a detailed study. For the purpose of representing the adaptability of the diagram the following conditions may be noted: First, when Reservoir No. 1, which has a storage capacity of 1,350 million gallons, and Reservoir No. 2, which has a storage capacity of 200 million gallons, may be completely drawn off during a dry year; under these conditions a maximum flow of 31 million gallons per day can be maintained during the dry season. Second, when owing to local conditions it is not advisable to draw more than 800 million gallons from Reservoir No. 1, 200 million gallons still being available from Reservoir No. 2; under these conditions the maximum supply that can be maintained in a dry season is 29.3 million gallons per day.

In the particular case under consideration it was desired to ascertain what increased flow might be obtained during a dry season by the addition of another storage reservoir of a capacity equal to Reservoir No. 1. As this suggestion was a tentative one it was assumed that the reservoir to be constructed would be exactly similar, as to area, capacity and contributary watershed, to Reservoir No. 1. This assumption results in a new line representing the mass curve for this tentative reservoir exactly superimposed on the mass curve of Reservoir No. 1, which fact must not be forgotten in considering the possible conditions if this new reservoir were in existence.

It also results necessarily in the construction of a new line representing the flow of the main stream, exclusive of contributary watersheds, as noted on the diagram. Following through one of the sets of conditions—that in which the two existing reservoirs can be completely drawn off—we find that in order to maintain in a year similar to 1914-15 a flow of at least 34 million gallons per day at all times the following procedure would be necessary:

During August the flow of the watershed would be less than the required amount, necessitating the addition of water from storage in Reservoir No. 1 to the amount of about 50 million gallons. During the next month the amount required is still larger; and on Nov. 1 this reservoir is completely drawn off and a further quantity is drawn from Reservoir No. 2, the gates of No. 1 still remaining open in order to utilize whatever water naturally flows from the watershed of No. 1 during this period.

During January, 1915, on account of increased flow it is seen that neither water from storage nor the natural flow from the subsidiary watersheds is necessary in order to maintain a flow of 34 million gallons per day, and all gates are closed, resulting in the line of accumulated flow from reservoirs becoming horizontal. The progress of filling may be measured at any point by the ordinate between the line of natural flow of the watershed and the horizontal line representing no outflow. It will be seen that No. 1 failed to fill entirely during the spring of 1915, that a slight draft was again required during September, 1915, and that the reservoir did not entirely refill until December, 1915.

In this method of treatment there are three factors of more or less importance, which are not taken into account: First, the changing area of water surface as the reservoirs are drawn down. This factor is not considered, in view of indeterminate features of such an investigation, as of great importance. Second, losses by evaporation or otherwise in the passage of water from the reservoirs to the point under consideration. There are no available data on this point. In the particular investigation under consideration gagings at the outlet of the reservoir and a point several miles downstream showed no losses from this cause. Third, no account is taken of the time necessary for the passage of water from the reservoirs to the place under consideration. Except in the very largest drainage areas no appreciable error would be due to neglect of this factor

Design of a Water Brake*

By Winslow H. Herschel†

The writer was recently called upon to design a 500-kv.-a. 100-per cent. power factor, or 745 b.hp., turbine with 50-per cent. overload capacity. The maximum load to be measured on test was somewhat over 1,100 b.hp. As no generator was available, it was necessary to design a dynamometer of sufficient capacity to absorb this load.

When it is a question of small amounts of power and slow speeds, a friction brake may be employed in which the load is applied by brake shoes, ropes or bands bearing on the circumference of a wheel. If the heat developed is considerable, the wheel must be water-cooled, but this becomes impracticable for very large loads. The fan dynamometer is also useful for small powers and has been used to some extent for testing automobile engines.

Not every dynamometer that will measure large amounts of power is suitable for use with steam turbines. The torsion dynamometer could not be used, because it measures but does not absorb the power, though this type of transmission dynamometer is well-adapted for use on steamers where a long propeller shaft is available. The Alden dynamometer will also measure very large powers, but not at the high speeds used with steam turbines. A cast-iron disk is mounted on the shaft and is surrounded by a casing to which are attached copper plates that lie one on either side of the disk. The friction between the copper plates and the disk is varied by the pressure of the water admitted to the casing. Since the disk must be of cast iron, the peripheral speed is limited to about 7,000 ft. per min. The power is limited by the heat that can pass through the copper plates, so that the large-capacity brakes require more than one disk.

The simplest water brake, the only type of dynamometer left to consider, consists of one or more smooth disks mounted on a shaft direct-connected to the turbine shaft and inclosed in a casing. In our brake the tendency of the casing to revolve was resisted by a lever fastened to the casing and acting on an ordinary platform scales, in place of the spring used in Froude's dynamometer. For convenience in calculating the horsepower the length of lever from the center of the water-brake shaft to the point where the lever acted on the scales was made 5 ft. 3 in., so that the power could be calculated by the formula,

$$B.hp. = \frac{W(2\pi R)n}{33,000} = \frac{Wn}{1,000} \qquad (1)$$

where

W = Reading of platform scales, in lb.;
n = Revolutions per minute, of turbine and brake, from tachometer;
R = Length of lever.

In any water brake the water must be supplied to the space between the rotor and the casing in sufficient quantity to prevent the formation of steam in any considerable amount. The required rate of feed of water may be calculated from the formula,

$$Q = \frac{b.hp.(33,000)}{778(t_2 - t_1)8.32} \qquad (2)$$

where

Q = Rate of feed of water, in U. S. gallons per min.;
t_1 = Temperature of water at inlet, in degrees F.;
t_2 = Temperature of water at outlet, in degrees F.;
778 = The mechanical equivalent of heat.

To find the rate of feed in our case, we must assume values for the temperatures. If we take the inlet temperature as 80 and the outlet temperature as 180, so as to avoid the boiling point of water by a safe margin, we shall have a rise of temperature of 100 deg. F. Introducing this value and that of 1,100 for the power into equation 2, we have

$$Q = \frac{1,100 \times 33,000}{778 \times 100 \times 8.32} = 56 \textit{ gal. per min.}$$

This shows that care must be taken to provide for an ample supply of water. Furthermore, since the rotor acts like a centrifugal pump, the water must be admitted to the compartment containing the rotor at a point near the axis of rotation, where the pressure is ow. The power absorbed is increased by throttling the vater as it escapes from the casing, thus increasing the vidth of the ring of water that is thrown to the circum'erence. The limit of power is reached when the casing s full of water and the rate of flow is not sufficient o prevent the formation of steam.

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*From "Power," July 25, 1916.

†Bureau of Standards, Washington, D. C.

The water brake designed to meet these requirements onsisted of six smooth disks 24 in. in diameter, such as re used for cutting slate. Each rotated in a separate ompartment, with a ½-in. clearance between the sides f the disk and the walls of the compartment. Between ach pair of disk compartments was an annular space ¼ in. wide through which water was admitted, entering rough the narrow clearance between the side walls of ie compartments and the hubs of the disks. The casing as supported on roller bearings so as to be free to move ith a change of load. To equalize the supply to the nnular cells, the water was pumped into a tank placed irectly above the casing and supported on it, and there as a pipe connection from this tank to each cell.

. Froude stated in his paper that of two dynamometers different size, "their respective moments of reaction, ith the same speed of rotation in each, should be as the 'th powers of their respective dimensions." This rule ould, however, not suffice to calculate the dimensions a dynamometer of a new type. The complete formula, uation 3, is given by Roetscher.

$$B.hp. = \frac{D^{5.366} n^{2.66}}{4.704 \times 10^{16}} \qquad (3)$$

iere

$B.hp.$ = Maximum power which can be absorbed by one disk;

D = Diameter of disk in centimeters;

n = Revolutions per minute.

This formula was derived from tests made with a brake ving perforated disks, while our disks were without rforations, so that it seemed possible that equation 3 ould give a power somewhat in excess of what could obtained with our water brake. If we take D equal 24 in., or 61 centimeters, and n equal to 3,600, the rmal speed of our turbine, the equation gives 230 hp. one disk, or 1,380 b.hp. for the six disks. The excess r 1,110 b.hp. seemed sufficient to allow for any lack power of the brake or superabundance of power of turbine.

The centrifugal pump employed to circulate the conısing water as well as to raise water to the water-brake ık was supposed to run at 110 r.p.m., but owing to eaky suction pipe and lack of a foot valve it was found essary to increase the speed to 540 r.p.m. The disarge pipe from the condenser was throttled from 8 vn to 4 in. in diameter at the end where it discharged o the open air. After these changes had been made, proved possible to raise the water through a 2½-in. pe to the water-brake tank.

The absence of a foot valve and the impracticability applying one below low tide caused considerable trouble ore a method was found for starting the centrifugal mp. A piston pump belonging to a steam-engine ıdenser was connected with the suction pipe of the ıtrifugal pump at a point a few feet nearer the ake. Futile attempts were made to start the flow the suction pipe by means of the piston pump and n keep the water flowing by means of the centrifugal mp after the piston pump was stopped. An ejector proved successful as a means for starting the centrifugal pump, but it was discarded as too wasteful of steam. The final solution was to place a flap over the 4-in. end of the discharge pipe, already mentioned, and exhaust the air through a pipe attached at one end to the priming hole of the centrifugal pump and at the other to the exhaust pipe of the turbine.

The supply of water to the water brake was, to the end, somewhat unreliable, owing to the increase in suction head at low tide. When at times the supply would entirely fail, the water in the water brake would turn to steam, and when the turbine was run without a governor, the consequent racing was a real source of danger. When the tachometer showed a rapid increase of speed and the needle appeared to be about to start around on a second lap, we knew that there was no time to be lost in closing the throttle.

Considerable trouble was experienced with the water-brake thrust bearings, which were replaced first by ball bearings and finally by roller bearings similar to those that had given satisfaction on the turbine from the beginning. Otherwise the water brake gave complete satisfaction. Trouble was experienced at times in trying to weigh large loads at low speeds, but as long as the normal speed of 3,600 r.p.m. was maintained there was no difficulty, although the load varied from 49 to 1,326 b.hp. It will be noticed that the maximum power measured was very close to the calculated maximum capacity of the brake, 1,380 b.hp. No measurements were made of the temperature or amount of cooling water used, but it is safe to say that a considerable saving was effected by using salt water instead of city water.

In the course of the tests the question arose as to the proper method of taking observations. It is of course impossible to keep the readings of the scales and of the tachometer absolutely constant by adjusting the load on the water brake. There will be unavoidable variations in boiler pressure, and it is safe to assume that readings of steam conditions at regular intervals of time will give the best average values. The question to be decided is whether readings for horsepower must be made at the same instant as readings for steam conditions. It is evident that readings of W and n in equation 1 must be taken simultaneously. But to take readings of speed and torque at regular intervals involves taking them during changes of speed, and it seems preferable to take readings only when the scales and tachometer are steady and the speed is normal, although this necessitates taking readings at irregular intervals of time. Apparently the reason why this method appears wrong to many engineers is that they assume that the consumption will vary with the speed as with the steam engine or hydraulic turbine. Yet it has been proved by theory and by test that the weight of steam that will pass through a steam turbine is independent of the speed of revolution.

The objection to taking readings at regular intervals of time is that when the speed is changing, the horsepower indicated would be too small by the amount expended in accelerating the rotor on a rising speed, and too large by the amount given out by the rotor on a falling speed. Although the few tests made by both methods failed to indicate any substantial difference in result, the method of taking readings at regular intervals was abandoned on account of being less convenient, as well as having no theoretical advantage.

News of the Engineering World

Tunnel Heading Cleared After Four Weeks' Work

Recovery on Aug. 20 of four bodies, the last of nine killed in the crib heading of the Cleveland water intake tunnel on July 24, 1916, closes the account of the serious accident. Excavation of the muck in the heading started a few days after the accident, and after the recovery of the bodies of ten rescuers who were killed by gas poisoning when they entered the tunnel. The muck filled the heading for about 275 ft. back from the face. Work had to proceed very carefully, as concrete lining blocks were found in the mass.

On Aug. 5, after about 35 ft., two bodies were found. No more were recovered until within 30 ft. of the face; on Aug. 18 two were found, and the other five were taken out during the next two days. One of the last two, lying against the shield, was S. H. Vokes, the civil engineer who was serving as acting foreman of the shift.

Evidences found in the tunnel prove that the accident of July 24 was a powerful explosion. Some of the bodies found near the face exhibited burns. Violent disturbance of muck cars, rails, and the concrete block lining showed the action of great force. As to conditions at the face itself nothing could be learned from the water-department officials.

Present intentions in the water department are to abandon the heading for some distance back of the face. There has been talk of carrying on all further work from the land heading, which is now about 2,000 ft. from junction. This, however, would delay completion of the tunnel by several months, and correspondingly postpone the date of putting into service the new West Side filter plant, to be supplied with raw water through the new intake.

On account of the divergence of the land heading from true line (noted in an item in another column), and the desirability of bypassing the present face of the crib heading with its gas streak, it has been proposed to bring the land heading into the side of the crib heading, making this junction well back of the present face of the crib heading. If this plan is followed the work can be carried on from both headings.

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A Million Dollars for Roads in the Forest States

Secretary Houston of the United States Department of Agriculture has made the tentative allotments of the $1,000,000 fund for Federal aid in road building to those states containing national forests. This fund is separate and distinct from those created by the Federal-aid road act, noted in *Engineering News*, Aug. 3, p. 238.

The method followed in apportioning the money was as follows: Ten per cent. of the amount available each year will be withheld as a contingent fund. One-half of the remainder will be allotted to the states in amounts which will be based on the area of national forest lands in each state. The other half will be apportioned on a basis of estimated value of timber and forage resources which the forests contain. Amounts apportioned but unexpended within three years, and any balance of the contingent fund which remains unapportioned at the end of each year, will be reapportioned on the same basis as the original allotments.

The tentative allotments to the principal national forest states and territories are as follows: Alaska, $46,280; Arizona, $59,795; Arkansas, $11,294; California, $140,763; Colorado, $62,335; Idaho, $108,010; Montana, $69,901; Nevada, $19,195; New Mexico, $42,622; Oregon, $127,794; South Dakota, $8,115; Utah, $40,982; Washington, $91,739; Wyoming, $40,566. In addition, a total of $9,552 has been tentatively assigned to Florida, Michigan, Minnesota, Nebraska, North Dakota and Oklahoma, while the Eastern States—Maine, New Hampshire, Virginia, West Virginia, North Carolina, South Carolina, Tennessee and Georgia—in which the government is purchasing lands for national forests, have been allotted a total of $21,057.

In general states and counties must be prepared to furnish coöperation equal to at least 50% of the estimated cost of surveys and construction. This coöperation may be in the form of money, labor and materials, or the construction of roads. Where other factors are equal, the approval of a project may be determined upon the relative amount of coöperation offered.

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Activated-Sludge Plant for Hermosa Beach, Calif.

The first Pacific Coast city to project an activated-sludge plant for the treatment of its sewage is Hermosa Beach, Calif. C. R. Sumner states that on Aug. 1, 1916, the trustees of that city authorized the construction of a "Brosius system of activated and aërated-sludge" treatment, a sewage-ejector plant, and an ocean outfall, and that it is expected bids will be received on Oct. 15, 1916.

The activated-sludge plant will consist of eight concrete tanks, each 12½ ft. in diameter and 13 ft. deep, an electric motor and a high-pressure blower.

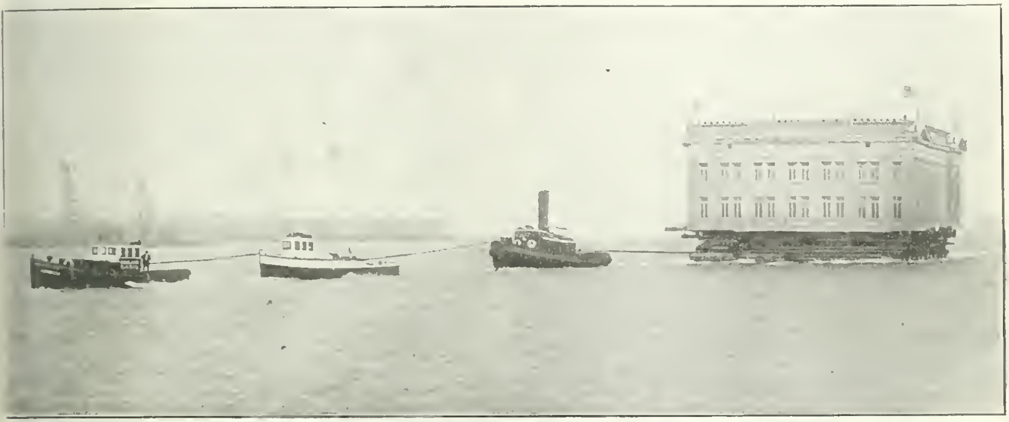
There will be two sewage ejectors, each with a capacity of 100 gal. per min., operated by electric motor-driven air compressors. These ejectors will force sewage through an 8-in. cast-iron force main 1,800 ft. long against a static head of 43 ft. to the treatment plant. From the plant there will be an ocean outfall consisting first of 830 ft. of 12-in. vitrified pipe, then 1,380 ft. of 12-in. reinforced-concrete pipe extending to the shore line, and beyond this 1,300 ft. of 10-in. cast-iron pipe laid on the ocean bed.

The force main for the 700 ft. length nearest to the treatment plant and the first 830 ft. of the outfall sewer will be laid in a 5½x7-ft. tunnel lined with timber. The estimated cost of the improvement described is $27,000.

Exposition Building Takes a Twenty-Five Mile Cruise

On Aug. 16 the Ohio State Building of the Panama-Pacific Exposition was placed on two barges and started on a 25-mi. cruise down San Francisco Bay.

The structure is a wood frame, stucco covered building, 131.5 ft. long, 80 ft. wide and 43 ft. high. It was placed t low tide on a skidway built out over the bay, and two 00-ton barges lashed together were floated into position nderneath it. When the tide rose one of the Exposition's argest State buildings was a temporary ark of gigantic limensions. It is being floated to San Carlos, San Mateo 'ounty, where it will be used as a clubhouse for the 'eninsula Country Club.



TOWING THE OHIO STATE BUILDING ACROSS THE BAY FROM PANAMA-PACIFIC EXPOSITION

F. S. Buckman superintended the loading of the building on the barges. Three tugs moved it through the ater at the rate of 7 mi. per hr. Captain R. P. Hurlburt as in charge of the navigation.

⁂

State Road Officials Confer

On Aug. 16 representatives of the highway departments f 37 states and of the governors of states without highway epartments met at Washington at the invitation of irector L. W. Page of the Office of Public Roads and ural Engineering to consult with him regarding the lministration of the new Federal law for coöperative ad building by the nation and the states. The law quires the Secretary of Agriculture to draw up regulations under which Federal money is spent by the states on eir roads. Secretary Houston explained the purposes nd significance of the law in an address which was eartly applauded by the delegates. Director Page stated at the fundamental object of Congress was not to stribute Federal funds to the states, but rather to help e latter to organize efficient state highway departments that the road work in each would be conducted in the ost economical manner. A set of tentative regulations as read and discussed, and the report of the discussion ll be used by Secretary Houston in drafting the aproved regulations. At the close of the meeting, the deleates adopted a resolution expressing their appreciation of the action of the Department of Agriculture in inviting the states to assist in this important feature of the Federal-aid work, a feature in which the law gives complete authority to the Secretary of Agriculture, as a matter of fact.

⁂

Still Few Data on Rainfall in West Virginia Mountains

Up to Aug. 21 the United States Weather Bureau had few data on the rainfall in West Virginia from Aug. 8 to 10 further than those included in the meager early reports noted in *Engineering News* of last week. A coöperative observer at Madison, Boone County, a short distance from the watershed of Coal Creek, reported a rainfall of about 6 in. on that watershed from Aug. 9 to 17.

The later reports to the United States Geological Survey are only slightly more informing. The gage keeper at McCorkle, W. Va., reports that the flood which did so much damage in Coal River Valley only slightly injured the gaging station at that point. The stay wire was caught by drift and taken out; the cable was also caught by drift but it did not break and he thinks it was not injured. Gage was reported uninjured. The highest point of the rise was 6 ft. over the top of the gage, which had been placed at the previous high-water mark. At Fuqua, W. Va., which is below the confluence of the Coal and Little Coal Rivers, the gage readings jumped from 3.73 at 7:30 a.m., Aug. 9 to +30 at 5 p.m. of that day, which latter reading was 4 or 5 ft. higher than the record.

⁂

An Investigation of Garbage Legislation has been ordered by the State Board of Health of Kansas. S. J. Crumbine, Secretary, C. A. Haskins, Engineer, and the Attorney of the Board will study the subject and prepare for submission to the next Legislature a bill designed to give the State Board of Health control of garbage disposal.

The International Nickel Co. has recently filed incorporation papers at Ottawa, which is to have $5,000,000 capital stock, and is to have its headquarters in Canada. This is the first step taken by the International Nickel Co. to carry out its agreement with the Dominion Government for the establishment of a nickel refining plant in Canada.

A New City with a prospective population of 25,000 in the near future is to be built at Sparrows Point, Md., just outside of Baltimore, in connection with the many changes and enlargements contemplated there by the Bethlehem Steel Co. interests, which have recently acquired the property of the Maryland Steel Co. As a preliminary to the enlarged city a new sewerage system and disposal plant is to be designed and built under the direction of Ezra B. Whitman, of the firm of Norton Bird & Whitman, Chicago and Baltimore.

A Tunnel Far Out of Line and Grade—The Cleveland water intake tunnel is said to diverge 165 or 170 ft. from true line, and to be 10 ft. above true grade. These figures apply to the land heading, now over 13,000 ft. long from its starting point at Crib 3, 7,800 ft. out from shore. The divergence from line is not so important with respect to the use of the tunnel as the divergence from grade, since the latter will result in making a summit in the tunnel. The heading driven landward from Crib 5 started at the designed elevation of the intake end, and will therefore have to rise in order to join with the other heading.

A Long Sea Wall is to be built by the City Commission, Longport, N. J., which is at the southwest end of the island in which Atlantic City is located. Taking advantage of the law passed last year by the State Legislature permitting municipalities to build sea walls for the protection of beach fronts, plans and specifications are to be prepared for the construction of a concrete sea wall more than a mile long. These plans will be prepared by the Case Coast Construction Co., of New York City. It is estimated that the approximate cost of the sea wall will be $275,000. The wall will cover almost the entire beach front of Longport. It will begin at a point on the neck of the island in Great Egg Harbor Inlet and run for a distance of more than 6,000 ft. along the ocean front of Longport, covering all of the improved property of that municipality.

Courses of Instruction for Concrete Foremen and Contractors are to be started by Wentworth Institute in Boston. The work is for boys and young men and is given with the idea of training them for a future along these lines. The institute has set aside one of its best laboratory rooms for this concrete course and is fitting it up with modern testing machinery and other necessary equipment to make possible various determinations that will illustrate the technical as well as the practical sides of the applications of concrete. The first sessions will begin Sept. 18. This work has been made possible largely by the coöperation of the Portland Cement Association, the work having been planned by its Extension Division. J. C. Donaldson, Field Engineer of the Extension Division, will be located at Wentworth Institute for some time, assisting in the necessary preliminaries and afterward in starting and directing the course along the lines planned.

Calumet Harbor Development at Chicago is in its initial legislative stage. The city proposes to acquire the Lake Calumet riparian rights from shore owners before undertaking to determine the nature of development, and tentative contracts for the acquisition of these rights have been negotiated. Ordinances based upon these contracts have been drafted, but before further action is taken it is the intention of the Council Committee on Harbors, Wharves and Bridges to hold meetings for the discussion of the contracts and ordinances with the shore owners. These meetings will be held in the fall. One plan proposed provides for a central basin about 3,000 ft. wide and 2 mi. long (north and south), with an area of 536 acres and 6 mi. of waterfront. The south end of this would be connected with the Calumet River by a channel 300 ft. wide and 2,000 ft. long, with a turning basin at its junction with the river. The harbor basin would be surrounded by city land having a width of about 2,150 ft., with an area of 1,608 acres, and around the boundary of this municipal property would be a roadway and a harbor belt railway, the latter having spur connections to the various industries and main lines.

PERSONALS

T. K. Legare, former Assistant City Engineer of Columbia, S. C., has been made City Engineer.

Robert Caldwell, for the past 14 years City Engineer of Beloit, Wis., has become City Engineer of Richland Center, Wis.

Charles M. Edwards, Resident Engineer, New York State Highway Department, has been promoted to be Division Engineer.

Charles D. Snead, recently Bridge Engineer of the State Highway Commission of Virginia, is now Bridge Engineer of the State Highway Department of Kentucky.

Donald S. Dixon has been appointed Industrial Agent of the Chicago Great Western R.R., with headquarters in the Continental and Commercial Bank Bldg., Chicago, Ill.

C. H. Sadler, Assoc. M. Am. Soc. C. E., has been made Pitometer Engineer of the Baltimore, Md., water department. He was formerly Assistant Engineer of the City Sewerage Commission.

Edmund Gelwix, Assistant Engineer of the St. Louis & San Francisco R.R., Springfield, Mo., has been appointed Valuation Engineer of the Kansas City, Clinton & Springfield Ry., Springfield, Mo.

Alberto J. Pani, a Mexican member of the international commission appointed to adjust the present differences between the United States and Mexico is a prominent civil engineer and railway manager.

Kenneth H. Osborn, Assoc. M. Am. Soc. C. E., Structural Engineer of the Cleveland, Ohio, Board of Education, has resigned to become Chief Engineer of the Osborn Engineering Co., 740 Engineers' Bldg., Cleveland.

La Vern J. Charles, M. Am. Soc. C. E., Construction Engineer of Elephant Butte dam, New Mexico, has resigned from the United States Reclamation Service to become Assistant State Engineer of New Mexico, in charge of hydrographic and stream gaging work.

Henry W. Thornton, former General Superintendent of the Long Island R.R., who went to England in February, 1914, as General Manager of Great Eastern Ry., has been made an honorary lieutenant colonel of the engineering and railway corps of the British territorials.

E. E. Hart, Chief Engineer of the New York, Chicago & St. Louis R.R. (Nickel Plate), has been made Chief Engineer of the Cleveland & Youngstown R.R. also. The Superintendent of Track Maintenance and Construction of the Nickel Plate now reports to the chief engineer, instead of to the general manager, as formerly.

Frank J. Engel and **Herman P. Hevenor** announce the formation of the firm of Engel & Hevenor, Engineers and Contractors, 220 Broadway, New York City. Mr. Engel was recently with the Boston & Albany R.R., and Mr. Hevenor has been with the New York, New Haven & Hartford R.R. and the Brooklyn Rapid Transit Co.

Ygnacio Bonillas, M. Am. Inst. M. E., Mining and Civil Engineer and Subsecretary of Communications and Public Works, City of Mexico, is a Mexican member of the international commission appointed to adjust the present differences between the United States and Mexico. He is a graduate of Massachusetts Institute of Technology, as is also his son, Y. S. Bonillas, of the Copper Queen Consolidated Mining Co., of Bisbee, Ariz.

H. H. Braun has been appointed General Superintendent for M. P. & J. T. Davis in charge of building the government dry docks and ship yard at Quebec. He was graduated from the University of California in 1908. He was Superintendent of Construction for the Arizona Power Co., leaving to become Construction Engineer for the Mexican Light and Power Co. Later he became Chief Engineer for the Mexican division of the United States Smelting, Refining and Mining Co. In January, 1912, he went to work in Spain on the plants for the 56,000- and 36,000-kw. hydro-electric developments of the Ebro Irrigation and Power Co. Since the outbreak of the war Mr. Braun has been Engineer for E. W. Moir, Representative of the Ministry of Munitions of Great Britain, engaged in organizing the munitions supply for the British government.

A. B. Fletcher, M. Am. Soc. C. E., Highway Engineer and executive officer of the California State Highway Commission, has been granted a temporary leave of absence in order to become Chief Engineer of the U. S. Office of Public Roads and Rural Engineering. His experience as the Secretary for many years of the Massachusetts Highway Commission brought him into close touch with road work in the Eastern States. Later he was in charge of the road work of San Diego County, Calif., and then organized the state highway work of California, which he has since directed. It was believed that his wide experience in both engineering and administration would be of much assistance at the outset of the coöperative road work of the nation and the states, and his temporary appointment to the position of chief engineer is the result.

Frank Rhea, M. Am. Soc. C. E., District Engineer, Eastern District, Division of Valuation, Interstate Commerce Commission, has been appointed Special Agent of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce. He will undertake an investigation of the field for American railway equipment in the Far East, Australia and South Africa. Mr. Rhea was born in 1867 and was graduated from the University of Pittsburgh in 1886. He serve! an apprenticeship with the Union Switch and Signal 'o., Swissvale, Penn., and after spending a year on the reconstruction of the signal system of the Pennslyvania R.R. at the Broad St. station, Philadelphia, he was appointed General Foreman of Signals of the Philadelphia Terminal division of he Pennsylvania R.R. He was subsequently with the 'lamond Telephone and Manufacturing Co., of Philadelphia, ınd was in charge of the railway signal department of the ;eneral Electric Co. when this business was transferred to the 'nion Switch and Signal Co. in 1911. His later experience vas as Assistant and Division Engineer of the Pennsylvania R.R.

Clarence D. Pollock and **George A. Taber,** M.'s Am. Soc. '. E., announce the formation of the firm of Pollock & Taber, 'onsulting Engineers, Park Row Bldg., New York City. Mr. 'ollock has for some time maintained an office at this address s a consulting expert on paving and municipal work. He was ormerly in charge of paving for the Boroughs of Manhattan nd Brooklyn, New York City; Havana, Cuba; and San Antonio, 'ex. Mr. Taber has been engaged in water-supply engineerng for over 15 yr. He has successively been in charge of he designing, maintenance and construction work of the)epartment of Water Supply in various Boroughs of New York 'ity, and for three years was engineer-in-charge of the main ffice of the Croton Aqueduct Commission, during which time everal large masonry dams on the Croton watershed were onstructed. He has also had extensive experience in connecon with the development of water power, fire protection, treet cleaning and sewage disposal, and in the valuation of rivate water companies for municipal and state purchase. e will retain his connection with the Polytechnic Institute f Brooklyn as consulting professor of water-supply and wage disposal.

R. A. Lundquist, Assoc. Am. Inst. E. E., Consulting Engineer f Minneapolis, Minn., has been selected by the Bureau of oreign and Domestic Commerce, United States Department ' Commerce, as a Special Agent to study markets for ectrical goods in China, India, Australia, and a number of her oriental countries and South Africa. Mr. Lundquist's ork will be to ascertain the types, qualities and costs, of ectrical apparatus with which American goods come into ımpetition, as well as to look into the general opportunities r the sale of such goods. Before leaving on the trip he will end some weeks in the principal business and manufacturg centers conferring with manufacturers, exporters and ısiness houses on the scope of the investigation. Mr. ındquist was graduated from the University of Minnesota 1905 with the degree of Electrical Engineer, following hich he spent six years with prominent electrical houses. nce 1911 he has been in business for himself in Minneapolis, ecializing in hydro-electric and transmission-line work. He the author of "Transmission Line Construction—Methods ıd Costs," and has contributed numerous articles to the hnical press. He is chairman of the Minnesota section of e American Institute of Electrical Engineers.

OBITUARY

A. C. Read. President of the Read Railroad Construction ·, Philadelphia, Penn., died Aug. 18 from pneumonia. He ıs formerly Vice-President and General Manager of the ılumbia Construction Co., of Pittsburgh. He was 46 years age and was a graduate and trustee of Pennsylvania State llege. He is survived by a widow, one son and two ughters.

Howard L. Fielding, employed by the Flinn-O'Rourke Co., ., contractors for the East River tunnels, New York bways, as engineer in charge of soundings, was drowned on ıg. 18 while on duty. His body has been recovered and will returned to his home in New Paltz, N. Y. He was 26 years l and had been employed as Assistant Field Engineer on the tskill Aqueduct, both by the State of New York and by the gnon Contracting Co. on sections up-state, and by Booth & lnn, Ltd., on New York City sections.

Ernest F. Tabor, M. Am. Soc. C. E., Project Manager for the ılted States Reclamation Service of the Flathead project, ›ntana, died on Aug. 20. Mr. Tabor was born in 1866 and s been engaged in engineering work for the past 30 years. r the Reclamation Service he conducted important work a number of Western States and had charge of the Flathead oject practically from its inception, including the design d construction of irrigation works costing upwards of a llion and a half dollars.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M Gunn, Boston, Mass.

The American Chemical Society at its annual meeting, to be held in New York City, Sept. 25-30, will conduct a symposium on "Occupational Diseases."

The New York State Association of County Superintendents of Highways will hold its annual meeting at the Court House, Syracuse, N. Y., Sept. 14 and 15. There will be morning sessions only. The chairman of the executive committee is George S. Tibbits; the secretary is Dwight B. Coleman.

The Iowa and Illinois Sections of the American Water-Works Association will hold joint meetings Oct. 10 and 11, in Davenport, Iowa, and Moline and Rock Island, Ill. In Davenport the headquarters will be the Hotel Black Hawk. The final business session on Oct. 10 will be held at 7:30 p.m and will be adjourned in time for the smoker at 9. The next day, at 9:30 a.m., the members of both sections will assemble at the filter plant, Rock Island Arsenal, going thence to the main pumping station of the Davenport Water Co., where lunch will be served. There will be a number of other inspection trips. Jack J. Hinman, Jr., of Iowa City, is secretary of the Iowa section.

The American Institute of Electrical Engineers, at a meeting of the Board of Directors in New York City on Aug. 8, voted to rename some of the existing technical committees as follows: Committee on Transmission to be renamed Transmission and Distribution; Railway, to Traction and Transportation; Industrial Power to Committee on Electricity for Industrial and Domestic Use; Electric Lighting to Lighting and Illumination Protective Apparatus to Protective Devices; Electrochemical to Electrochemistry and Electrometallurgy; Records and Appraisal of Properties, to Committee on Economies of Electric Service Upon recommendation of President Buck and the Meeting and Papers Committee, it was decided to hold the October Institute meeting, in Philadelphia, omitting the usual New York meeting. The December meeting will be held in Boston.

Appliances and Materials

Electric-Motor-Driven Diaphragm Pumps

For contracting work in large cities electric power is often found to be cheaper and more convenient than either steam or air. To meet the demand for motor-driven equipment the Domestic Engine and Pump Co., of Shippensburg, Penn., has produced a line of electric-motor-driven pumps. On account of variation in voltage requirements, make of motor, etc., prices are quoted only on the pump and mounting. Prices range from $80 to $120 for single-diaphragm pumps, to $190 for double diaphragm.

BAKER INJECTOR

* * *

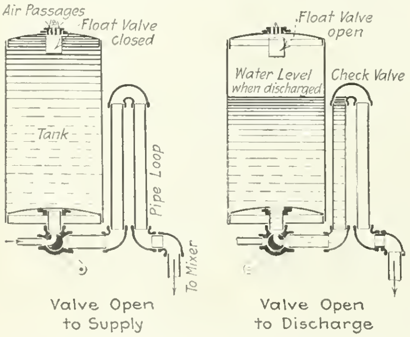
Air Lift for Injector

A foot-piece for air-lift pumping from deep wells, known as the "Baker Injector," is being made by the Chicago Pneumatic Tool Co., and is shown in the accompanying view. The air is injected into the water through a small nozzle at high velocity. It is claimed that no "booster" (vented separation chamber) is required to raise the water above the surface level, as to a tank.

* * *

Water Feed for Concrete Mixers

An automatic device for delivering water to a concrete mixer is shown in the accompanying sketch. The supply hose is attached to the 1-in. bottom pipe, where a three-way valve is fitted. When the handle is pulled down, the valve is opened to the supply pipe and water will enter the tank, a float valve being closed automatically when the tank is full. When the handle is pushed up, the three-way closes the supply connection and opens the discharge connection, allowing the water to flow from the tank to the mixer. In the discharge pipe is a U-shaped loop of 2-in. pipe with swivel joints, and the amount of water discharged from the tank can be adjusted or varied by shifting this loop to different angles, the amount discharged being that between the top of the tank and the top of the loop pipe. In the vertical position the amount supplied is at its minimum, but if the loop is horizontal the full contents of the tank will be discharged. This device is a specialty of the Lakewood Engineering Co., Cleveland, Ohio.

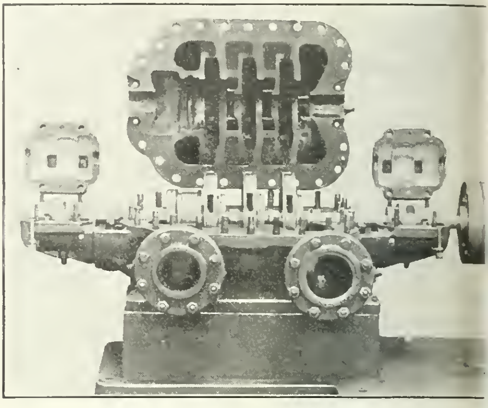


AUTOMATIC WATER FEEDER

* * *

High-Speed Centrifugal Pump

A new high-speed multi-stage boiler-feed centrifugal pump is being manufactured by the Cameron Steam Pump Works, of New York City. It is designated as their "BT" type. Adequate vane length with an impeller of small external diameter has been secured by bringing the vanes well down into the hub. The shaft is protected with bronze sleeves wherever it would be in contact with the water pumped. The impellers (inclosed type) are one-piece castings. Surrounding each hub are a pair of rings, one attached to the casing and one to the impeller; these allow restoring initial tightness of stage joints without fitting. There is a hydraulic thrust-balancing device consisting of a revolving disk at the high-pressure end in a cylinder supplied with water at high pressure. Stuffing boxes are deep and water sealed by lantern glands connected to the pump discharge. The bearings are self-aligning ring oiling and horizontally split. This type is intended for steam turbine drive.



CAMERON BOILER-FEED PUMP

* * *

Low-Priced Motor Car

A low priced ($540) commercial motor car having a capacity of 1,000 lb. burden has been announced by the Sheridan Commercial Car Co., 1509 South Michigan Boulevard, Chicago. The motor (22 hp. at 1,800 r.p.m.) has four $3\frac{1}{8}$x4-in. cylinders and thermo-siphon cooling system. The wheel base is 104 in.; tread, 36 in.; road clearance, 10 in.; weight, 1,500 lb. The chassis carries a sliding-gear transmission with three speeds forward and one reverse. The clutch is a multiple-disk type. The drive is through shaft and bevel gears with the pinion shaft in a housing on two roller bearings. The frame is of pressed steel channels. Forward springs are semi-elliptical; rear springs three-quarters. Wheels are 30x3 in. of hickory and fitted with ball bearings front and roller bearings rear. Wire wheels are optional. Oversized non-skid 31x$3\frac{1}{2}$ in. tires are fitted. The body is of hardwood and sheet steel, 44x56 in. The top is made of matched strips covered with waterproofed cloth; side and rear curtains are of the same material. There are two acetylene headlights, two oil side lamps and one oil tail lamp.

SHERIDAN 1,000-LB. CAR

* * *

Gasoline Switching Locomotive

A 22-ton gasoline switch engine has been made by the Baldwin Locomotive Works for the Erie R.R. in Chicago. A four-cylinder engine gives 500 tons hauling capacity.

Engineering News

OLUME 76 AUGUST 31, 1916 NUMBER 9

Straightening 70-Ft. I-Beams Bent by Flood

The complete reconstruction of the Susquehanna River idge of the Cumberland Valley R.R., at Harrisburg, enn., is being carried on from a working trestle built on e rock floor of the river and extending alongside the idge. The trestle consists of timber bents set on sills the river bottom, the rock preventing the driving of les. The striking feature of the structure is the use of ft. 15-in. I-beams for stringers. These are not drilled l would have brought a good price at the end of the son. However, an unexpected and disastrous flood in e washed out the trestle and wrapped the I-beams und the concrete pier noses. Fig. 1 gives some idea of deformation.

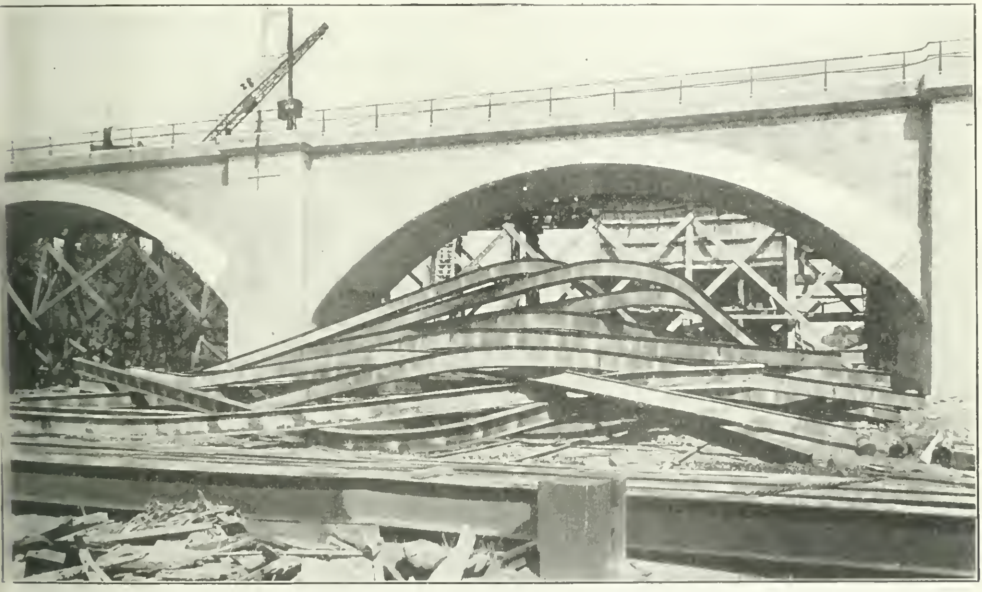


FIG. 1. TRESTLE STRINGERS BENT BY FLOOD, AWAITING STRAIGHTENING BY FIRE, HARRISBURG BRIDGE, CUMBERLAND VALLEY R.R.

t was imperative that a new trestle be erected just oon as the water went down sufficiently. In the meane recovery of the beams went forward. A Browning e, with 60-ft. boom, running on top of the bridge sed up the beams from the river and transported them n island that is crossed by the Susquehanna bridge. there was but one track, this fishing had to be done ween trains, so as not to interrupt traffic.

In order to build another trestle it was necessary either to buy more beams or straighten the ones recovered. Economy urged the latter course, and the blacksmith of the Robert Grace Contracting Co. was called upon to perform this difficult task.

The views and sketch show the method used to straighten the beams. Two gin-poles were erected and guyed, and one of the deformed beams was suspended between the poles, with the convex side toward the ground. Under the curved portion a fire was built of waste from the wood forms.

As the bend heated, the two ends of the beam began to lower. The beam was then guyed to deadmen so that it would straighten true to its original line. It dropped down on rails placed to receive it. The work was accomplished in a very satisfactory manner. Some of the straightened beams are shown in the foreground of Fig. 1. These beams are now employed in the new trestle built since the flood. They are entirely satisfactory for this service, although minor kinks remained and they could hardly have been used in a structural frame.

The trestle consists of six-post bents on four plumb posts and two batter posts, 23 ft. apart on centers; 12x12-in. caps; 2x6 sash timbers and bracings; four stringers, 15-in. I-beams under each rail. The 70-ft. I-beams alternated with 24-ft. lengths, the long ones in each case facing an arch span, while the short length is at the pier. The lengths lapped each other without connection, no rivets or bolts being used. Rail spikes held the beams down on the caps. Midway between them the beams were braced by bridging consisting of plank diaphragms cut in between the beams and a pair of transverse clamping strips above and below the beams, tied together at the ends by bolts.

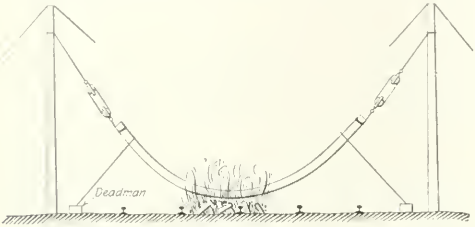


FIG. 4. SETUP FOR STRAIGHTENING A 70-FT. I-BEAM

The trestle carried two tracks, the two inner rails being of standard gage to permit the operation of a locomotive crane. The dinkeys and concrete cars run on the two narrow-gage tracks. There is a double turnout from these narrow-gage tracks into the mixer siding. The trestle is extended around the mixing plant and material trestle so that the cars can be drawn out on the main portion of the trestle and then backed around the mixing plant to a position convenient to the island spans. These spans are concreted by the Browning crane noted.

The new bridge at Harrisburg, as described in *Engineering News*, Mar. 23, 1916, p. 537, is a two-track reinforced concrete viaduct, made up of 45 arch spans averaging 76 ft. each. It is being built in two longitudinal halves, the first having been completed in 1915 and the second now approaching completion. F. P. Kemon is superintendent for the contractor, while Crosby Tappan supervises the work for the Cumberland Valley R.R., under the direction of T. H. Kennedy.

Pneumatic Concreting and Its Development

By J. H. Graham*

Some eight or nine years ago, several engineers separately conceived the idea of conveying concrete through pipe by means of compressed air or steam. The first attempts were to convey concrete made up of comparatively small stone (1 in.) through 4-in. pipe. The greatest difficulty encountered was the constant clogging of the pipe, owing to arching, or toggle-like packing of the concrete. The natural inclination was to enlarge the pipe and not to hunt for the cause of the clogging. Experiments were made first with 4-in. pipe, then 6-in. and finally 8-in. pipe, with only imperfect success.

When the writer first came in touch with the pneumatic process, some five years ago, the tendency was to increase the size of pipe to 10 in., to relieve the clogging. The writer took issue with this theory at once, on account of the cost and difficulty of moving large-size pipe, and the waste of power or compressed air.

The first pneumatic conveyors consisted of a cast-iron hopper with air-worked door, capable of handling a charge of about 12 cu.ft., the bottom of this hopper being funnel-shaped and entering into a conveying pipe. It was found that it was necessary to apply compressed air at the top of the hopper or above the mass of concrete in order to feed it into the pipe, and also inject compressed air at the bottom of the pipe, acting in the direction of the pipe line, this bottom feed being the means of propulsion through the pipe line. At Tallulah Falls, Ga., the writer found that by properly balancing the pressures at top and bottom inlets, concrete could be fed into the pipe without clogging, but this balancing of pressure depended entirely upon the skill of the operator. Properly operated, the machine gave very good results, conveying concrete at Tallulah Falls (in 1912) to a maximum distance of some 1,100 ft.

Experience showed that cast-iron hoppers are unsafe, as on occasions they would explode from high pressure, and later a sheet-metal hopper was designed, quick-acting valves being placed on the air inlets.

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*President, Pneumatic Placing Co., 2 Rector St., New York.

FIGS. 2 AND 3. TWO VIEWS OF BEAM-STRAIGHTENING PROCESS

Various facts were learned during the early work: The relative size of stone had no effect upon clogging: small stone would clog as quickly and as easily as large stone. Gravel would clog easier than crushed stone, and small gravel easier than large gravel (this in 8-in. pipe). If a clog occurred and was found to be absolutely air-tight, it would be impossible to remove it by any amount of pressure applied. On the other hand, with even the very smallest opening through the mass of concrete for a whisper of air to pass, tapping of the pipe when pressure was applied would remove the clog.

Where hopper-type conveyors have been employed they iave also been used as mixers, there being a mixing action vhile the materials were blown through the pipe. The nixture has generally passed the requirements of engiieers throughout the country.

During 1913 and 1914 successful work attracted a great deal of attention to the pneumatic mixer, notably on oundations for the Ontario Power Co. at Niagara Falls; n the O. K. Creek sewer tunnel in Kansas City, Mo.; a unnel under the Interborough power house at 74th St., New York City; an abutment wall at Akron, Ohio; foundations for the Otis Steel Co. at Cleveland, Ohio, etc. hese were for one-bag batches, except that on the Ontario ower Co. work the first two-bag batch or 20-cu.ft. mixer as tried, and after a few slight changes in the hopper was uccessful.

During 1915 the pneumatic process proved itself as specially adapted for lining tunnels—the Kennerdell tunel; the Mill Creek sewer tunnel, St. Louis; Mile Rock unnel, San Francisco; aqueduct tunnels, Los Angeles; undy Ridge tunnel. As much as $2 per cu.yd. was saved; e labor cost in many instances was not more than 10c. r cu.yd.

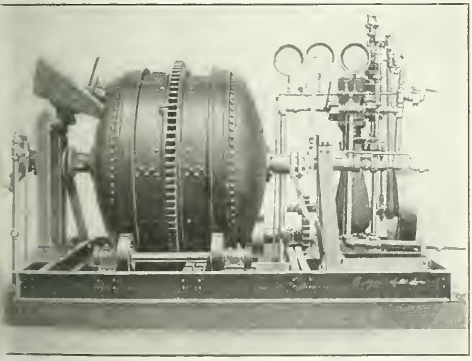

FIG. 1. ROTARY CONCRETE MIXER ATTACHED TO PNEUMATIC DISCHARGE

On outside work the conveyors did not prove so successl, because of the large amount of compressed air cessary and the difficulty of moving the 8-in. pipe.

On the theory that the process should be made of iversal application on all kinds of concrete work, the iter placed it on every type of work on which the engier or contractor would allow it to be placed. More luable data and experience were gained from the failes than from the successes. Several years of both sucs and failure left the following deductions: (1) aller pipe is necessary in order to give flexibility of distribution. (2) The amount of compressed air wasted in the operation should be conserved, as the compressed air used was not doing its maximum amount of work. (3) The possibility of clogging should be eliminated, and the process should be made fool-proof. (4) Extreme care in the manipulation should not be necessary; the operation ought to be put upon the plane of ordinary labor. (5) The flow of the concrete through the pipe should be uniform and under uniform pressure, eliminating the kick or jar in the pipe line due to the uneven distribution of pressures within the batch of concrete as it passes through the pipe.

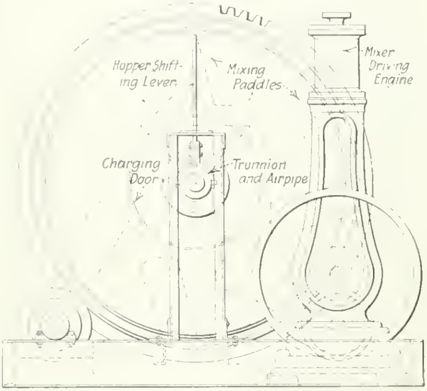

FIG. 2. SECTION THROUGH MIXER

Two years ago it was found possible to convey concrete through pipe the diameter of which equaled twice the diameter of the stone; in other words, 1½-in. stone would require 3-in. pipe, 2-in. stone 4-in. pipe. This decrease in the size of the pipe from 8 in. decreases the amount of air necessary. Further, by a mechanical arrangement developed recently, the flow of the concrete in the conveying pipe can be controlled. These two developments have resulted in the design of a radically new machine.

MIXER WITH AIR DISCHARGE FOR UNIVERSAL SERVICE

The machine is a unit which combines the action of mechanical mixer and pneumatic conveyor. The outlet pipe is made to suit the quantity of concrete desired per hour or per day, the size of stone used being only a minor factor. The construction is such that the flow of the concrete into the pipe is uniform.

It has been found that the time required for conveying a given amount of concrete is practically the same for small pipe as for large pipe. Thus, by varying the flow the velocity of outflow can be regulated to suit location and purpose.

One form of the machine is shown by the photograph. The air inlet here is at the right, discharge at the left, through the trunnion. The charging door is at the left, outside the trunnion box. In the interior are two circles of mixing blades and a small middle hopper, with controllable connection to the discharge. Air can be admitted both below and above the hopper.

Changed design, indicated in the sketch, includes combining air inlet and discharge at the same end of the machine, and using a central charging door in the other end. This door, operated by air, makes it possible to charge while the machine is running.

How Can Professional Misfits in Engineering Be Avoided?

By W. M. Wilson*

In discussing the efficiency of engineering schools, it is well to remember that a university is about the only factory that attempts to produce a high grade finished product without adequate control of its raw material. If metal is to be used for a counterweight, it needs only one requirement, weight; but if it is to be used for a bridge it must meet each of a dozen or more requirements as to chemical composition, heat treatment, strength, ductility, etc. In the manufacturing world, the more refined the product the more searching is the selection of the raw material. Yet the specifications for the raw material from which engineers are to be made contain but one requirement: that they shall be graduates of an accredited high school. A boy having qualified in this one respect, our universities agree to make him into an engineer with absolutely no regard for his fitness for or his interest in engineering work.

Different products require different qualities in the raw material from which they are made. A high grade of steel is satisfactory for watch springs, but it is worthless for a chemist's crucible. Both require the very best material of its kind, but they require different kinds of material. Likewise for the so-called learned professions, the requirements are not only high, but they are also specific. A man who would make a good minister might be a poor engineer, or a man who could succeed as a lawyer might fail as a doctor, not because the qualifications are necessarily higher in the one case than in the other, but because the qualifications are different.

Scientists have taught the manufacturer to use steel where steel is needed, copper where copper will best serve, etc., but no one has yet shown how to select good lawyer material for making lawyers, or doctor material for producing doctors. In general, a youth in America is allowed the greatest freedom in selecting his profession, and this must continue to be the case. It is not, however, necessary that he should continue to select his profession without knowledge of the qualifications for success in the profession selected or the nature of the work involved.

The expression, "continue to select his profession without knowledge," has been used advisedly, for it must be admitted that there is but little knowledge of the qualifications required for or of the relative opportunities for success in the different professions. Everybody knows that the Mississippi Valley is more fertile than the New England hills, and that the economic conditions for the poor are better in America than in Europe; but who knows the relative average income of the lawyer, doctor, farmer, editor, merchant, manufacturer, etc.?

Among the American people, knowledge of the relative agricultural resources of the different states is quite universal; but of the knowledge much more important to them—the relative opportunities in the various trades and professions—the great masses of American people are totally ignorant.

In this age of specialized university courses in which college training is provided for all lines of commercial as well as professional activities, enrollment in a college course usually means the selection of a life's activities. Statistics show that 85% of the graduates of the College of Engineering of the University of Illinois are following some line of engineering work. This means that for the most part, college graduates soon, if not immediately, upon graduating from the high school select the line of work which they are to follow through life. The decision at this age is often governed by a mere whim or fancy, and is seldom based upon a knowledge of the opportunities offered or of special qualifications to meet the requirements of the work to be followed. Under these conditions it is no reflection upon the universities that their engineering schools graduate many a man who is not an engineer, never will be and never should be an engineer. He has not the qualifications of an engineer, he does not like the environment in which engineering work is done, and he loathes the work itself. These are facts which vitally affect a man's entire life, yet, under our present system, he does not learn them in many cases until after he has been out of college a number of years. Thus are wasted many of the best years of life, a tragedy for which some one is responsible and which should be prevented.

In order to end this evil the writer proposes that students in our universities and colleges shall not be permitted to decide upon the course they are to take until they have completed one year of college work; and that a considerable portion of the freshman year should be devoted to a thorough study of the characteristics of the professions.

This will delay an important decision a year at the age when a boy is developing very rapidly. A large number of boys have seen but little of the world when they enter college. In most cases the freshman year is the first year spent away from home. It is the student's first opportunity to meet others of his own age away from the influence of his parents and the provincialism of his home town.

The fact that the student is about to select his course should give him an interest in a study of the characteristics of the professions. He should learn of the relative opportunities which the professions offer; their mental and physical requirements; the environments in which the professional work is conducted; the amount and kind of work which they require, etc. With this knowledge fresh in the student's mind at the time he selects his course, the number of misfits should be materially reduced.

The establishment of courses in which the professions are studied will lead to a more exact knowledge of the relative merits of the professions. The facts being at hand they will be eagerly sought by the interested public.

The fact that courses are not selected until the beginning of the second year in college should present no great administrative difficulties. It is true that all freshmen would have to take substantially the same work, but it should be possible to select at least one year's work which will be beneficial alike to men of all professions.

The selection of a college course, after a study of the relative opportunities offered and the qualities required by the different professions and trades, would come as a real decision, not something drifted into, and would therefore command some thought. Furthermore the decision would come at a time when the student possesses facts governing the decision. An intelligent selection of the line of work to be followed should result in a much smaller number of misfits than exist under the present system.

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*Assistant Professor of Structural Engineering, University of Illinois.

The present system makes the student narrow. His course being selected before he has much knowledge of any profession, his mind is wrapped up in the one thing that he is studying to the exclusion of all others. His ollege course is made up of subjects closely related to is special field. Upon graduation he will join a professional society devoted to his specialty, and he will ssociate with men in the same line of work. The further e goes the deeper is his rut, and it is only by an almost uperhuman effort that he is able to check this tendency o become narrow. The result is, if he is an engineer, e dies knowing nothing but a single line of engineerng: or, if a doctor, he will know of nothing but medicine. f he has selected the line of work for which he is preminently fitted, he is fortunate; if not, he is so hedged n with ignorance and prejudice that he can see nothing f the opportunities in other fields.

There is a work in the world for every man and every an should search diligently for his particular job.

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Scouting for Water Power

By D. N. Showalter*

Most water powers are developed by capitalists who have eir attention called to the project by a promoter, who ually gets a good fee for his work. Most electric comnies operating in a certain territory like to keep well inrmed concerning all possible water power in that terriry, both with an eye to future expansion and with a dere to control all strategic situations, thus keeping comtitors out. Then also there are the large chemical, ectrochemical and pulp companies, which must have eap power. These companies search for large water pows, remote from ordinary markets. Such powers can usuly be had and developed cheaply. Lastly, there is the gineer who has become a promoter, or the business man o has made a successful power-project promotion by me happy chance and is looking for another similar oject. All these scout for water power.

The way in which the problem is approached is, first, by tting a fair idea of the areas where the general elevation the country changes and where there is a fair or good infall; and, secondly, to study thoroughly all available vernment topography sheets of the region.

In rough country, where are found the headwaters of eams, there are two types of water power—(1) the all stream with a high head, and (2) the large stream th a steep slope, flowing through a valley or gorge before reaches the lowlands. There is also usually a large ount of power in the lower courses of rivers, but it is so pensive to develop that it generally is not attractive less there is an excellent market near.

Of the foregoing powers the one with the high head and all flow is usually most attractive, for it can be develd with a low dam and small pipe line, and it can ally be made to yield nearly all primary power by derate storage. This storage, being small, does not rflow much land, and the land is usually inexpensive. en, too, with the headwaters of a stream regulated, the er water-power sites farther down become more value and can be developed later. The disadvantage of power developed on the headwaters of a stream is that it is usually far from a market; but this is not a great drawback, since long-distance transmission is not too expensive.

When the scout has found from the map a good prospective power on the headwaters of a stream, he takes a reliable contour sheet (most recent Government topography sheets are sufficiently accurate) and with one leg of a compass at the storage-dam site he draws a series of circles. The lowest contour within reasonable distance of the storage dam is a possible power-house site. It is not necessarily on the same river, but caution has to be used in diverting water from one watershed to another, particularly if the water is diverted from one county to another or from one state to another. Theoretically, mill owners downstream must prove damage, which of course they cannot easily do, if floods are lessened and minimum river stages are increased. In reality, mill owners imagine damages, and public opinion is nearly always against a water-power corporation.

Having found the best power-house site, the topography is investigated for "backbone" ridges out which to lead the pipe line, so that it will be under low pressure as far as possible. It is aimed then to plunge down a uniform slope, as steep as possible (up to say 45°) to the power house.

Having thus located a possible water power on paper, the scout journeys to the proposed site. It has been a safe rule to talk "timber" when looking for water power and vice versa. Nowadays one can even be looking for a place to take moving pictures, when hard pressed for an excuse for being in a sparsely settled country. After having arrived at the village nearest the site and inquired the ownership of timber lands in that vicinity, the scout travels in the neighborhood a little while, acquiring all the information he can as to land values, titles and pending lawsuits regarding titles. He generally then repairs to the office of the register of deeds at the county seat and there gets from the deed books sufficient information to plot out a rough map of the property owners in the storage basin. In some states the value of the properties at the last sale is also recorded in the deed. In the adjoining office of the clerk of the courts he finds records of all suits in progress concerning title to land in the county. In some Southern states land titles are so poor and there are so many conflicting grants that no capitalist will risk large amounts of money until the title is proved to be absolutely clear. Capitalists do not like to buy lawsuits.

Now the scout investigates the available market. The large-scale post-office maps of the Government are excellent for this purpose. The power house is plotted on one of these maps, and circles are struck with it as a center. These circles are variously of 25-mi., 50-mi. radius, and so on. The power consumed in the different towns in the zones is found by visiting them or from the directories of the various industries, as, for instance, the "Textile Directory," which gives exhaustive information concerning cotton mills. After having made several gagings of the stream, the scout is ready to make his preliminary report.

In cases when this report has been favorably accepted and capital raised to promote the project, the next step has been to purchase the land. Possibly the scout was lucky, and all the flowage is on one or two big timber tracts. Timbermen may usually be dealt with easily, they reserving the timber and mineral rights and deeding the water rights. When such a deed is drawn, there is sometimes put in a joker clause, in which the owner of mineral rights is allowed to use all the water necessary for mining. In a high-head development, where water is scarce, this could be so interpreted as absolutely to ruin the power company. The kind of mining should be specified, as should also the maximum amount of water to be diverted.

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*Frick's Lock, Penn.

If there are a number of small farms or lots in the storage basin, the scout at once tries to find an intelligent resident of the vicinity, whom he hires at a small monthly salary as a land agent. A local man can nearly always buy land cheaper and quicker than an outsider. Before this move is made, however, the scout makes absolutely sure that there are no mills with waterwheels of any kind, nor any water or power rights on his stream. If any are discovered, they are bought up first, before there is any talk concerning the new project. It is usually cheaper and easier to buy whole farms than only flowage rights. A local attorney, of course, examines titles and draws up papers for all sales.

To forestall gossip, the scout sometimes has stationery printed for a large orchard company and actually sets out some "cull" trees, or he has formed a hunting-preserve company and starts to stock the land with game. The whole idea has been to prevent people from knowing that one certain area is required.

It generally pays when most of the land has been purchased, to have the selected flood contour run, to make sure that no land has been omitted. Especial care is then taken to locate the contour in tributary stream valleys and with two or three feet in height allowed all around for waves and seepage. If all the land is not bought when the contour is run, two or three false lines are run also, to mislead the residents. All stakes are well concealed. In fact, on a preliminary survey of this kind stakes are often not used. All fences, streams, houses, etc., near the contour are located and mapped. In a high-head development it usually has paid to make the reservoir large enough to equalize the stream over several years instead of only one. The slight extra expense of the reservoir dam is small compared with the dependable annual primary power output.

It is sometimes thought best to option property before buying, but the writer has found that most small farmers do not understand options and are afraid of them. On the other hand, money is usually scarce and a payment of several hundred dollars in cash is quite attractive. It has been found well to make the balance of the payments on the properties in three to six annual installments. This has not only given the proposition a chance to get on its feet and earning before final payments are made, but also it sometimes has happened that a property is not needed or title is poor, in which case the bargain may be thrown out if only a small first payment has been made.

Finally, after the rights-of-way for the pipe line and the "fee simple" lands for the power house have been bought, a complete and accurate boundary and contour survey is made and plotted. The outside boundaries of the whole tract bought are well marked with stone monuments. Such a map is now ready to be turned over to the engineers for final design and construction.

The water-power scout always bears in mind that the value of water power on the lower reaches of a stream depends on the variation of flow of the stream, on the available market and on the price of coal. There usually has been little or no profit in secondary power alone; it is only in connection with a fair amount of primary power that it is valuable.

To determine the most probable minimum flow of a stream is usually a long and complicated process. In most cases the absolute primary output is based on at least a 50-yr. period. Commonly the stream-flow records of recent years are supplemented by rainfall records running back from 20 to 50 yr., so that the probable minimum flow has been safely predicted.

There are hundreds of thousands of horsepower on available streams still going to waste in both the eastern and western parts of the United States, but with the decreasing cost of electric power produced in large steam units, it is only the most attractive of these powers that can now be financed.

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Train-Shed with Columns Between the Tracks

In train-sheds having a series of spans supported by intermediate columns the almost universal plan in this country has been to place the columns in the center of the platforms. The columns are sometimes serious obstructions when the platforms are crowded.

The train-shed of the new Lehigh Valley R.R. passenger terminal at Buffalo, N. Y., is notable in having its supporting columns placed between the tracks, thus leaving the platforms unobstructed. This arrangement permits an effective skylight plant, and it also gives a roof of greater height, since its lower portions come over the tracks, where 16-ft. clearance is required. One obvious objection to this location of the columns is the possibility of damage by a derailed train, but in a terminal station derailment is improbable.

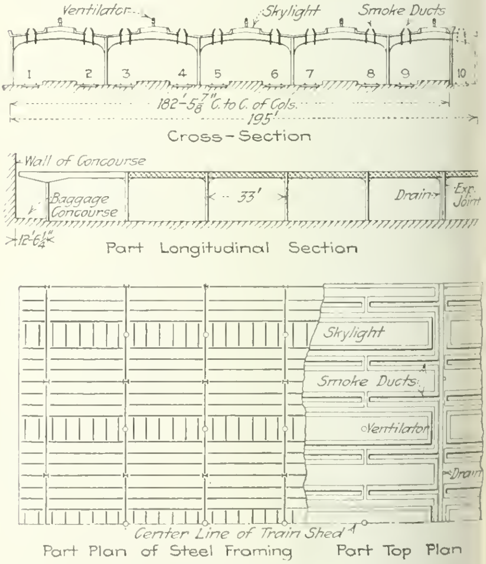

FIG. 1. SECTION AND ELEVATION OF TRAIN-SHED AT BUFFALO, N. Y.

Note that the supporting columns are between the tracks

This train-shed is of the low-roof type patented by Lincoln Bush, consulting engineer, New York, and was designed by him. E. B. Ashby is Chief Engineer of the Lehigh Valley R.R.

The general design of the train-shed is shown in Fig. 1. It consists of five spans, or bays, covering ten tracks and five platforms. At present, however, the tenth track will be omitted, and the north bay will be narrower than the others. The reason for this is that the track and outer columns would be directly over the old Hamburg sewer, costly reconstruction of which would be necessary. In fact, additional expense is in-·urred by a cantilever construction necessary to carry he present columns clear of the sewer.

The columns are spaced transversely 38 ft. 10⅜ in. ·. to c., the platforms being 14 ft. wide and the tracks ·paced alternately 24 ft. 2⅜ in. and 14 ft. 8 in. c. to c. hey are connected by the roof girders, forming trans-erse bents. The clear headway is 16 ft. from the rails o the lower sides of the smoke ducts and about 18 ft. the center of the platform. Longitudinally the lumns are spaced 33 ft. c. to c. There are 26 bents, aking a length of 825 ft., the total length being in-eased to 842½ ft. by a short cantilever projection each end.

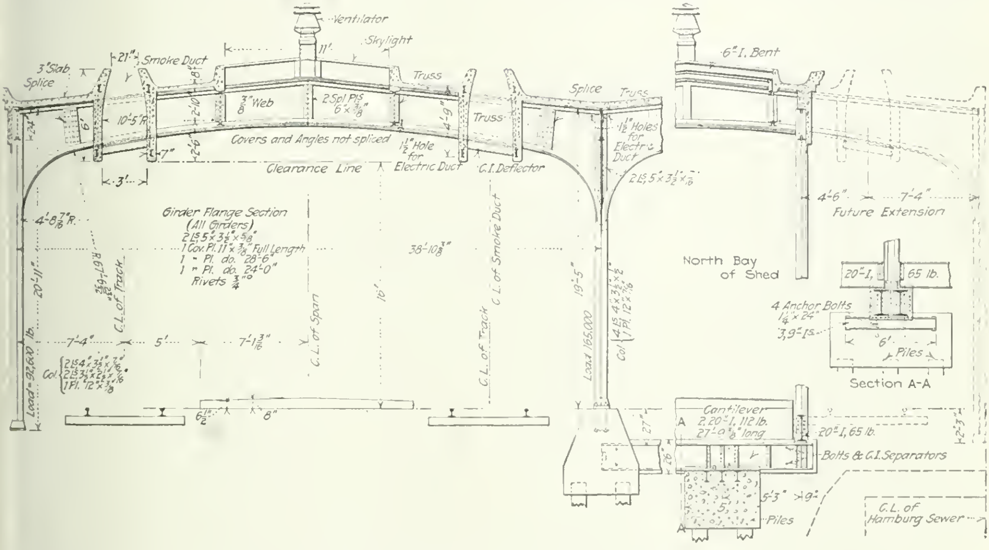

FIG. 2. DETAILS OF TRAIN-SHED; LEHIGH VALLEY R.R.

The cantilever support for the temporary north wall and columns is to avoid interference with a large sewer

The bents are connected by lines of lattice girders; ese are placed over the columns, in the smoke-duct ılls and at the sides of the skylights. Expansion arings are provided at each fifth bent. The track and of have a descending grade of 0.32% from the head-use end. Roof drains are provided at the expansion nts, with downspouts on the columns and leading to e sewer.

The columns are of H-section, composed of a web ite and four angles, the web plate (and greater dimen-on) being parallel with the track in order to get nimum width. The outside columns on the south side of the train-shed have six angles. The girders have ⅜-in. webs, with two flange angles and three cover plates on each chord. Where the girders pass through the smoke ducts, they are cased with concrete and fitted with cast-iron deflectors on the under side to protect them from the cinders and blast of the engines.

Cantilever girders support the present columns along the north side, as foundation pedestals could not be provided without interference with the sewer. The arrangement is shown in Fig. 2. The girders are pairs of 20-in. I-beams, having the inner ends embedded in anchor blocks of concrete (forming pedestals for the next row of columns). Near the outer end each girder rests on a base plate and grillage on a concrete block. The distance between supports is 21 ft. 9⅜ in., and the cantilever projection is 5 ft. 3 in. to center of column. A line of 20-in. I-beams along the ends of the cantilevers serves to support the curtain wall.

The concrete roof slab is 3 in. thick, with curb walls to carry the skylights, which are continuous between the roof expansion joints, 165 ft. apart. These skylights have heavy trough-shaped glass panes set in reinforced-concrete ribs and are made by the Keppler Glass Constructions, of New York. For ventilation of the space over the platforms there is at each bent a cast-iron flue with a 12-in. copper siphonage ventilator made by the Kernchen Co., of Chicago.

The smoke ducts are of special design, having the faces curved inward instead of being vertical. The base width is 3 ft., which is ample to allow for lateral motion of the engines. The 21-in. top width is designed to prevent driving rain from reaching the platforms, while at the same time giving free exit for the blast, so that there will be no back pressure causing smoke and cinders to escape inside the roof. The sides of the train-shed have concrete curtain walls. Large wire-glass windows provide light and have movable sash for ventilation.

Gravel Roads Are Economical Construction in Michigan

By Frank F. Rogers*

The popularity of gravel roads in Michigan is indicated by the fact that this type comprises 2,535 mi., or 60% of the total improved road mileage of the state, and this is due to the following reasons:

1. Gravel roads, constructed according to the specifications of the State Highway Department, draw a relatively large state reward—frequently one-third or more of their cost.

2. Suitable gravel is usually available locally, the expense is chiefly for labor, and all money spent in construction is kept at home.

3. Gravel roads are easily built and repaired, requiring no expensive machinery.

4. The first cost is low.

5. They are durable and can be maintained satisfactorily at a low cost in sections where the volume of the traffic is not beyond the capacity of the type of road.

Under the highway laws now in force in Michigan, state aid is extended to counties and townships in the shape of rewards paid to the local authorities on each mile of road built according to the specifications of the State Highway Department. There are seven classes of roads, varying from earth roads of a certain standard to concrete and brick-paved roads. The rewards vary from $250 to $1,700 per mi., which amounts are doubled if the road built forms a part of the state trunk-line system. The minimum width of road that it is permissible to build is 9 ft. A gravel road built in accordance with the state's specifications can command a reward of from $500 to $1,700 per mi., depending upon its width and location.

Why Gravel Roads Are Favored

It should not be inferred that the Michigan State Highway Department is in favor of any one type of road. In a system so large as to serve a whole state, every type of road has its place. However, large deposits of gravel suitable for road metal exist throughout the state, and its utilization in localities where the traffic is not so excessive as to cause high maintenance expense is in accordance with the best engineering practice.

The bank gravels of Michigan are of glacial origin and vary widely in character from those in the upper peninsula and northern part of the state, which contain a large proportion of limestone pebbles, to the gravels in the southern part, which are largely derived from such igneous rocks as granite and trap, and quartzite. Experience has shown that Michigan gravels are valuable for road purposes as follows:

1. Almost in direct proportion to the percentage of pebbles constituting the mass.

2. In direct proportion to the value as road material of the rock fragments constituting the pebbles.

3. In direct proportion to the value as a cementing material, under all conditions of weather, of the finer particles of earth matter constituting the filler or binder.

There is a tendency to place too much stress upon the immediate packing qualities of the gravel, and the fact is lost sight of that the only thing which makes a gravel road better than an earth road is the pebbles, or stone, that it contains. The material most sought after as a binder in road gravel is clay. If this is present much in excess of 10%, however, the road will become muddy whenever there is a prolonged wet period. Ideal clay gravel should contain only enough clay to coat the pebbles with no free lumps.

Conforming to these principles the requirement in the specifications is that at least 60% by weight, a larger percentage if possible, of the gravel shall be pebbles more than ⅛ in. in size, with no pebbles in the bottom layer that will not pass through a 2½-in. screen, none in the top layer that will not pass through a 1½-in. screen, and that not more than 10% of the mass shall be clay, uniformly mixed and having no free lumps.

Specifications for Gravel Roads

The specifications of the Michigan State Highway Department for state-reward gravel roads provide for the construction essentially as follows: Before building any state-reward road, the plan and profile of the road must be submitted to and approved by the State Highway Commissioner. No grades may exceed 6%. The road is graded to conform strictly to the plans and specifications with due attention given to drainage. Shoulders are formed on either side of the roadway to retain the gravel within the width and depth specified. The subgrade is rolled until it is firm, and is 8 in. below and possesses the same crown as the finished grade.

The gravel, the specifications for which have already been given, is spread in two courses, the bottom and top courses being respectively 6 in. and 4 in. deep, loose measure, forming a total compacted depth of 8 in. In both courses all depressions and ruts that form during construction are filled, and each course in turn is thoroughly harrowed and rolled until it is everywhere hard and smooth, and the finished surface conforms to the proposed grade and cross-section. The importance of complete harrowing is emphasized. The ordinary spiked-toothed harrow is a tool second to none for compactin the gravel. The rolling is done after the gravel has been thoroughly wetted by sprinkling or rains.

Turning now to a discussion of the cost, we find a great diversity of plant used and a wide range of conditions from suburban streets to roads through uncut forests. An average cost based on 59 jobs, aggregating 68.42 mi. of 9-ft. gravel roads is about $2,500 per mi. With a quarter-mile haul the cost was $2,340, and with a 5-mi. haul, $2,850.

No matter how painstaking the work of construction may be, the final set of the gravel on the ordinary country road will come only under travel, and to insure a good surface the road must be kept smooth during the formative period. For this purpose the most effective tools are the plank and log drags, or some of the various types of steel drags that accomplish the same purpose.

These drags should be systematically used after rains, when the gravel is in a packing condition, and in the subsequent maintenance of the road. When once compacted and maintained in a manner that gives perfect surface drainage a gravel road may be expected to carry from 200 to 500 vehicles per day with an annual maintenance charge of from $100 to $200 per mi.

To conclude, the experience in Michigan has been that gravel is a satisfactory road material from many standpoints for roads of moderate traffic. It would seem that there are many locations throughout the country where a properly constructed gravel road would fulfill the requirements of a truly economical road.

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*State Highway Commissioner, Lansing, Mich.

Long-Time New York Rainfall as Basis for Sewer Design--I

By O. Hufeland*

SYNOPSIS—Tabulations and diagrams of the New York City rainfall for the years 1869 to 1913 inclusive, were made, no storms being used in which the rate of precipitation was less than 1 in. per hour for a period of 10 min. The tabulations were made both by the "average-rate" and the "uniform-intensity" methods. The object is to show the widely different results obtained by the two methods and to point out that the "average-rate" method is seriously misleading when used in sewer design.

The data here discussed were taken from the rainfall harts of the Central Park observatory in New York ity, for the period from April, 1869, to December, 913. The apparatus used was the Draper recording ain gage in which the charts are secured to a vertical rum that makes one revolution in 24 hr. and the reording pen is attached to a tipping bucket which, as it ills, carries the pen down across the chart against the ction of a spring until the bucket contains ½ in. of ainfall. It then tips and the spring brings back the mpty bucket to its original position for a repetition f the operation. Each line across the chart made by e pen indicates ½ in. of rainfall, while the rotation the drum gives the period during which this half inch r fraction of it fell. The vertical motion, 5¼ in., is ufficiently great clearly to indicate the quantity, but e time space of a little less than ½ in. for an hour is ather short for exact reading. However, some study the charts permitted readings of sufficient accuracy to ake the records of great value.

The charts for every day of the whole 45 yr. were careully examined, and those which indicated a rate of innsity of 1 in. per hr. for 10 min. were selected for a eliminary study. These showed that the lower intenties for short periods were so frequent that they need t be considered in sewer design, and a series of minium intensities was selected that were believed to be fely within the requirements of the purpose. These ill be given later on. In this article the word "rainll" indicates the quantity of rain that fell in any given riod and the word "rate" means the rate in inches per ur at which it fell.

Figures above the minimum were tabulated by two fferent methods—the "average rate" and the "uniform tensity." I will first give the one that has been most ed.

"Average-Rate" Method of Tabulation

Table 1 shows maximum accumulations of rainfall r selected periods, with average rates for such periods d the dates on which the storms occurred. Accumued rainfall for whole storms was not sought except it met the conditions of the tabulation. The figures this table were obtained by selecting from the record chart of each storm the maximum rainfall for periods beginning with 5 min. and ending with 120 min. From the 5- to the 20-min. periods, 5-min. intervals were used; from 20 to 60 min., 10 min.; and from 60 to 120 min., 20-min. intervals. The rate was obtained by dividing the total quantity of rainfall for the selected period by the time. For the shortest period (5 min.), rates below 3 in. per hr. are omitted; for 10 and 15 min., below 2 in.; for 20 min., 1½ in.; and for the others 1 in. per hr. is the minimum, the rates below these figures occurring too frequently to need consideration. The table shows a gradual increase in quantity of rainfall for the successive periods in each storm, but these periods need

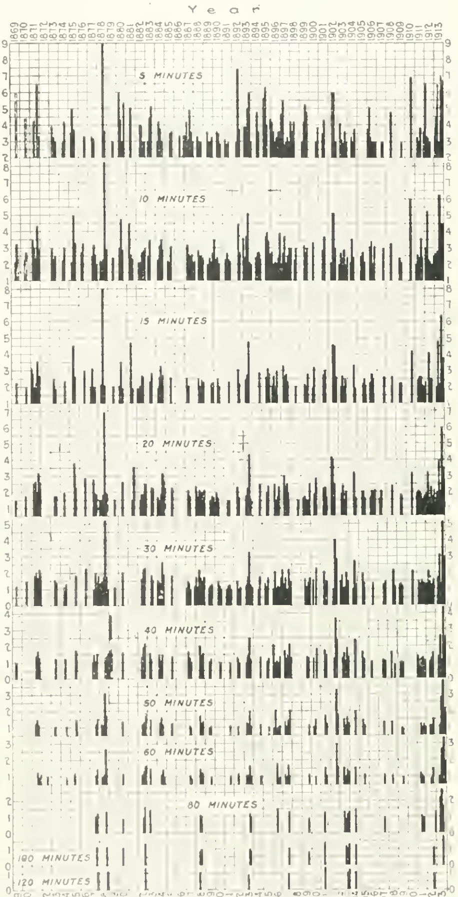

FIG. 1. FREQUENCY AND RATES OF RAINFALL, NEW YORK CITY, 1869 TO 1913; "AVERAGE-RATE" METHOD

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*Assistant Engineer, Consulting Engineer's Office, Borough Manhattan, Municipal Building, New York City.

TABLE 1 STUDY OF RAINFALL AT NEW YORK CITY, 1869 TO 1913, BY "AVERAGE RATE" METHOD

Maximum Accumulations of Rainfall in Inches for Periods from 5 to 120 Min., with Average Rates in Inches per Hour and Dates of Occurrence

		5 Min		10 Min		15 Min		20 Min		30 Min		40 Min		50 Min		60 Min.		80 Min		100 Min.		120 Min.	
Date	Year	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate
June 21	1869			0.35	2.10			0.50	1.50	0.60	1.20	0.68	1.02										
Aug. 13	1869	0.49	5.88	0.52	3.12	0.56	2.24	0.57	1.71														
Aug. 15	1869	0.49	5.88	0.37	2.22																		
June 27	1870			0.37	2.22	0.50	2.00	0.59	1.77	0.76	1.52												
July 28	1870	0.36	4.32	0.45	2.70																		
June 7	1871	0.35	4.20	0.59	3.54	0.78	3.12	0.86	2.58	0.91	1.82	0.96	1.44	1.01	1.21								
July 16	1871	0.25	3.00	0.50	3.00	0.72	2.88	0.88	2.64	1.02	2.04	1.15	1.72	1.22	1.46	1.30	1.30						
Aug. 16	1871					0.50	2.00																
Sept. 26	1871			0.38	2.28	0.57	2.28	0.68	2.04	0.81	1.62	0.89	1.34	0.94	1.13	0.97	0.97						
Oct. 11	1871	0.54	6.48	0.73	4.38	0.90	3.60	1.06	3.18	1.10	2.20					1.14	1.14						
Oct. 26	1871	0.27	3.24	0.49	2.94	0.72	2.88	0.87	2.61	0.91	1.82												
July 25	1872															1.00	1.00						
July 5	1873	0.33	3.96	0.50	3.00	0.62	2.48	0.70	2.10	0.77	1.54	0.82	1.23	0.86	1.03								
July 27	1873	0.27	3.24	0.38	2.28	0.48	1.92	0.58	1.74	0.70	1.40												
Aug. 21	1873	0.25	3.00	0.41	2.46																		
July 10	1874	0.25	3.00	0.37	2.22	0.41	1.64	0.45	1.35	0.57	1.14	0.84	1.26	0.85	1.04	0.98	0.98						
July 12	1874	0.35	4.20	0.50	3.00	0.60	2.40	0.66	1.98	0.67	1.34												
June 22	1875		3.48	0.35	2.10																		
July 26	1875	0.41	5.00	0.83	5.00	1.14	4.56	1.27	3.81														
Aug. 18	1875	0.31	3.72	0.55	3.30	0.66	2.64	0.77	2.31	0.92	1.84	1.16	1.74	1.22	1.47	1.25	1.25						
May 26	1876			0.45	2.70																		
Aug. 16	1876	0.28	3.36	0.54	3.24	0.75	3.00	0.96	2.88	1.14	2.28												
June 21	1877									0.50	1.00	0.68	1.02										
July 3	1877	0.28	3.36	0.43	2.58	0.50	2.00																
July 17	1877	0.27	3.20	0.53	3.18	0.78	3.12	0.92	2.76	1.00	2.00	1.00	1.50	1.00	1.20	1.09	1.09	1.38	1.04				
Aug. 14	1877					0.50	2.00	0.64	1.92	0.70	1.40	0.76	1.14										
Aug. 25	1877	0.23	2.76	0.43	2.58																		
Oct. 4	1877			0.33	2.00	0.50	2.00	0.63	1.86	0.90	1.80	1.06	1.59	1.27	1.52	1.50	1.50	1.70	1.28	2.00	1.20	2.15	1.08
June 21	1878							0.50	1.50	0.68	1.36	0.86	1.29	0.96	1.15	1.00	1.00						
July 10	1878			0.36	2.16																		
July 21	1878			0.35	2.10																		
July 31	1878							0.50	1.50	0.74	1.48	0.93	1.39										
Aug. 1	1878			0.37	2.22	0.54	2.16	0.61	1.83	0.86	1.72	1.06	1.59	1.01	1.21	1.12	1.12						
Aug. 5	1878	0.75	9.00	1.37	8.22	2.00	8.00	2.31	6.93	2.61	5.22	2.62	3.93	2.64	3.17	2.66	2.66						
Sept. 4	1878	0.30	3.60	0.48	2.88	0.52	2.08	0.64	1.92	0.86	1.72	1.06	1.59	1.43	1.72	1.50	1.50	1.80	1.35	2.00	1.20	2.20	1.10
Nov. 27	1878									0.50	1.00												
Aug. 25	1878	0.25	3.00	0.40	2.40	0.50	2.00	0.51	1.53	0.54	1.08												
July 12	1880	0.50	6.00	0.79	4.74	0.86	3.44	0.87	2.61	1.02	2.04	1.08	1.62	1.16	1.39	1.17	1.17	1.23	0.92	1.85	1.11		
July 27	1880	0.36	4.32	0.50	3.00	0.51	2.04																
Aug. 10	1880	0.25	3.00																				
Aug. 20	1880	0.45	5.40	0.48	2.88	0.49	1.96																
May 22	1881	0.42	5.04	0.75	4.50	1.17	4.68	1.19	3.57														
July 4	1881	0.35	4.20	0.43	2.58	0.48	1.92	0.51	1.53														
Aug. 7	1881	0.35	4.20	0.38	2.28																		
June 15	1882	0.33	4.00																				
June 19	1882	0.33	4.00					0.50	1.50														
June 26	1882					0.48	1.92																
Sept. 11	1882			0.35	2.10	0.48	1.92	0.62	1.86	0.81	1.62	0.92	1.38	1.01	1.21	1.10	1.10	1.25	0.94				
Sept. 20	1882	0.33	3.96	0.46	2.76	0.52	2.08	0.58	1.74														
Sept. 22	1882	0.25	3.00	0.47	2.82	0.67	2.68	0.85	2.55	1.11	2.22	1.25	1.87	1.28	1.53	1.34	1.34						
Sept. 23	1882	0.25	3.00	0.50	3.00	0.66	2.64	0.82	2.46	1.15	2.30	1.45	2.18	1.58	1.90	1.74	1.74	2.16	1.62	2.27	1.36	2.62	1.31
May 21	1883	0.25	3.00	0.42	2.52	0.58	2.32	0.77	2.31	0.93	1.86	1.03	1.55	1.18	1.42	1.51	1.51	1.93	1.44				
June 6	1883	0.37	4.44																				
July 13	1883	0.43	5.16	0.58	3.48	0.67	2.84	0.75	2.25	0.78	1.56	0.81	1.21										
June 25	1884			0.33	1.98	0.48	1.92	0.56	1.68	0.78	1.56	1.00	1.50	1.10	1.32	1.18	1.18						
July 4	1884	0.25	3.00																				
July 12	1884	0.25	3.00	0.38	2.28	0.46	1.84	0.50	1.50	0.71	1.42												
Aug. 5	1884	0.35	4.20	0.53	3.18	0.62	2.48	0.65	1.95	0.68	1.36	0.71	1.07	0.73	0.88								
Aug. 22	1884	0.31	3.72	0.59	3.54	0.81	3.24	1.06	3.18	1.35	2.70					1.45	1.45						
Aug. 30	1884	0.25	3.00	0.48	2.88	0.68	2.72	0.88	2.64	0.95	1.90	0.97	1.45	0.99	1.19	1.01	1.01						
June 5	1885	0.25	3.00	0.36	2.16																		
July 29	1885	0.29	3.48	0.35	2.10																		
Aug. 3	1885	0.30	3.60	0.52	3.12	0.64	2.56	0.75	2.25	0.92	1.82	0.93	1.39	1.06	1.27								
Nov. 18	1886	0.28	3.36																				
May 31	1887	0.28	3.36	0.53	3.18	0.63	2.52	0.71	2.13	0.77	1.54	1.12	1.68										
June 17	1887	0.28	3.36																				
June 20	1887	0.35	4.20	0.43	2.58	0.46	1.84			0.54	1.08												
June 22	1887	0.26	3.12	0.42	2.52	0.51	2.04	0.58	1.74	0.70	1.40	0.80	1.20	0.96	1.15	1.08	1.08						
Aug. 18	1887	0.41	4.92	0.43	2.58																		
Aug. 21	1887	0.30	3.60	0.35	2.10																		
Aug. 22	1887									0.50	1.00	0.64	0.96	0.80	0.96	0.92	0.92						
Aug. 24	1887	0.25	3.00	0.36	2.16																		
May 28	1888									0.60	1.20												
May 29	1888					0.40	1.60																
June 26	1888	0.27	3.30	0.47	2.82	0.62	2.48	0.78	2.34	0.89	1.78												
July 19	1888	0.25	3.00	0.41	2.46	0.52	2.08	0.54	1.62	0.56	1.12												
Aug. 4	1888			0.42	2.52	0.60	2.40	0.71	2.13	1.10	2.20	1.36	2.04	1.41	1.69	1.45	1.45	1.50	1.12	56	0.94	2.03	1.02
Aug. 21	1888	0.23	2.76	0.40	2.40	0.57	2.28	0.66	1.98	0.81	1.62	0.96	1.44	1.06	1.27	1.21	1.21	1.46	1.09	1.67	1.00		
Sept. 8	1888							0.50	1.50	0.77	1.54												
Sept. 20	1888	0.25	3.00	0.50	3.00			0.71	2.13	0.88	1.76	1.03	1.54	1.10	1.32	1.21	1.21						
June 11	1889			0.33	1.98																		
June 15	1889									0.55	1.10												
July 27	1889							0.50	1.50	0.60	1.20	0.71	1.07	0.82	0.98								
July 30	1889	0.30	3.60	0.40	2.40	0.55	2.20	0.57	1.71	0.68	1.36	0.83	1.24	0.92	1.10	1.00	1.00						
July 31	1889	0.25	3.00	0.35	2.10																		
Aug. 2	1889	0.25	3.00																				
Sept. 17	1889	0.27	3.24	0.45	2.70	0.56	2.24	0.55	1.65														
June 6	1890	0.30	3.60	0.58	3.48	0.62	2.48	0.66	1.98	0.75	1.50												
July 17	1890			0.38	2.28																		
Aug. 22	1890	0.29	3.48	0.40	2.40	0.49	1.96	0.54	1.62	0.60	1.20	0.67	1.00										
Sept. 16	1890	0.24	2.88	0.34	2.04																		
Sept. 17	1890									0.50	1.00												
Apr. 23	1891	0.26	3.12																				
June 17	1891	0.24	2.88	0.38	2.28					0.50	1.00												
July 23	1891	0.25	3.00	0.44	2.64	0.58	2.32	0.50	1.50	0.60	1.20												
Aug. 23	1891			0.38	2.28			0.50	1.50	0.61	1.22	0.67	1.00	0.95	1.14	1.04	1.04						
Sept. 5	1891			0.36	2.16																		
June 9	1892	0.25	3.00																				
July 3	1892	0.62	7.44	0.74	4.44	0.76	3.04	0.77	2.31	0.77	1.54	0.85	1.27	0.91	1.09	1.13	1.13						
Aug. 9	1892									0.53	1.06	0.65	0.97										
Sept. 13	1892	0.31	3.72	0.45	2.70	0.54	2.18	0.55	1.65	0.56	1.12												
June 6	1893	0.32	3.84	0.60	3.60	0.61	2.44	0.62	1.86	0.64	1.28	0.65	0.97	1.05	1.26	1.08	1.08						
July 26	1893	0.32	3.84	0.40	2.40																		
Aug. 19	1893	0.42	5.04	0.62	3.72	0.69	2.76	0.75	2.25	0.87	1.74	0.94	1.41	1.00	1.20	1.07	1.07						
Aug. 20	1893	0.50	6.00	0.85	5.10	1.20	4.80	1.45	4.35	1.65	3.30	1.66	2.49	1.67	2.00	1.68	1.68	1.76	1.17	1.79	1.07	1.84	0.92
Aug. 23	1893									0.60	1.20	0.76	1.14	0.90	1.08	1.05	1.05	1.30	0.97	1.57	0.94	1.74	0.87
Sept. 7	1893			0.35	2.10																		
Oct. 27	1893	0.25	3.00	0.33	1.98			0.50	1.50	0.54	1.08												
July 29	1894			0.40	2.40																		
Aug. 3	1894	0.40	4.80	0.45	2.70					0.50	1.00												
Sept. 8	1894	0.30	3.60	0.45	2.70	0.71	2.84	0.84	2.52	0.89	1.78	0.89	1.33	1.00	1.20	1.03	1.03						
Sept. 16	1894	0.30	3.60	0.38	2.28																		

TABLE 1. STUDY OF RAINFALL AT NEW YORK CITY, 1869 TO 1913, BY "AVERAGE-RATE" METHOD —Continued

Maximum Accumulations of Rainfall in Inches for Periods from 5 to 120 Min., with Average Rates in Inches per Hour and Dates of Occurrence

		5 Min.		10 Min.		15 Min.		20 Min.		30 Min.		40 Min.		50 Min.		60 Min.		80 Min.		100 Min.		120 Min.	
Date	Year	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate	Rainfall	Rate
June 5	1895	0.47	5.64	0.62	3.72	0.65	2.60	0.67	2.01	0.69	1.38	0.71	1.06										
Aug. 4	1895									0.58	1.16												
Aug. 6	1895	0.53	6.35	0.66	3.96	0.78	3.12																
Aug. 31	1895	0.33	3.96	0.57	3.42	0.70	2.80	0.79	2.37	0.82	1.64	0.85	1.27	0.87	1.04								
May 28	1896									0.52	1.04												
June 10	1896	0.36	4.32	0.44	2.64	0.50	2.00																
July 6	1896	0.35	4.20	0.45	2.70	0.66	2.64	0.82	2.46	1.06	2.12	1.38	2.07	1.70	2.04	1.85	1.85	1.95	1.46				
July 15	1896	0.30	3.60	0.33	2.00			0.50	1.50	0.52	1.04	0.65	0.97	0.80	0.96								
July 20	1896	0.25	3.00	0.35	2.10					0.61	1.22	0.71	1.06										
July 22	1896	0.27	3.24	0.34	2.04	0.50	2.00	0.58	1.74	0.60	1.20	0.66	0.98	0.89	1.07	0.92	0.92						
July 30	1896			0.40	2.40																		
Sept. 3	1896	0.30	3.60	0.65	3.90	0.73	2.92	0.77	2.31	0.85	1.70	0.90	1.35	0.92	1.10	0.94	0.94						
Sept 15	1896	0.30	3.60	0.34	2.04																		
Sept. 18	1896	0.39	4.68	0.44	2.64																		
May 24	1897	0.46	5.52	0.62	3.72	0.81	3.24	1.01	3.03	1.10	2.20	1.15	1.72	1.16	1.39	1.18	1.18						
June 9	1897	0.24	2.88	0.35	2.10					0.64	1.28	0.84	1.26	0.92	1.10	1.02	1.02						
July 21	1897	0.25	3.00																				
July 23	1897	0.27	3.24	0.42	2.52	0.67	2.68	0.79	2.37	0.86	1.72	0.92	1.38	1.02	1.22	1.06	1.06						
July 28	1897									0.50	1.00												
Aug. 23	1897	0.25	3.00	0.50	3.00	0.69	2.76	0.85	2.55	1.11	2.22	1.40	2.10	1.70	2.04	1.74	1.74	1.78	1.33	1.82	1.09	1.92	0.96
Sept. 1	1897	0.35	4.20	0.50	3.00	0.58	2.32	0.65	1.95	0.72	1.44	0.76	1.14										
Apr. 24	1898	0.30	3.60	0.38	2.28																		
uly 4	1898	0.35	4.20	0.50	3.00	0.50	2.00	0.51	1.53														
une 15	1899									0.81	1.62												
une 28	1899	0.25	3.00																				
uly 12	1899	0.35	4.20	0.53	3.18	0.54	2.16	0.55	1.65														
ug. 10	1899	0.44	5.28	0.46	2.76	0.49	1.96	0.52	1.56	0.59	1.18												
ept 1	1899							0.50	1.50	0.71	1.42	0.90	1.35	1.00	1.20	1.20	1.20	1.27	0.95	1.50	0.90		
ept. 3	1899	0.40	4.80	0.50	3.00	0.70	2.80	0.82	2.46	0.85	1.70	0.87	1.30										
lay 19	1900					0.48	1.92	0.62	1.86	0.79	1.58	0.83	1.24	0.88	1.06	1.04	1.04						
ug. 12	1900	0.25	3.00																				
ug. 26	1900	0.32	3.84	0.55	3.30	0.80	3.20	0.94	2.82	1.15	2.30	1.23	1.84	1.26	1.51								
uly 5	1901	0.29	3.48	0.48	2.88	0.68	2.72	0.75	2.25	1.05	2.10	1.18	1.77	1.45	1.74	1.60	1.60	1.81	1.36	2.40	1.44	2.65	1.32
uly 6	1901	0.36	4.32	0.61	3.66	0.75	3.00	0.76	2.28	0.77	1.54												
ug. 24	1901							0.56	1.68	0.77	1.54	0.96	1.44	1.03	1.24	1.08	1.08						
une 21	1902									0.50	1.00	0.67	1.00										
uly 20	1902			0.35	2.10																		
uly 28	1902	0.50	6.00	0.86	5.16	1.15	4.60	1.40	4.20	2.04	4.08	2.46	3.69	2.77	3.32	3.02	3.02						
ug. 5	1902	0.50	6.00	0.86	5.16	1.13	4.52	1.35	4.05	1.45	2.90	1.57	2.35	1.59	1.81	1.61	1.61						
eb. 28	1903	0.34	4.08																				
une 14	1903			0.33	1.98	0.50	2.00	0.65	1.95	0.71	1.42	0.85	1.27										
une 21	1903	0.26	3.12																				
une 29	1903	0.24	2.88	0.45	2.70	0.65	2.60	0.80	2.40	0.91	1.82	1.04	1.56	1.27	1.52	1.55	1.55	1.85	1.36	2.00	1.20	2.10	1.05
uly 2	1903			0.40	2.40																		
uly 22	1903	0.30	3.60	0.48	2.88	0.50	2.00	0.50	1.50	0.52	1.04												
pt. 16	1903									0.53	1.06	0.70	1.05	0.95	1.14	1.03	1.03	1.26	0.94				
pt. 17	1903			0.33	1.98																		
ct. 8	1903	0.25	3.00	0.40	2.40	0.60	2.40	0.68	2.04	1.00	2.00	1.25	1.87	1.36	1.63	1.44	1.44	1.64	1.23	1.71	1.03		
ct. 9	1903									0.75	1.50	0.89	1.33	1.08	1.30	1.35	1.35	1.82	1.36	2.15	1.29	2.42	1.21
ay 30	1904			0.35	2.10																		
ly 11	1904									0.50	1.00												
ly 28	1904	0.27	3.24																				
ug. 4	1904	0.25	3.00																				
ug. 19	1904	0.31	3.72	0.59	3.54	0.82	3.28	1.07	3.21	1.38	2.76	1.60	2.40	1.66	1.99	1.72	1.72	1.96	1.47	2.05	1.23	2.15	1.07
pt. 14	1904			0.40	2.40	0.48	1.92	0.54	1.62	0.63	1.26												
ne 22	1905			0.41	2.46	0.55	2.20	0.68	2.04	0.98	1.96	1.11	1.66	1.19	1.43								
ug. 13	1905			0.45	2.70	0.61	2.44	0.65	1.95	0.70	1.40	0.76	1.14	0.95	1.14	1.11	1.11						
t. 19	1905			0.36	2.16	0.52	2.08	0.55	1.65														
ay 5	1906	0.31	3.72	0.52	3.12	0.55	2.20	0.55	1.65														
ay 27	1906	0.42	5.04	0.57	3.42	0.68	2.72	0.69	2.07														
ly 10	1906	0.22	2.64	0.34	2.04	0.45	1.80	0.58	1.74	0.70	1.40	0.72	1.08										
ly 17	1906	0.27	3.24	0.52	3.12	0.61	2.44	0.70	2.10														
pt 13	1906	0.25	3.00																				
ug. 9	1907	0.25	3.00																				
ug. 24	1907							0.50	1.50	0.65	1.30	0.80	1.20	1.00	1.20	1.15	1.15	1.30	0.97				
pt. 11	1907	0.25	3.00	0.50	3.00	0.64	2.56	0.69	2.07	0.76	1.52	0.77	1.15										
ly 14	1908	0.40	4.80	0.55	3.30	0.65	2.60	0.80	2.40	1.10	2.20	1.14	1.71	1.15	1.38	1.16	1.16						
pt 28	1908									0.55	1.10	0.65	0.97										
ne 28	1909			0.40	2.40	0.55	2.20	0.61	1.83	0.65	1.30	0.67	1.00										
ug 4	1909									0.66	1.32	0.68	1.02	0.83	0.99	0.96	0.96						
ug. 13	1909	0.25	3.00	0.35	2.10	0.55	2.20	0.57	1.71	0.60	1.20	0.67	1.00	0.82	0.98								
ly 31	1910			1.00	6.00	1.05	4.20	1.07	3.21	1.08	2.16												
ar. 27	1911	0.27	3.24	0.33	1.98																		
ne 10	1911			0.42	2.52	0.60	2.40	0.63	1.89														
ne 11	1911	0.25	3.00	0.40	2.40	0.65	2.60	0.68	2.04	0.77	1.54	0.93	1.39	1.04	1.25	1.28	1.28	1.40	1.05				
ly 20	1911	0.32	3.84	0.60	3.60	0.65	2.60	0.66	1.98	0.67	1.34	0.68	1.02										
g 15	1911			0.40	2.40	0.52	2.08	0.62	1.86	0.78	1.56	0.80	1.20	0.82	0.98								
g 24	1911							0.50	1.50	0.68	1.36	0.89	1.31	1.02	1.22	1.08	1.08	1.23	0.92				
t 19	1911					0.50	2.00	0.57	1.71	0.67	1.34	0.75	1.13	0.85	1.02	1.00	1.00	1.25	0.93				
b. 27	1912	0.30	3.60	0.50	3.00	0.57	2.28	0.63	1.89	0.67	1.34	0.71	1.06										
y 30	1912	0.55	6.60	0.88	5.28	1.03	4.12	1.07	3.21	1.08	2.16												
ne 17	1912	0.28	3.36	0.38	2.28			0.53	1.59														
y 21	1912	0.27	3.24	0.36	2.16	0.62	2.48	0.77	2.31	0.89	1.78	0.91	1.36	0.94	1.13	0.96	0.96						
g. 10	1912	0.25	3.00	0.34	2.04			0.56	1.68	0.62	1.24												
t 12	1912			0.41	2.46	0.60	2.40	0.70	2.10	0.81	1.62	1.07	1.61	1.32	1.58	1.53	1.53	1.73	1.30	1.89	1.13	1.93	0.96
ne 20	1913	0.37	4.44	0.44	2.64	0.49	1.96	0.50	1.50	0.87	1.74	0.93	1.39	0.97	1.16	1.02	1.03						
v 1	1913							0.65	1.95														
y 24	1913	0.42	5.04	0.47	2.82																		
y 28	1913	0.54	6.48	1.05	6.30	1.22	4.88	1.31	3.93	1.58	3.16	1.80	2.70	2.40	2.88	2.68	2.68	2.94	2.20				
g. 7	1913	0.25	3.00	0.40	2.40	0.53	2.12	0.65	1.95	0.67	1.34	0.76	1.14										
t 1	1913	0.60	7.20	1.18	6.90	1.60	6.40	2.00	6.00	2.56	5.12	2.95	4.42	3.20	3.84	3.40	3.40	3.60	2.70				
t. 1	1913	0.56	6.72	0.75	4.50	0.93	3.72	1.15	3.45	1.49	2.98	1.73	2.59	1.78	2.14	1.90	1.90	2.20	1.65	3.14	1.88		

t necessarily be connected. The maximum quantity for min., for instance, may have fallen at one point of a orm, that for 10 min. at another and that for 15 min. a third, and in none of them need the rainfall have en uniform, the rate given always being the average r the whole period. Or all of the foregoing may be nnected to make the 30-min. period, and then the rate ven would be the average of the total quantity that l in the three periods at different rates.

In addition to the data described in the preceding ragraph, it is necessary to know how often the various intensities occurred. This information is given in Table 2, which shows how often each intensity occurred in each of the selected periods. In order to give a general view of the frequency, Figs. 1 and 2 have been prepared for every period from 5 to 120 min. for the whole 45 yr. On these the rates have been plotted in the order of their occurrence, so that the frequency of any rate for the period can be found by inspection. These diagrams also show a fact that is generally overlooked—namely, that a 3-in. rate for 5 min., for instance, instead of occurring only 39 times, as an inspection of the table would seem

TABLE 2. STUDY OF RAINFALL AT NEW YORK CITY, 1869 TO 1913, BY "AVERAGE-RATE" METHOD

Number of Recurrences of Rainfall and Rates for Periods from 5 to 120 Min., Arranged in the Order of Increasing Intensities

5 Min. Rate, 3 In. and Over			10 Min. Rate, 1.80 In. and Over			15 Min. Rate, 1.60 In. and Over			20 Min. Rate, 1.44 In. and Over			30 Min. Rate, 1 In. and Over			40 Min. Rate, 0.63 In. and Over			50 Min. Rate, 0.96 In. and Over			60 Min. Rate, 0.90 In. and Over			80 Min. Rate, 0.83 In. and Over			100 Min. Rate, 0.79 In. and Over			120 Min. Rate, 0.70 In. and Over		
No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate	No.	Rainfall	Rate
39	0.25	3.00	2	0.30	1.80	3	0.40	1.60	1	0.48	1.44	8	0.50	1.00	1	0.63	0.94	2	0.80	0.96	1	0.92	0.92	1	1.12	0.83	1	1.32	0.79	2	1.40	0.70
4	0.26	3.12	3	0.32	1.92	2	0.42	1.68	17	0.50	1.50	3	0.52	1.04	4	0.65	0.97	2	0.82	0.98	1	0.94	0.94	1	1.16	0.87	1	1.34	0.80	1	1.41	0.70
10	0.27	3.24	9	0.33	1.98	1	0.43	1.72	3	0.51	1.53	2	0.53	1.06	1	0.96	0.99	1	0.85	1.02	1	0.96	0.96	2	1.18	0.89	1	1.36	0.82	1	1.42	0.71
7	0.28	3.36	4	0.34	2.04	2	0.44	1.76	1	0.52	1.56	2	0.54	1.08	3	0.67	1.00	1	0.87	1.04	1	0.97	0.97	2	1.23	0.92	1	1.38	0.83	1	1.43	0.71
3	0.29	3.48	11	0.35	2.10	3	0.45	1.80	1	0.53	1.59	2	0.55	1.10	2	0.68	1.02	1	0.88	1.06	3	1.00	1.00	2	1.25	0.94	1	1.42	0.85	1	1.58	0.79
10	0.30	3.60	3	0.36	2.16	1	0.46	1.84	4	0.54	1.62	1	0.56	1.12	1	0.70	1.05	1	0.89	1.07	2	1.02	1.02	1	1.26	0.95	1	1.50	0.90	1	1.74	0.87
1	0.31	3.72	3	0.37	2.22	1	0.47	1.88	2	0.55	1.65	1	0.58	1.16	4	0.71	1.06	1	0.91	1.09	1	1.03	1.03	1	1.27	0.96	1	1.56	0.94	1	1.75	0.87
2	0.32	3.84	9	0.38	2.28	6	0.48	1.92	1	0.56	1.68	1	0.59	1.18	1	0.72	1.08	3	0.92	1.10	1	1.04	1.04	2	1.30	0.97	1	1.57	0.94	1	1.76	0.88
2	0.33	4.00	11	0.40	2.40	4	0.49	1.96	2	0.57	1.71	5	0.60	1.20	1	0.75	1.13	2	0.94	1.13	1	1.07	1.07	1	1.38	1.04	1	1.67	1.00	1	1.92	0.96
1	0.34	4.08	3	0.41	2.46	12	0.50	2.00	3	0.58	1.74	2	0.61	1.22	4	0.76	1.14	3	0.95	1.14	3	1.08	1.08	1	1.40	1.05	1	1.71	1.03	1	1.93	0.96
8	0.35	4.20	6	0.42	2.52	2	0.51	2.04	4	0.59	1.77	1	0.63	1.26	3	0.80	1.20	1	0.96	1.15	1	1.09	1.09	1	1.46	1.09	1	1.82	1.09	1	2.03	1.01
2	0.36	4.32	4	0.43	2.58	4	0.52	2.08	1	0.61	1.83	1	0.64	1.28	2	0.83	1.25	1	0.97	1.16	1	1.10	1.10	1	1.50	1.12	1	1.85	1.11	1	2.10	1.05
3	0.37	4.44	5	0.44	2.64	1	0.53	2.12	4	0.62	1.86	1	0.65	1.30	1	0.84	1.26	4	1.00	1.20	1	1.11	1.11	1	1.64	1.23	1	1.89	1.13	2	2.15	1.07
1	0.38	4.56	7	0.45	2.70	1	0.54	2.16	2	0.64	1.92	1	0.66	1.32	3	0.85	1.27	1	1.01	1.21	1	1.13	1.13	1	1.70	1.28	3	2.00	1.20	1	2.20	1.10
1	0.39	4.68	1	0.46	2.76	2	0.55	2.20	5	0.65	1.95	5	0.67	1.34	1	0.86	1.29	2	1.02	1.22	1	1.15	1.15	1	1.73	1.30	1	2.05	1.23	1	.242	1.21
5	0.40	4.80	2	0.47	2.82	2	0.56	2.24	4	0.66	1.98	3	0.68	1.36	3	0.89	1.34	1	1.03	1.24	1	1.16	1.16	1	1.78	1.33	1	2.15	1.29	1	.262	1.31
2	0.41	4.92	4	0.48	2.88	2	0.57	2.28	1	0.67	2.01	1	0.69	1.38	2	0.90	1.35	1	1.04	1.25	1	1.17	1.17	1	1.81	1.36	1	2.27	1.36	1	2.65	1.33
3	0.42	5.04	1	0.49	2.94	4	0.58	2.32	3	0.68	2.04	3	0.70	1.40	1	0.91	1.37	1	1.05	1.26	1	1.18	1.18	1	1.82	1.37	1	2.40	1.44			
1	0.44	5.28	10	0.50	3.00	4	0.60	2.40	2	0.69	2.07	2	0.71	1.42	2	0.92	1.38	1	1.06	1.27	1	1.20	1.20	1	1.85	1.39	1	3.14	1.88			
1	0.45	5.40	3	0.52	3.12	2	0.61	2.44	3	0.71	2.13	2	0.72	1.44	4	0.93	1.40	1	1.08	1.30	2	1.21	1.21	1	1.92	1.44						
1	0.46	5.52	4	0.53	3.18	1	0.62	2.48	1	0.72	2.16	1	0.74	1.48	1	0.94	1.41	1	1.10	1.32	1	1.28	1.28	1	1.95	1.46						
1	0.47	5.64	2	0.54	3.24	2	0.63	2.52	1	0.74	2.22	1	0.75	1.50	3	0.96	1.44	1	1.15	1.38	1	1.30	1.30	1	1.96	1.47						
1	0.49	5.88	2	0.55	3.30	3	0.64	2.56	3	0.75	2.25	1	0.76	1.52	1	1.00	1.50	2	1.16	1.39	1	1.35	1.35	1	2.16	1.62						
7	0.50	6.00	2	0.57	3.42	6	0.65	2.60	4	0.77	2.31	5	0.77	1.54	2	1.03	1.55	1	1.18	1.42	1	1.44	1.44	1	2.20	1.65						
1	0.53	6.36	1	0.58	3.48	3	0.66	2.64	3	0.79	2.37	1	0.78	1.56	1	1.04	1.56	1	1.19	1.43	1	1.45	1.45	1	2.94	2.20						
1	0.54	6.48	1	0.59	3.54	2	0.67	2.68	2	0.80	2.40	2	0.79	1.58	1	1.06	1.59	1	1.22	1.46	1	1.50	1.50	1	3.60	2.70						
1	0.58	6.96	3	0.60	3.60	2	0.68	2.72	2	0.82	2.46	5	0.81	1.62	1	1.07	1.61	2	1.27	1.52	1	1.51	1.51									
1	0.62	7.44	3	0.62	3.72	1	0.69	2.76	1	0.83	2.49	1	0.82	1.64	1	1.08	1.62	1	1.32	1.58	2	1.55	1.55									
1	0.65	7.80	1	0.65	3.90	2	0.70	2.80	2	0.85	2.55	1	0.85	1.70	1	1.09	1.64	1	1.36	1.63	1	1.60	1.60									
1	0.67	8.04	1	0.66	3.96	1	0.71	2.84	1	0.88	2.64	3	0.86	1.72	1	1.11	1.66	1	1.41	1.69	1	1.68	1.68									
1	0.75	9.00	1	0.70	4.20	1	0.72	2.88	1	0.92	2.76	2	0.87	1.74	1	1.12	1.68	1	1.43	1.72	1	1.72	1.72									
			1	0.73	4.38	2	0.73	2.92	1	0.96	2.88	1	0.88	1.76	1	1.14	1.71	1	1.45	1.74	1	1.74	1.74									
			2	0.75	4.50	1	0.75	3.00	1	1.00	3.00	1	0.89	1.78	1	1.15	1.72	1	1.58	1.90	1	1.85	1.85									
			1	0.77	4.62	1	0.76	3.04	1	1.01	3.03	1	0.90	1.80	1	1.16	1.74	1	1.66	1.99	1	1.90	1.90									
			1	0.78	4.68	4	0.78	3.12	1	1.06	3.18	2	0.91	1.82	1	1.18	1.77	1	1.67	2.00	1	2.66	2.66									
			1	0.79	4.74	1	0.81	3.24	1	1.07	3.21	2	0.92	1.84	2	1.25	1.88	2	1.70	2.04	1	2.68	2.68									
			1	0.83	4.98	1	0.82	3.28	1	1.15	3.45	1	0.93	1.86	1	1.36	2.04	1	1.78	2.14	1	3.02	3.02									
			2	0.86	5.16	1	0.86	3.44	1	1.26	3.78	1	0.98	1.96	1	1.38	2.07	1	2.40	2.88	1	3.40	3.40									
			1	0.95	5.70	1	0.90	3.60	1	1.27	3.81	2	1.00	2.00	1	1.40	2.10	1	2.64	3.17												
			1	1.00	6.00	1	0.93	3.72	1	1.31	3.93	1	1.02	2.04	1	1.45	2.18	1	2.77	3.32												
			1	1.02	6.12	1	1.03	4.12	1	1.35	4.05	1	1.05	2.10	1	1.60	2.40	1	3.20	3.84												
			1	1.20	7.20	1	1.05	4.20	1	1.40	4.20	1	1.06	2.12	1	1.66	2.49															
			1	1.37	8.22	1	1.13	4.52	1	1.45	4.35	3	1.10	2.20	1	1.73	2.60															
						1	1.14	4.56	1	2.00	6.00	2	1.11	2.22	1	1.80	2.70															
						1	1.15	4.60	1	2.31	6.93	1	1.14	2.28	1	2.46	3.69															
						1	1.17	4.68				2	1.15	2.30	1	2.62	3.93															
						1	1.22	4.88				1	1.45	2.90	1	2.95	4.38															
						1	1.25	5.00				1	1.49	2.98																		
						1	1.60	6.40				1	1.50	3.00																		
						1	2.00	8.00				1	1.58	3.16																		
												1	1.65	3.30																		
												1	2.04	4.08																		
												1	2.56	5.12																		
												1	2.61	5.22																		

TABLE 3. STUDY OF RAINFALL AT NEW YORK CITY, 1869 TO 1913, BY "AVERAGE-RATE" METHOD

Nine Maximum Rates from Which "Rainfall Curves" Were Plotted with Interpolated Points for "10-Yr. Curve"

Date of Storm	5 Min.	Date of Storm	15 Min.	Date of Storm	30 Min.	Date of Storm	50 Min.	Date of Storm	80 Min.	Date of Storm	120 Min.
Aug. 5, 1878..	9.00	Aug. 5, 1878 .	8.00	Aug. 5, 1878..	5.22	Sept. 4, 1913..	3.84	Sept. 4, 1913..	2.70	July 5, 1901..	1.33
Sept. 4, 1913..	8.04	Sept. 4, 1913 .	6.40	Sept. 4, 1913..	5.12	July 28, 1902 .	3.32	July 28, 1913..	2.20	Sept. 23, 1882..	1.31
July 3, 1892..	7.80	Aug. 4, 1893 .	5.00	July 28, 1902..	4.08	Aug. 5, 1878..	3.17	Oct. 1, 1913..	1.65	Oct. 9, 1903..	1.21
May 30, 1912..	7.44	July 28, 1913	4.88	Aug. 20, 1893..	3.30	July 28, 1913	2.88	Sept. 23, 1882..	1.62	Sept. 4, 1878..	1.10
Interpolated 10 Yr... .. .	7.17	Interpolated 10 Yr.	4.76	Interpolated 10 Yr.	3.32	Interpolated 10 Yr..	2.47	Interpolated 10 Yr. .	1.54	Interpolated 10 Yr... . .	1.09
July 31, 1912..	6.96	May 22, 1881..	4.68	July 28, 1913.	3.16	Oct. 1, 1913..	2.14	Aug. 19, 1904 .	1.47	Oct. 4, 1877..	1.08
Oct. 11, 1871..	6.48	July 28, 1902 .	4.60	Aug 19, 1904..	3.00	Aug. 23, 1897..	2.04	July 6, 1896..	1.46	Aug. 19, 1904 .	1.07
Aug. 6, 1893..	6.36	July 26, 1875 .	4.56	Oct. 1, 1913	2.98	July 6, 1896 .	2.04	May 21, 1883..	1.44	June 29, 1903..	1.05
July 12, 1880..	6.00	Aug. 5, 1902 .	4.52	Aug. 5, 1902..	2.90	Aug. 20, 1893..	2.00	June 29, 1903..	1.39	Aug. 4, 1888..	1.01
Oct. 1, 1913..	6.00	July 31, 1910..	4.20	Sept. 23, 1882..	2.30	Aug. 19, 1904 .	1.99	Oct. 9, 1903..	1.37	Oct. 23, 1912..	0.96

	10 Min.		20 Min.		40 Min.		60 Min.		100 Min.
Aug. 5, 1878..	8.22	Aug 5, 1878..	6.93	Sept. 4, 1913..	4.38	Sept 4, 1913..	3.40	Oct. 1, 1913..	1.88
Sept. 4, 1913..	7.20	Sept. 4, 1913 .	6.00	Aug. 5, 1878.	3.93	July 28, 1902 .	3.02	July 5, 1901..	1.44
May.30, 1912..	6.12	Aug. 20, 1893..	4.35	July 28, 1902.	3.69	July 28, 1913	2.68	Sept. 23, 1882..	1.36
July 31, 1910.	6.00	July 28, 1902	4.20	July 28, 1913.	2.70	Aug. 5, 1878	2.66	Oct. 9, 1903..	1.29
Interpolated 10 Yr...	5.83	Interpolated 10 Yr...	4.12	Interpolated 10 Yr..	2.64	Interpolated 10 Yr... .	2.24	Interpolated 10 Yr... . .	1.26
July 28, 1913..	5.70	Aug. 5, 1902..	4.05	Oct. 1, 1913..	2.60	Oct. 1, 1913..	1.90	Aug 19, 1904..	1.23
Aug. 5, 1902 .	5.16	July 28, 1913	3.93	Aug. 20, 1893..	2.49	July 6, 1896..	1.85	June 29, 1903..	1.20
July 28, 1902..	5.16	July 26, 1875 .	3.81	Aug. 19, 1904 .	2.40	Aug. 23, 1897 .	1.74	Oct. 4, 1877..	1.20
July 26, 1875..	4.98	Aug. 22, 1884 .	3.78	Sept. 23, 1882 .	2.18	Sept. 23, 1882 .	1.74	Oct. 23, 1912..	1.13
July 12, 1880..	4.74	Oct. 1, 1913 .	3.45	Aug 23, 1897..	2.10	Aug. 19, 1904 .	1.72	July 12, 1880..	1.11

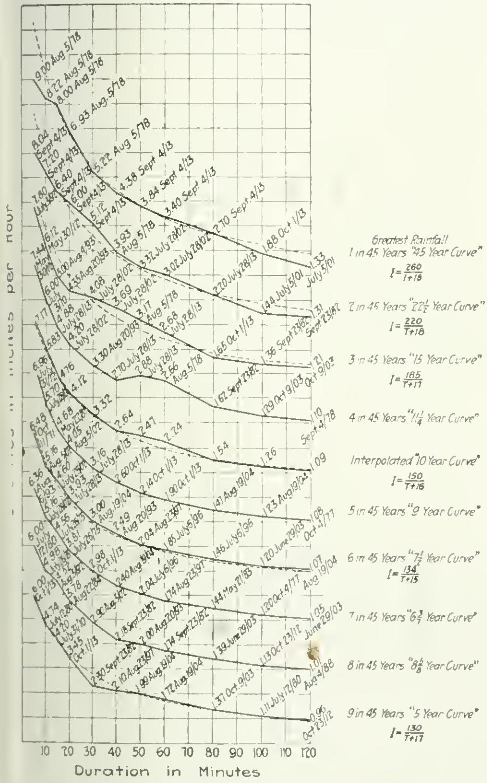
to show, really occurs 123 times, because a 3-in. rate and more occurred with every higher intensity of the period; and that a 4 in. rate, instead of occurring only two times, occurred 47 times, etc. By counting the storms that cross the ordinate for the rate required (Fig. 1) the number of times when that rate was reached or exceeded in that period can be found. These diagrams, together with the tables, give a complete compilation of the rainfall records according to the "average rate" method.

From the data so obtained rainfall curves are developed which are supposed to show the frequency of maximum storms based on their past occurrence.

Fig. 2 shows such curves for intervals of from 5 to 45 yr. and for storms of from 5 to 120 min. duration. The curves are constructed in the following manner:

Table 3 shows the nine highest rates selected from each of the periods in Table 1. These were plotted into a like number of curves on coördinate paper, the abscissas representing time up to 120 min. and the ordinates rates in inches per hour. The highest rates recorded for each of the eleven periods from 5 to 120 min. form what is called the "45-Yr. Curve," because they occurred but once in that period. The second highest are similarly treated, and because they occurred twice in 45-yr., become the "22½-Yr. Curve"; the third because they occurred three times form the "15-Yr. Curve" and so on to the ninth, which is supposed to give the intensities that occur once in 5 yr. To the nine curves so obtained from the tables another is added by interpolation, which is supposed to represent a "10-Yr. Curve." The equations opposite some of the curves represent the curves drawn through them in broken lines.

From this series of curves one is selected as a basis of sewer computation. If it is desired to construct sewers that will carry off the water from storms that occur every 5 yr., the figures supplied by the "5-Yr. Curve" are used; if the 10-yr. period is selected, that curve is used;



IG. 2. NEW YORK RAINFALL CURVES BY "AVERAGE-RATE" METHOD FOR INTERVALS OF 5 TO 45 YR.

if it is desired to provide for the heaviest storms reorded, the figures from the "45-Yr. Curve" are applied. The reasoning on which these curves are based is that orms that have occurred but once in 45 yr. will probly not occur again in a shorter period; those that have curred twice in 45 yr. may be expected to occur every ½ yr.; those that have occurred three times will occur ery 15 yr., and so on. It is an application of the avere method to the frequency as well as to the rates.

I have carefully described this method of average rates sed on accumulated rainfall for selected periods and ven all the data on which its reasoning is based because desire to point out some of its peculiarities. But before do that I will give all the data in another form.

(To be continued)

Paving Methods in Manhattan Borough Revised

The following excerpts from the recently issued report of Eugene W. Stern, Chief Engineer of the Bureau of Highways, Borough of Manhattan, New York City, are of interest to paving engineers. Of the adequacy of 6-in. concrete foundation he writes:

> The question is often raised as to the desirability of increasing this depth on account of heavy traffic and to provide sufficient strength in the base to span settlements, cave-ins and shrinkage in the subgrade. Investigation of the failures in concrete foundations in this city shows that unless there is reason to believe that the subgrade is a recent fill, 6 in. is adequate and is able to support the pavement under normal loads.

In regard to the treatment of creosoted wood paving blocks, Mr. Stern says:

> To avoid bleeding, besides the ordinary treatment when being creosoted, the blocks have a final steaming and vacuum treatment, and the amount of oil has been reduced from 18 to 16 lb. per cu.ft.

He has experimented with night work to expedite pavement construction in congested thoroughfares, and writes:

> One of the more important streets paved during the year was 32nd St. between 5th Ave. and Broadway. This is a very busy street, connecting Fifth Ave. with the Pennsylvania Station. The work was expedited as much as possible, night and day, the contract providing that the contractor should work 16 hr. a day, and it is believed that a record was made in its completion, which took 18 days from start to finish, during which time the street was closed to traffic for only eight days.
>
> The result of handling the work in this manner proved so satisfactory in every way that it is proposed in the future to require night and day work on all streets in congested districts where there could be no objection to night work.

It seems that Mr. Stern has definitely abandoned the sand-cushion method of granite-block pavement construction, and has substituted asphalt for tar as a joint filler. He states that:

> A 1-in. mortar bed, consisting of 1 part portland cement to 3 parts sand has been substituted for the sand bed, or so-called cushion. This has proved entirely satisfactory, and the resulting improvement in the pavement has fully justified the change.
>
> For some time it has become apparent that the paving pitch for filling the joints, made of coal tar, was not giving satisfaction. At the end of even one year the joints would not remain filled. This was due to the fact that in warm weather the coal-tar filler would soften and leave the joints, and in cold weather it would chip out When the joint does not remain filled, the paving blocks quickly wear round on the edges and soon a noisy rough pavement is the result.
>
> To improve this condition, early in the year 1915 asphaltic joint filler was adopted, for the reason that it had greater tenacity, was less brittle in cold weather and not so soft in warm weather. The asphaltic filler has justified expectations; a comparison of those streets laid last year with asphaltic and coal-tar filler proves conclusively the superiority of the former.

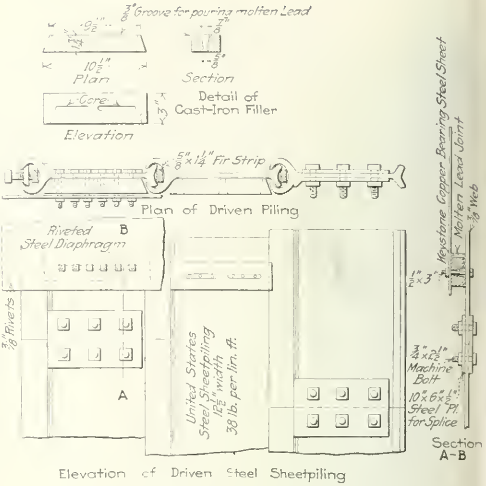
⁂

A Rail-and-Road Electric Car has been built by C. J. Spencer, manager of the Bradford (England) Tramways. The vehicle consists of a modified standard motor-truck chassis, provided with a battery, enabling it to leave the tramway rails and operate as an ordinary self-contained vehicle when the occasion demands. In addition to being self-contained for special work, it is also equipped with electric street-car equipment, including a trolley. Contact with the rails is made by means of a cast-iron block connected to the steering gear and automatically steering the vehicle. The motors are of 20 hp., operating normally at 500 volts on the usual series-parallel system of control. When the vehicle leaves the tramway the rail contactor is lifted, the trolley pole pulled down, and a switch thrown to bring the batteries into action Owing to the batteries having lower voltage than trolley wire, the speed free running is lower than when on rails, but the vehicle is able to climb any ordinary road gradients The batteries can be charged while running on the tramway routes.

Earth Dam with Sheet-Steel Diaphragm and Cutoff

In enlarging a 67-ft. earth dam founded partly on the silt bed of the Sevier River in Juab County, Utah, a novel method was employed to prevent seepage under and through the dam. Parts of the dam, the two ends, where rock is found at moderate depth (see Fig. 1), are provided with reinforced-concrete core-walls, which in plan follow approximately the contour of the underlying ledge. The middle part of the dam rests on 30 to 40 ft. of silt overlying the ledge, and here steel sheetpiling was driven; to the top of the piling a sheet-steel diaphragm was fastened and carried above the water level of the reservoir. The ends of the steel piling and diaphragm were incased in the ends of the concrete core-walls, forming a water-tight curtain from bedrock to 6 ft. above the high-water line of the reservoir. Construction has been in progress since 1912 and is now about completed.

The original dam, having about a 1,000-ft. crest, was designed to store a 60-ft. head of water with 7-ft. freeboard. The new dam, with a 1,300-ft. crest, completely incloses the old one and stores 80 ft. of water with 13-ft. freeboard. The base of the old dam was widened from 300 to 700 ft., at the maximum cross-section, and the surface area of the reservoir was increased from 3,630 to 10,000 acres. The capacity of the reservoir has been increased from 104,000 to 250,000 acre-ft. In order to accommodate the increased base of the dam, the outlet tunnel was extended upstream 202 ft. as a reinforced-concrete conduit, and a gate tower with gates at elevations 0, 30, 40 and 50 ft. was added for better control of the outflow. A spillway is cut in solid rock at the north end of the dam, with gate-controlled outlets at 60- and 80-ft. elevations.



3/8" Groove for pouring molten Lead
9 1/2"
1 1/4"
7/8"
10 1/2"
5/8"
Plan
Section
Core
3"
Detail of Cast-Iron Filler
Elevation
5/8" x 1 1/4" Fir Strip
Plan of Driven Piling
Riveted Steel Diaphragm
B
3/8" Rivets
A
United States Steel Sheetpiling 12 1/2" width 38 lb. per lin. ft.
Keystone Copper Bearing Steel Sheet
Molten Lead Joint
3/8" Web
1/2" x 3"
3/4" x 2 1/2" Machine Bolt
10" x 6" x 1/2" Steel Pl. for Splice
Section A-B
Elevation of Driven Steel Sheetpiling

FIG. 2. DETAIL OF WATER-TIGHT CONNECTION OF STEEL PILING AND DIAPHRAGM

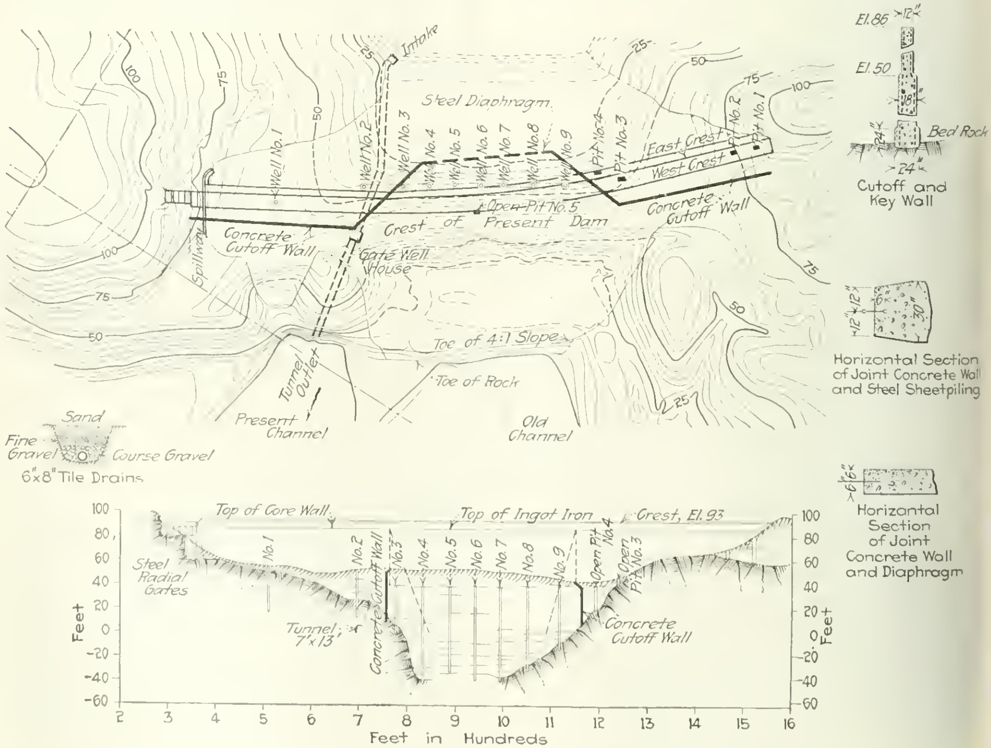


FIG. 1. PLAN AND LONGITUDINAL SECTION OF SEVIER BRIDGE DAM, JUAB COUNTY, UTAH

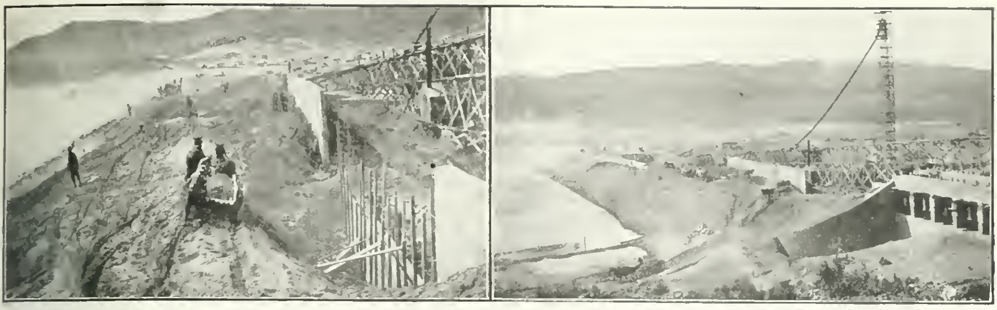


FIG. 3. CONSTRUCTION VIEWS OF SEVIER BRIDGE DAM, JUAB COUNTY, UTAH

The old dam contained about 200,000 cu.yd. of material. The additional material on the downstream side of the center line amounts to 140,000 cu.yd. and on the upstream side 340,000 cu.yd.—in all, the new dam contains about 680,000 cu.yd. of earth. The new fill was made with a mixture of clay and gravel, the gravel being luiced and carted from the north end of the dam and he clay carted from the opposite end. The carts were lriven across the dam, loading alternately on opposite ides, which provided for about the right mixture of gravel and clay and at the same time assisted in compacting the material. The hydraulic fill is on the upstream side. A temporary hydraulic power plant furnished the power for the pumps that supplied the monitors for sluicing, electric power for lighting and the air compressors for furnishing air to the pneumatic riveters.

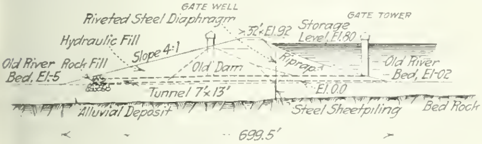


FIG. 4. CROSS-SECTION OF SEVIER BRIDGE DAM, SHOWING STEEL DIAPHRAGM

Previous to adding any new fill, the reinforced-concrete core-walls were extended as shown in Fig. 1, leaving a gap of about 210 ft. for the steel diaphragm. For the steel sheetpiling a trench was dug near the upstream toe of the old dam, as shown in the cross-section, Fig. 4. Approximately 11,000 lin.ft., or 200 tons, of 12½-in. 38-lb. United States steel sheetpiling was driven to bedrock in lengths of from 20 to 40 ft. The cost of driving, including plant and preliminary work, was about 35c. per lin.ft. The actual driving occupied about 30 days, two shifts, five to eight men in a shift. The total cost of the sheetpile cutoff, including the connections with the concrete wing core-walls, was about $21,000.

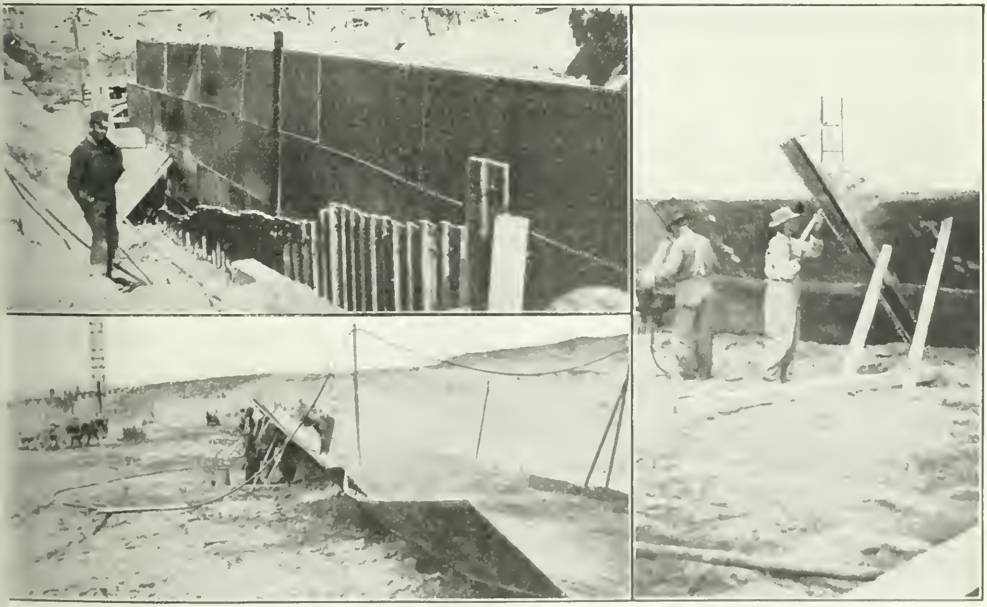


FIG. 5. ERECTION OF SHEET-STEEL DIAPHRAGM, SEVIER BRIDGE EARTH DAM, JUAB COUNTY, UTAH

The top of the sheetpiling is at about the elevation of the bottom of the reservoir (zero). To the piling were attached 4x10-ft. plates of copper-bearing Keystone steel, No. 10 gage, fabricated by the American Bridge Co. A detail of the water-tight connecting joint is shown in Fig. 4. The ends of the plates lapped over on the upstream face and were riveted with $\frac{3}{8}$-in. rivets, with $1\frac{1}{2}$-in. spacing. Every five plates, or at intervals of 50 ft., expansion joints made of U-shaped pieces of the same steel were placed (see Fig. 5).

The diaphragm was carried up vertically to an elevation of 61 ft., then bent in on a 1:1 slope to an elevation of 86 ft. (see cross-section, Fig. 4). About 30,000 sq.ft. of metal was used in the diaphragm. Besides the shop coat of red lead, the metal was given two coats of asphaltic paint, applied hot. Experience with steel drills left in holes in the outlet tunnel, constructed in 1905, leads to the belief that little deterioration will occur, for the river water is strongly impregnated with lime, which is precipitated and forms a protective coating on exposed iron and steel. The cost of the steel delivered at the dam was about $6,500 and the cost of erection about $4,500, making a total of $11,000.

The core-walls, which contain approximately 3,000 cu.yd. of concrete, cost complete, including excavation, about $30,000. The total cost of the water-tight curtain, steel sheetpiling, diaphragm and core-walls was about $62,000, or 8% of the total cost of enlarging the old dam, including land damages. Experiments show that the seepage through the fill has been practically stopped, but there exist some small springs on the downstream side whose flow is probably through fissures in the underlying rock.

The dam is known as the Sevier Bridge dam because its crest carries a highway. It is part of the reservoir and water-supply system of four large irrigation companies, namely, the Delta Land and Water Co. the Deseret Irrigation Co., the Melville Irrigation Co. and the Sevier River Land and Water Co. whose several projects cover more than 100,000 acres of land in eastern Millard County, Utah. The last named company, with offices in Salt Lake City, has administered the business detail of the enlargement of the dam and reservoir. J. R. Harsch is secretary of the Sevier River Co. The following engineers have been connected with the work: Charles Hardy, chief engineer, 1905 and 1906; R. R. Lyman, chief engineer, 1907 to 1913, and consulting engineer to date; D. G. Martin, resident engineer, 1914; C. A. Tush, consulting engineer, 1913 to 1916; and Clarence S. Jarvis, chief engineer, 1914 to date. The late James D. Schuyler made a study and a report on the enlargement of the dam and insisted on the necessity of a cutoff wall to at least 30 ft. above the bed of the river. Mr. Jarvis first suggested the steel diaphragm in 1914, originally intending it to be of corrugated ingot iron, but owing to the experience with Sevier River water already referred to, he changed to copper-bearing steel. Associated with Mr. Jarvis during 1915 and 1916 has been L. H. Kimball in direct charge of the construction of the diaphragm. A precedent for the metal diaphragm is the Avalon dam on the Pecos River, New Mexico.

* *

Condition of Iron in the Old Keokuk Bridge

By George C. Hinckley*

SYNOPSIS—A study in depreciation and obsolescence. Analysis of condition of the 45-year-old cast-iron and wrought-iron bridge across the Mississippi at Keokuk. Metal shows up remarkably well after many years of service.

During the past year, the old iron toll-bridge which spanned the Mississippi River at Keokuk, Iowa, for nearly half a century, has been dismantled and replaced by a modern double-decked structure, descriptions of which appeared in *Engineering News* of Aug. 5, 1915, and Apr. 13, 1916.

The old structure carried a narrow, combined highway and single-track railway floor. The decision to replace it was partly responsive to the popular demand that the highway and railway floors be separated, in order to relieve the congestion and provide a safe crossing for the rapidly increasing automobile traffic. It was due primarily, however, to the fact that the old bridge was too light to sustain with safety the increased loading from the modern rolling stock of its tenants, the Wabash Ry. and the Toledo, Peoria & Western Ry.

In these respects the old structure presents an interesting and typical example of obsolescence, due to inadequacy in the face of an increasing volume of traffic, and to its inability safely to sustain modern loads. But it is the purpose here to record the conditions of actual wear and deterioration due to nearly 50 years of use and exposure and the degree to which the strength and stability of the structure have been effected thereby. Reliable information of this kind is of value aside from its purely engineering value, in view of the widely divergent opinions and practices now existing with respect to the assumed "normal service life" of railway structures, and consequently to the assignment of corresponding depreciation reserves and sinking funds, and to the establishing of valuation rules and precedents.

The old bridge was a wrought-iron and cast-iron structure, designed by J. H. Linville for a live-load approximating Cooper's E-20, and built by the Keystone Bridge Co. in 1869 and 1870. It consisted of a 380-ft. drawspan, two 256-ft. and eight 165-ft. fixed spans. All of these were skewed through-truss spans of a modified Whipple type, otherwise known as the Linville-Pratt truss, with vertical end-posts, and double-intersection web systems, giving panel lengths of 12 to 15 ft.

The combined highway and single-track railway floor was supported upon Douglas-fir stringers resting at the anel points upon iron floor-beams. These were built up rom two wrought channels with cast-iron separators. nd stiffened by means of queen-post trusses consisting f wrought eye-bars and cast posts. The floor-beams ere hung from the lower chord pins by two short rought loop-rod hangers at each end. These passed own between the channels through cast yokes beneath. e connections being held more or less rigidly by means f cast saddles, fitting between the floor-beams and the wer chord pins, so that when the nuts on the lower ds of the hanger rods were tightened, the beams were amped tightly to the pins. No floor-beams were provided between the end-posts over the piers, these posts ing spaced laterally at their bottoms by cast struts and ng bolt-rods.

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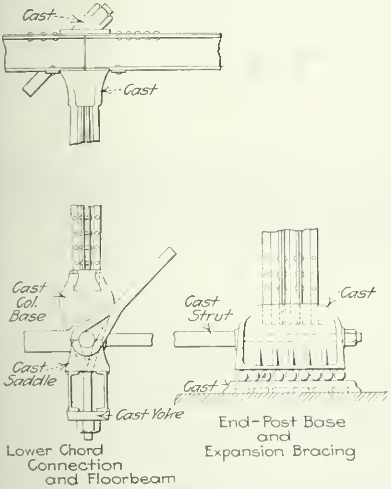
*Constructing Engineer, Keokuk, Iowa; Resident Engineer of the Keokuk and Hamilton Bridge.

The bottom lateral system consisted simply of adjustle wrought loop-rods fastened to the sides of the or-beams. The lower chords, except on the drawspan, re composed of wrought eye-bars, the end panels being med by loop-rods bolting through the cast bases of end-posts and stiffened by cast struts. The truss gonals were all square wrought loop-rods extending m the lower chord pins diagonally up through the top rd just over the posts where they were fastened by ans of large nuts screwed down against cast-iron chairs ting on top of the upper chord.



IG. 1. DETAILS OF TRUSSES OF THE OLD KEOKUK BRIDGE

The intermediate posts were built up of four rolled pes fastened together edgewise by rivets and spacers form open hollow Phœnix-like columns, tapering from center toward the ends, around which were molded cast-iron tops and bottoms. This is shown in Fig. 1. e cast tops abutted on the top chord without any tening whatever. The bottom castings were webbed l chambered to engage the upper half of the lower ord pins and act as spacers for the eye-bars. All the sts were set in loosely between the chords and were mped to secure positions by the tightening of the ts on top of the diagonals and by the action of the ss under load.

The upper chords were composed of sections of one-panel length, made up of two channels and two I-beams each, to which was riveted a single top cover-plate. These sections abutted over the intermediate posts but were not spliced, being held in position by the diagonals and the action of the loaded bridge. The vertical end-posts were built-up hollow wrought columns around which were molded cast-iron tops and bases. The upper chords simply rested upon the end-posts, being held down by the diagonals which passed up through the cast tops. The end-post bases rested either directly upon pier pedestal castings or upon expansion bearings consisting of nests of 2-in. rollers for the short spans and 3-in. rollers for the two long spans. Portals were all made up of cast-iron sections bolted together and to the posts. The top lateral system consisted of cast struts at the panel points and wrought adjustable loop-rod diagonals.

The drawspan was of similar design except that the upper chord sections were spliced to form a continuous bow-shaped member. The lower chords were stiff, being built up and spliced similar to the upper chords. There being no pins in the bottom chord, the diagonal rods and counters extended down through the chords to cast chairs, being held by nuts, precisely as at the upper chord points, while the intermediate posts were held in place between the chords, both at the top and bottom, by the tension in the diagonals. The drawspan trusses were provided with full systems of adjustable counters. The intermediate floor-beams on the draw were similar to those of the fixed spans and were similarly suspended from the lower chord by hanger bolts. The end floor-beams were built up from two channels with top and bottom cover plates, and were similarly hung from the lower chords.

The drawspan was a full center-bearing structure for all loads and positions, the live-ring rollers under the drum simply acting to steady the motion. The load was carried on a wrought-iron drum built up as a curved box girder with two webs. This was hung on the center bearing by means of adjustable radial rods extending inward and upward from the bottom of the drum to a large forged spider resting on an ingeniously designed double cone-roller bearing in the center casting. It was operated by a small reversible steam engine of approximately 12 hp., operating through the usual gear reductions to two opposite pinions on the drum engaging a cast-iron rack which was bolted with the lower roller-tread castings to the pier. The ends of the drawspan were raised by means of a centrally operated pair of hydraulic jacks and were wedged by a hand-operated mechanism. The engine and operating machinery were built about 1865 by William Sellers, of Philadelphia, Penn.

The substructure consisted of the abutments at either end of the bridge and 11 river piers, including the pivot pier of the draw-span. Of these, all but five of the smaller ones were built directly upon the rock bottom of the river, which at low water nowhere exceeds 8 or 10 ft. in depth. The remaining five piers were founded upon shallow timber grillages resting on the rock bottom. The pier masonry was quarry-faced ashlar, except that the upstream nose-stones, starlings and copings were hammer-dressed, and were laid up in mortar probably made from Utica (Ill.) natural cement.

and backed with large stones laid at random in spalls and mortar. All the stone was a local magnesium limestone. The pivot pier was a hollow structure with a solid center pier connected by four radial walls to an outer masonry ring.

During its 46 years of service the old superstructure was repainted five times, always with either red or white lead and oil. The original pine floor stringers were replaced with another set of pine timbers after ten years' service, and these were again replaced ten years later by Douglas fir stringers. These remained in service for the remarkable period of 22 years and were then found to be perfectly sound, except for dry-rot at their ends. In 1889, a new center casting was installed at the draw to replace the original one, which had been cracked by unequal settling due to the disintegration of the center coping stones.

Aside from the above, there has been practically no further outlay required for superstructure maintenance, except for the occasional replacing of a cracked yoke casting on the floor-beam hangers and for small current repairs to the operating machinery. On four or five of the piers, including the center of the pivot pier, the copings and top courses had become so cracked and loosened that it became necessary several years ago to reinforce their tops by means of cast-iron jackets set in grout and clamped on by long bolts. The piers have been repointed once and some patching has been necessary from time to time in order to repair stones broken by floating ice.

Observations covering a long period prior to the dismantling of the bridge disclosed the fact that several of the expansion bearings were not acting, but instead, that the vertical end-posts of the trusses were acting as rockers, fixed at their bottoms and carrying the span on their tops. Temperature stresses in the bottom chord had resulted in many cracked end-post bases, havin caused the end chord members to be pushed entirel through these castings in several cases. It is fortunat that in this type of truss the end sections of the bottom chord are not required to carry live-load stresses, a otherwise the conditions described above must have been attended with very serious consequences.

Upon dismantling the expansion bearings, they were found to be badly rusted without exception, and in some cases the rollers were incased in solid masses of rus and showed no evidence of having moved for severa years. While this condition, which was the worst encountered so far as rust was concerned, can be attribute in a measure to the fact that the roller nests were to compact and inaccessible for proper cleaning and ai circulation, it was caused principally by water accumulating in the bottoms of the hollow end-posts and base castings, which in freezing probably cracked the bases an gradually seeped down onto the rollers, keeping them continually wet.

Excepting the roller bearings, the structure was foun to be remarkably free from rust. The only instances noted that are worthy of mention were at some of the contacts between the upper chord and the top castings of intermediate posts, where the chord flanges had been reduced about $\frac{1}{16}$ in., corresponding to less than 5% of the chord section area. Also a few instances where rust had expanded under the edges of the chord cover plates, causing them to buckle between rivets which were too widely spaced, but not seriously reducing the sectional area. The threads on pins and hanger and diagonal rods were found in perfect condition, no difficulty whatever being experienced in removing the nuts. There were no signs of serious deterioration where the exhaust gases of locomotives had come in contact with the portals and top laterals, a condition largely due to the fact that these members were mostly of cast iron.

On the whole, the lower chord pin connections were found to be in uniformly excellent condition both as to wear and rusting. The pins themselves were practically free from rust pitting and no instance was noted where

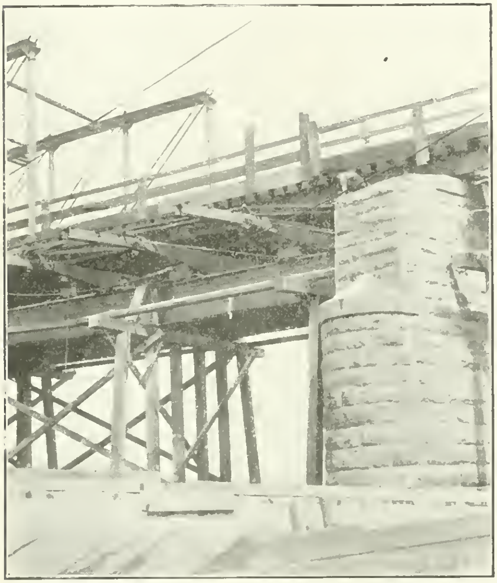


FIG. 2. DISMANTLING THE OLD KEOKUK BRIDGE ACROSS THE MISSISSIPPI

The view at the left shows the trusses partly dismantled, and the temporary track stringers and deck supported on falsework. The view at the right shows a pile of old truss posts, etc., beneath one of the new spans he wear from the chord bars or diagonals had exceeded ½ in., corresponding to about 2% of the pin-section rea. The pin holes in some of the chord bars showed little pitting, but no evidence of wear worth mentioning. he pin holes of the diagonal loop-rods, on account of eir elongated shape, allowed of motion on the pins arallel to the axes of the diagonals. Such a movement ust have occurred in several cases, as many of these n holes were found to be worn down as much as ⅛ in. their upper sides, where they lay on the pins, thereby sulting in area reductions up to about 5% of the effec-ve section of the diagonal.

This wear was obviously the result of the sliding of the ns down into the bottoms of the eyelets upon application the live-load, a fault due to loop-rod members which ve not been kept in good adjustment. The pin bearing rfaces on the cast bases of the intermediate posts were t noticeably worn, nor was any evidence of serious ar noted in the eyelets of the floor-beam hangers.

Considering the large percentage of cast iron in the d structure, there were surprisingly few cracked castings countered, aside from those mentioned in connection th the expansion bearings. At the ends of the draw-an the pedestal castings on the piers were found so dly cracked as to be worthless, a condition no doubt e to impact with the closing drawspan, which had ttled below its end clearance. Other instances of acked castings were confined to an occasional top chord air casting and a few floor-beam hanger yokes.

NO CRYSTALLIZATION FOUND

In view of its long term of service and the heavy erloading which the old bridge had been sustaining in ent years, it was expected that evidence of crystalli-ion would be found, especially in the diagonal tie-rods d floor-beam hanger rods. It is reliably reported, how-r, that during the past 35 years no failures whatever ve occurred which could be attributed to crystallization, th the possible exception of three or four broken unters and one main diagonal which had snapped off der the nut while it was being adjusted. The counters re said to have been adjusted too tightly, a condition quently encountered on railway bridges whose adjust-nts have been left to bridge foremen unfamiliar with elements of truss action.

The absence of crystallization was further demonstrated ring the process of wrecking the structure, when the agonal rods were burned off near their tops and were owed to fall or swing down onto the lower chords and r-beams in such a manner that nearly all the rods re bent and some were bent almost double. Moreover, of the wreckage was piled indiscriminately, and in doing a number of the chord bars and other wrought mbers were badly bent and twisted. Notwithstanding s severe bending not an instance was noted wherein rod or other wrought member had been broken or cked. Considering this behavior under treatment tly more severe than the standard drop and bending ts, it must be admitted that crystallization, if present all in the structure, had not reached a stage approach- the dangerous.

Practically all of the original operating machinery was l in use on the bridge when it was dismantled. The boiler had passed state inspection for the current year l was in fair condition. The engine showed considerable racking and lost motion, as did the gear train, where the teeth had been worn off an average of about one-third their thickness. The friction clutches, hydraulic jacks and other machinery were in fair workable condition. On the whole, it may be fairly said of the machinery, that it had reached that stage of depreciation when its future efficiency could not have been relied upon without constant and relatively expensive repairs.

CONDITION OF MASONRY

As the rebuilding of the bridge involved the removal of the top five or six courses of masonry from all the old piers, in order that new concrete copings could be substituted, the condition of the upper parts of the piers could be ascertained with accuracy. Below the new copings the piers were given a careful surface examination, the cracks and open joints being probed as well as possible, and the grillages and foundations being examined with the aid of a diver's outfit. On practically all of the piers the coping stones under the bridge seats were found to be cracked, while in some cases they were badly shattered and loose on their beds. That this condition must have existed several years ago on four or five of the piers, is evidenced by the cast-iron jackets, already mentioned, which were placed at that time.

This same condition was found generally true for the first few courses below the old copings, where the face stones were found to be loose and the backing more or less disintegrated, but except in one or two instances, this condition did not seem to extend below the starling coping courses. Several of the piers showed small, closed vertical cracks extending down from the bridge seats, sometimes to below the water line, but only in the case of one pier were they considered of enough moment to warrant rebuilding below the starling.

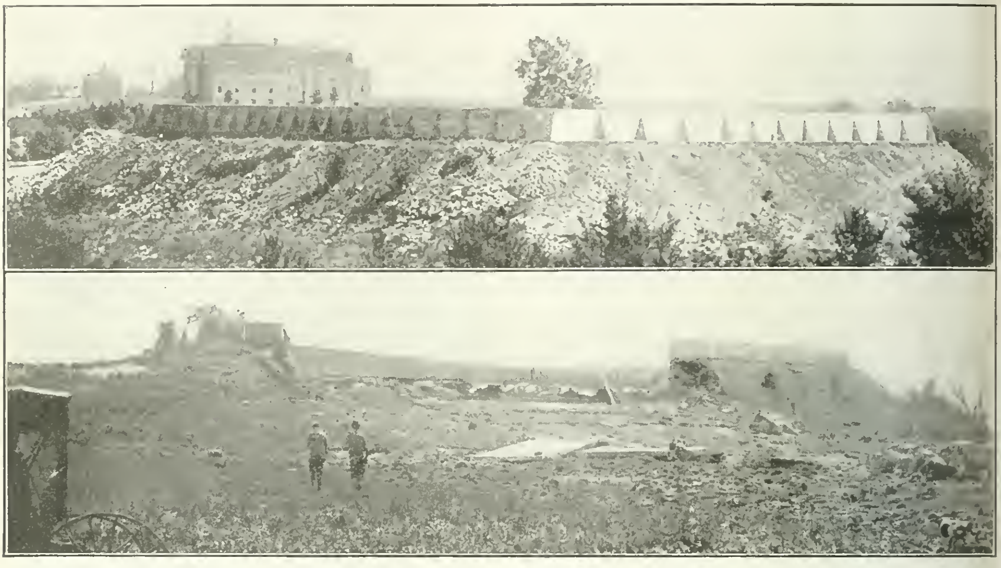
Between the high and low water lines at several of the channel piers, the nose stones showed the effects of ice erosion, some cases being noted where parts of stones were missing and their openings sometimes patched with concrete. This damage was not found to be extensive, except on one of the long span piers, where the entire nose had been wrecked and several of the stones carried away. Below the water line both the masonry and timber grillages were observed to be in uniformly good condition.

Considering the above details of deterioration with a view to their effect upon the ability of the structure safely to continue performing the functions and sustaining the loads for which it was originally conceived and designed, the one manifestly important conclusion to be drawn is that it had not nearly approached a state of general depreciation serious enough to impair its usefulness. With an expenditure estimated at less than 5% of the structure's value, to cover pier repairs, new expansion bearings, and partial renewal of operating machinery, there was no reason deducible from the foregoing data, why an additional 20 or 30 years of service could not conservatively have been expected of the structure. This would be attended, perhaps, by slightly increasing annual outlays for maintenance, and provided of course, that the weight and volume of the traffic should remain within the limits imposed by the original design.

The Strobel Steel Construction Co., of Chicago, had the contract for the removal of the old bridge and the construction of the new bridge. The latter structure was designed by Ralph Modjeski, Consulting Engineer.

Failure of Concrete Reservoir Built on Old Stone Wall

A concrete reservoir wall at Winfield, Kan., failed on June 6 under about the full head of the reservoir. The escaping water caused quite a flood in the neighborhood of the near-by St. Johns College, but little material damage was done to anything but the structure itself. The wall was of crude design, and its failure is interesting because of that fact and because, too, the city officials had been warned of the insufficiency of the design.



FIGS. 1 AND 2. ENLARGED RESERVOIR AT WINFIELD, KAN., BEFORE AND AFTER FAILURE

About 40 years ago an emergency reservoir was built on a slight height of land in Winfield, by inclosing a rectangular area in a masonry wall and filling outside to a normal slope. This basin was about 10 ft. deep and had the natural rock bottom. In 1914 the need for additional storage led the city to design a new wall, increasing the depth of the reservoir 6 ft. This consisted of a thin concrete lining reaching from the bottom of the basin, which was floored with plain concrete, to the top of the old wall, and with slightly increased thickness extending up the required 6 ft. as a buttressed concrete wall. The buttresses, as shown in the views, rested on an outside platform of concrete poured on top of the stone wall. The new reservoir was to have a capacity of about 1,000,000 gal.

The concrete in the new section was not reinforced in the original design. In an effort to persuade the city to build a more secure addition, a reinforcing-steel company submitted to the city the plans for a similar design, in

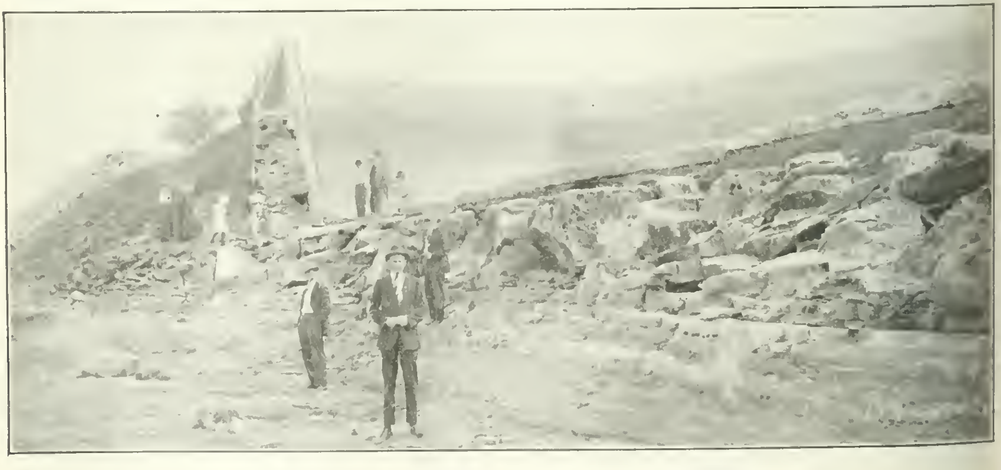


FIG. 3. NEAR VIEW OF BREAK IN WINFIELD RESERVOIR

which the floor was reinforced and the walls and lining were carried up as a reinforced-concrete slab tied into the floor, but depending for stability on the restraint given by the stone wall against which this slab backed. This design was made by a consulting engineer at the instance of the steel company and on the representation that the old wall was very carefully built of dimension stone and laid up in cement mortar—in short, that it was a ery good specimen of stone masonry.

The steel company submitted its design together with bid for $1,500 for the reinforcement, but it was rejected by the city on account of the extra cost and because of the opinion that the original design was fully strong enough. As a concession to the views expressed, however, a concrete floor was added (but it was not reinforced), and orizontal reinforcement was placed, extending about 3 ft. ach side of the corners in the vertical walls. The contruction was carried out on this plan, the resulting reservoir appearing as shown in Fig. 1.

The failure of June 6 washed out practically all of one de of the wall (Fig. 2), carrying the sections of concrete and old stone wall down the slope and washing out ractically all the old earth slope opposite the break. It thought that the first break occurred between the new oncrete floor and the new concrete lining and that the ater thus released easily passed through the stone wall, hich was anything but good masonry. Fig. 3 shows ery well the section and condition of the old masonry and he general form of the concrete addition. At places there ppears to be evidence of reinforcement, but the sections rods are very light and the distribution most general.

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New York Zoning Regulations*

The city government of New York has just put into fect by a virtually unanimous vote of the Board of stimate and Apportionment the radical and much talked zoning restrictions. All future buildings will be restricted as to their height, size and use, and the restrictions ll be different in different parts of the 327 sq.mi. of e city.

In general, the law will limit the height of buildings proportion to the widths of the streets on which they ce, all the way from 2½ times the width of the street the financial district, through two times the width of e street in central Manhattan, with 1½ times in the mainder of Manhattan and in small portions of the her boroughs, down to once the width of the street roughout all the rest of the city. A future Equitable uilding could only be a third as high, because it faces narrow streets; but a tower in the center of it, half large again as the Woolworth tower, might rise to any ight. The Woolworth Building, on the other hand, facing on a park, might be very nearly duplicated. he shopping district on Fifth Ave. will consist of ildings not much higher than Tiffany's, but along nd St. buildings may rise about as high as the Hotel nhattan or the Knickerbocker. Twelve- and 11-story artments will continue to go up on the main avenues d eight and nine-story apartments on the side streets, ut no building of any kind can go any higher except being set back from the street. Throughout most of the y, however, four or five stories will be the limit. Towers may be built to any height, but they can not cover more than a quarter of the lot. Mansards, dormers and terraces are encouraged—anything that will open up the streets and bring light down into them by setting the upper part of the buildings back from the street above a reasonable height.

The size of buildings will be controlled by the fact that the law requires just so much open space on each lot. This again ranges all the way from the warehouse districts along the commercial waterfront and along the freight railways, where a building may cover the whole of its lot, through the B, C and D districts so called, in each of which in succession a building has to provide for larger and larger yards and courts, down to the villa districts where a house can cover only 30% of its lot and must be widely separated from its neighbor on at least one side. Throughout Manhattan and the densely built-up portions of the other boroughs, yards and courts in office buildings, factories, lofts, hotels, apartments, in fact all buildings, would have to be as large as those that have been required for the last 11 years in tenement and apartment houses. Everywhere the yards and courts have to be increasingly larger at the top as a building goes up in height, so much so that these requirements tend to limit the practicable economic height of buildings even more effectively than do those directly affecting height. This is particularly true in the outlying boroughs. One important feature of the law is the encouragement it gives to playgrounds, for material concessions are allowed to anyone who will provide adequate recreational space in connection with his buildings.

Right here it is desirable to sound a note of warning. It would be most unfortunate if the law were applied as it stands to other cities, for it is full of unduly liberal provisions in the way of height and size that tend strongly to defeat the object of the law, but which were necessitated by the exceptional economic conditions of New York.

As to the use of buildings there are only two general classes of restrictions: (1) The districts which are restricted against business and industry of all sorts, the so-called "residence" districts, and (2) the tracts which are restricted only against manufacturing and public stables and garages, the so-called "business" districts. In the former almost any kind of building that people live in is allowed, also churches, schools, hospitals and various institutional buildings. In the business districts any residence use is allowed and even a certain small proportion of the unobjectionable types of manufacturing. The use districts have been laid down street by street and in fact block by block, depending on existing conditions and tendencies. The result has been that about two-fifths of Manhattan and about two-thirds of the whole city have been set aside for all time for strictly residential use, while the main thoroughfares, the transit streets and all other streets that are or might be appropriately used for stores or showrooms are set aside as business streets. Many streets which are now seriously invaded by factories or garages are restricted against them from now on, because it was felt that they were a distinct harm to the street. On this ground all of the central part of Manhattan above 23rd St. was made a business district despite the fact that there were already hundreds of factories employing in all upward of 30,000 operatives within the district. This law will not touch the existing factory lofts, as it is in no sense retroactive; but the

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*From a statement by George B. Ford, Consultant to the nmission on Building Districts and Restrictions, New York y.

"Saving New York" movement, in which most of the merchants along Fifth Ave. combined to oust the factories in the neighborhood, has already succeeded in persuading almost all the manufacturers to move away. It was a remarkable and timely vindication of the economic need of this law.

All the rest of the city which is not in one or the other of these two kinds of districts is left unrestricted. It includes all the land appropriate for industry along the navigable waterfront and along the freight railways, as well as most of the territory which is now given over to manufacturing. It includes also scattered throughout the city a number of blocks which are already invaded by public garages or which are appropriate for that use. Certain other areas, especially around Jamaica Bay and along the shores of Staten Island, are left entirely undetermined in their use pending the working out of the plans for the port and terminal facilities of New York.

The law will be administered by the city superintendents of buildings in each of the five boroughs; and in so far as it affects tenement houses the law will be administered by the tenement-house commissioner, while the following up of buildings after they are completed will be under the jurisdiction of the fire commissioner. In any case, wherever there is any question about the application of the law in a specific case, the matter can be taken to the newly constituted Board of Appeals, which is the board of review for all matters that relate to the construction or use of buildings. In addition, the law has in it a number of specific clauses giving the Board of Appeals discretion in allowing exceptions to the law.

The law itself can be changed only by the Board of Estimate and Apportionment, which created it, and this body can, after due notice and hearing, make amendments at any time; but if in any case 20% of the property owners affected by a change object, the Board of Estimate can make the change only by a unanimous vote. There is also a clause which says that if on any street or district 50% of the property owners sign a petition for a change in the map as affecting that district, then the Board of Estimate must act on it in one way or another within 30 days.

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Continuous Package Elevators on Philadelphia Piers

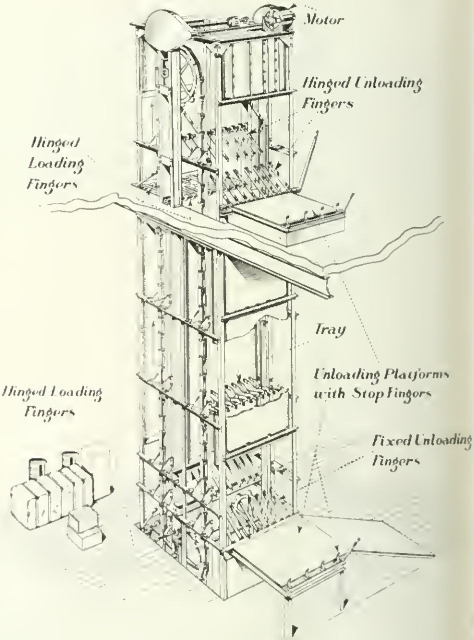
By Henry J. Edsall*

In order to facilitate to the greatest possible degree the handling of freight on the new Southwark piers in Philadelphia, it was the aim of the designers to provide the most modern types of equipment. The piers are therefore liberally provided with platform elevators, continuously operating package elevators, chutes, electric winches and automatic electric freight trucks. These piers, described in *Engineering News*, Aug. 26, 1915, p. 421, are at the foot of Queen and Christian St. and front on Delaware Ave., which is a very wide street along this part of the Deleware River waterfront. Each pier is 550 ft. long by 180 ft. wide, and the docks, on each side, are 200 ft. in width. At the inshore ends there are bulkhead sheds 30 ft. wide, extending along Delaware Ave., thereby increasing the cargo storage space and providing additional platform room for loading and unloading trucks. The substructures of the piers are of a permanent construction with massive concrete walls supported by groups of piles. The shed of each pier, of fireproof steel and concrete construction, is built with an upper deck 26 ft. 6 in. above the main deck.

The continuously operating package elevators are of more than usual interest, since they are of the latest improved design and are probably the largest installation of this kind in existence. These machines, of which there are four on each of the two piers, are arranged to handle bales, barrels and boxes and are automatic in their operation, it being necessary only to load the package onto the loading fingers, after which one of the trays picks it up and discharges it at either the upper or lower deck as desired.

Essential Elements of Elevators

These elevators consist, essentially, of two strands of heavy steel strap chain, with steel trays attached to the chains at intervals, by means of hangers at the ends, these hangers being hung on pins extending out from the chains. The chains travel around sprocket wheels at head and foot, but the hangers of the trays always hang vertically and the tray bottoms always remain horizontal. These trays are made with I-beams extending across centrally between the hangers and with fingers made of flat irons on edge attached to the beams at intervals and extending across them at right angles. This construction forms a tray bottom with slots between the fingers so that, at the loading and unloading points, other fingers can extend into these slots and either hold the package until it is picked up by a tray at the loading point or remove it from a tray at the unloading point.



PERSPECTIVE VIEW OF CONTINUOUS OPERATING PACKAGE ELEVATORS, SOUTHWARK PIERS

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*Engineer, Link-Belt Co., Nicetown, Philadelphia, Penn.

While machines of this type operate at slow speed and equire little power, because of the slow speed, and also ecause the up-and-down sides balance each other, xcept for any excess of load on one side or the other, till their handling capacity is great since the trays move onstantly in one direction and come along at close ntervals. In this case, the speed is only 30 ft. per min. nd the trays are spaced a little over 14 ft. apart so that hey come along at the rate of about 2 per min., or 120 er hr. There are four of these machines on each pier o that the combined capacity is over 480 packages per our. The detail construction of these machines is as llows:

Framing of Machines

The framework of each machine is built of steel apes, the corner members being 6x6x½-in. angles. nstead of the headshaft running through from one side the other there are two studshafts. These studshafts e supported in heavy bearings, or brackets, attached tween two vertical 10-in. channels, these channels aming into one of the girders of the upper deck on e side and into one of the deck I-beams on the other de. The footshaft runs through, and each takeup aring for this shaft is bolted to a ¼-in. plate attached two 3x2x¼-in. angles that, in turn, are attached to e main frame. At intervals there are 3x3x¼-in. gles forming girts around the frame. These girts are veted to the corner angles. In between the ascending d descending trays there are double 2½x2½x¼-in. tie gles and at the loading and unloading points heavier s of double 8-in. channels and, in one case, an 8-in. beam, these ties also forming supports for the inside ding and unloading fingers.

For the ascending and descending chains there are uble 4x3x$\frac{5}{16}$-in. angles to form guides. These angles attached to the girt angles. There are also two 3x¼-in. vertical angles on each side that are riveted the girt angles and to the crossties. At the front d back of both the ascending and descending trays re are ⅛-in. guide plates extending all the way across that the packages going up or down are confined tween these plates which are riveted to 2x2x¼-in. rtical angles that, in turn, are attached by means of p angles to the girt angles for the outside plates and crossties for the inside plates.

The girt angles around the top of the frame are 6x⅜-in. angles. These support the bearings for two untershafts and also the motor, which is bolted to a te that is riveted to the angles. There is an unload- platform 15 in. above the upper deck and one 3 ft. in. above the lower deck. These are built of angles d channels with steel-plate bottoms. At the outer end re are hinged stop fingers keyed to a shaft and ranged to be raised or lowered by means of a lever. ese stops are designed to keep the packages from going r the edge of the table when they are discharged to it.

Details of Tray Construction

The trays are built as follows: The hangers are built 5-in. channels and have a drop of 3 ft. 8 in. from center of the pin to the top of the cross I-beam. om out to out of hangers it is 5 ft. 8 in., which leaves ut 5 ft. 4 in. clearance between the hangers for the kages. At the top of each hanger there is a casting through which the 1⅜-in. pins extend. This casting is also designed to travel between the vertical guides. At the bottom of each hanger there is another casting that travels between the guides and prevents the trays from swinging when they are ascending or descending. The I-beam across between the hangers is a 6-in. beam and the fingers across the top of this I-beam are made of 2x¾-in. flats. These flats are bent down in the center so that a barrel will rest in the center of the trays and not roll out sideways. The clearance between the flats is 6¼ in.

The chains that carry the trays are built of 2x⅜-in. flats and are 12 in. pitch c. to c. of joints. These chains have ⅞-in. pins, 3¼-in. diameter rollers and case-hardened steel bushings at the joints.

The loading and unloading fingers that extend into the slots of the trays are built of steel angles, the ones at the unloading point on the lower deck being fixed in position and the others being hinged so that they can be thrown back out of the way. When sending packages from the lower deck to the upper deck, the lower-deck loading fingers and upper-deck unloading fingers would be in position, and the upper-deck loading fingers would be thrown back out of the way so that packages could pass this point, as it is necessary for the packages to travel up and over the head so that the unloading fingers can remove them from the trays as they are descending. When sending packages from the upper deck to the lower deck, the reverse is the case—that is, the upper-deck loading fingers would be thrown into position and the upper-deck unloading fingers would have to be thrown back out of the way so that the packages could travel up over the head and down through the unloading point on the upper deck until they reach the unloading point on the lower deck, where the fingers are always fixed in position. In order to hinge the fingers, the angle-irons are attached to cast-iron hubs that are keyed to shafts.

Each of these machines is driven by a 5-hp. motor, operating at 900 r.p.m. and wound for a 220 volt, three-phase, sixty-cycle, alternating current. Each motor is equipped with a solenoid brake so that the machine can be stopped quickly when desired. The drive from the motor to the first countershaft is by means of silent chain and wheels, this countershaft being geared to the next countershaft by means of cut spur gears. The second countershaft is, in turn, geared to the headshafts by means of cut spur gears, these gears being cast as rings without arms or hubs and the rings being bolted to the sprocket wheels on the headshafts. The sprocket wheels are bushed with bronze bushings and run loose on the headshafts. The countershaft next to the motor is $2\frac{3}{16}$ in. in diameter, the other one $2\frac{7}{16}$ in. in diameter, and the headshafts are $4\frac{7}{16}$ in. in diameter. The electric-control system is arranged with push buttons for starting and stopping the machine.

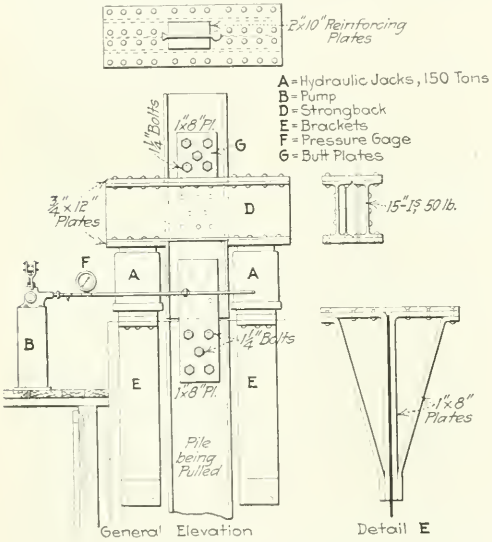
This equipment makes a very efficient system for handling packages of various kinds. The machines tend to act as pacemakers for the stevedores and keep them constantly at work on one deck without the necessity of their going back and forth from one deck to another. The machines were installed by the Link-Belt Co., under the direction of John Meigs, at that time Director of Wharves, Docks and Ferries. George W. Norris was director at the time the piers were designed, and George S. Webster is the present director.

Field and Office

Pulling Steel Sheetpiles from Earth-Filled Coffer-Dam

By D. A. Watt*

In the construction of the new lock and dam across the Hudson River at Troy, N. Y., a part of the river was laid dry behind a coffer-dam made up of steel sheetpiles driven to form cells which were filled hydraulically with sand and gravel from the river channel. The pockets, or cells, had a width of 24½ ft., a length of 24 to 32 ft. and a depth varying from 20 to 40 ft. About 3,170 piles were used, and when the coffer had served its purpose they all had to be drawn. The piles were of the United States section, made by the Carnegie Steel Co. of Pittsburgh, Penn.



RIG USED IN JACKING LOOSE STEEL SHEETPILES FROM TROY COFFER-DAM

In this operation, owing to the tension in the interlocks, each pocket had to be "broken" by raising one pile with hydraulic jacks until its friction became reduced enough to allow the removal to be completed with shear legs. The latter were mounted on the bow of a derrick boat and were capable of exerting a pull of perhaps 40 or 50 tons. They were used to lift out the remaining piles until some were reached where the friction became comparatively negligible, whereupon the rest were pulled by a derrick boat with ordinary rigging.

The pile selected for jacking had to be on the outer face, so that the pulling boat could reach it later, and the closure piles were avoided as it was found that the friction on them was excessive.

The pulling device is shown in the accompanying drawing. Two hydraulic jacks of 150-ton capacity each were used, mounted on heavy bar-iron brackets resting one on each adjoining pile. Across the jacks a strongback was placed with a short extension pile passing through it, bolted to the pile below. After each lift of the jacks, blocking was placed under them and another lift made; if the blocking became too high before the pile became "easy," it and the extension pile were removed, the jacks were put back on the brackets, the 1×8-in. bearing plates were attached to the main pile, and the jacking was resumed.

The jacking of these key piles took from one to several days (including the time for fitting up, drilling, etc.), depending on their obstinacy. In several instances the pile chosen had to be abandoned and another one tried, as the bolt holes would elongate in the web and sometimes tear out its end. The limiting pulls for starting varied from 25 to 190 tons per pile; but in a few cases, where the driving had been tight, the pockets could be broken by the shear legs, and no jacks were used. A flux of kerosene and engine oil was frequently poured down the interlocks in order to assist the jacking.

Several other methods for removing the piles were experimented with, but that described above was found to be the most satisfactory. Thus, an inverted steam-hammer hung from a derrick was used in several cases; but the breakages of the hammer rendered the method slow and expensive, and with obstinate piles no effect could be produced. A toggle arrangement was also tried in order to avoid having to drill the webs for the 1×8-in. plates, the toggles being hinged to side bars that straddled the pile and rested on the jacks, following them up or down. The toggles gripped the piles satisfactorily; but under a heavy strain they tended to crush their tool-steel faces, and their use was finally abandoned. With piling driven for deep sheeting and out of the reach of the boats, the most satisfactory results were obtained by using the powerful shears taken off the derrick boat and set on the ground. Where these failed to get a pile, as happened in a few cases, it was abandoned. In pulling the piles the best record for one boat in 8 hr. was 58, and the general average for one boat in 8 hr. was 12.

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Double-Derrick Platform for Large Caisson Job

In sinking a large open-dredging caisson for the substructure of the Lifton pumping station of the Utah Power Co. at Bear Lake, Utah, the Jarrett-Chambers Co., contractor, used two sets of double derricks for the timber erection and excavation. As the caisson is high out of the ground at the start and when the second build-up is added, the derrick platforms are placed 15 ft. above ground. This height permits running a material track under the platforms. Timber for the caisson was brought in on the track, and, later, excavation spoil was carried away.

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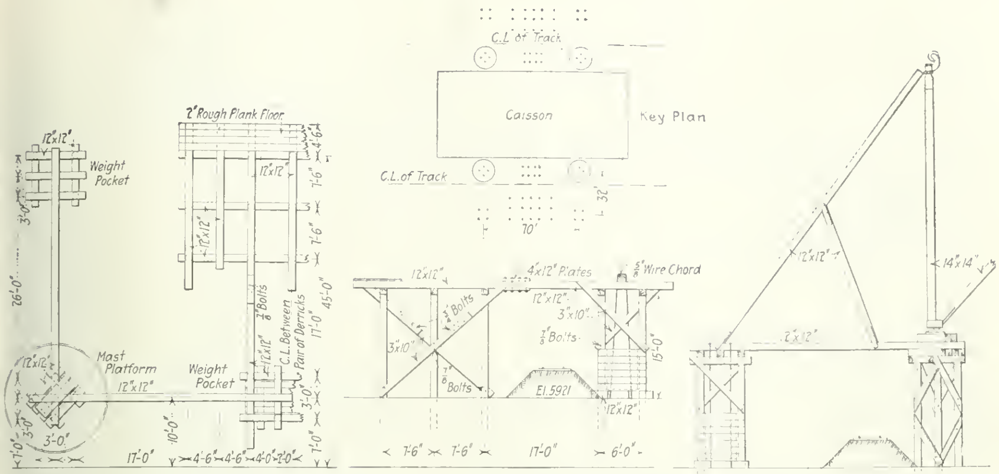
*Principal Assistant Engineer, United States Engineer Office, Albany, N. Y.



PLATFORM FOR TWO DERRICKS FOR FRAMING AND SINKING OPEN-DREDGING CAISSON
Designed and built by Jarrett-Chambers Co. for substructure caisson of Lifton Pumping Station, Bear Lake, Utah

The drawing shows the construction of a platform or two derricks, with three weight pockets to tie down he stiff-legs. The mast load is taken by a four-pile tower, raced by diagonals. This tower being very close to the ide of the caisson, flows of ground during the sinking roduced settlement of the tower on one or two occaions. Except for this the derrick structure was stable nd satisfactory throughout. The soil, a fine sand tightly acked, was able to carry large pile loads.

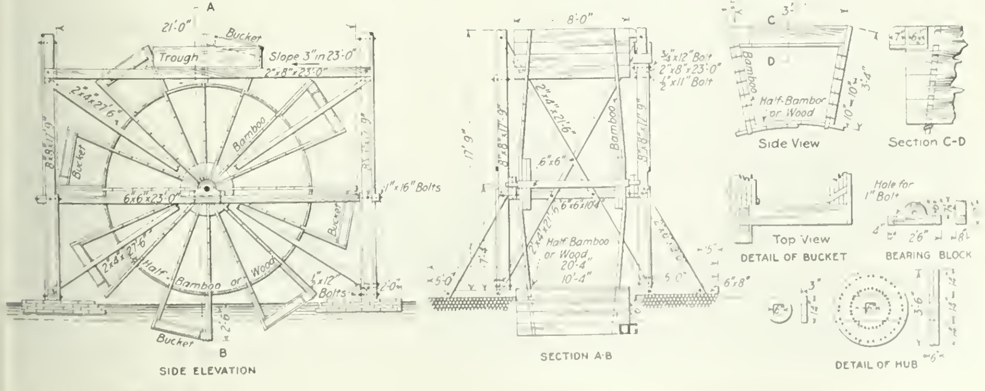
* * *

ight Home-Made Waterwheel for Irrigation

The Cotabato River in the Province of Cotabato, P. I., t low stages is from 10 to 20 ft. below banks, and the verage velocity of the current is 3 mi. per hr. A waterheel built cheaply and intended to serve as a pattern r the Moros was recently placed at Kudarangan. The urrent is used to raise water to irrigate land belonging the agricultural school of the district. This wheel is described by A. E. Haley, District Engineer, in the *Quarterly Bulletin* of the Bureau of Public Works, Manila.

When the wheel was first erected, it revolved so rapidly that spokes were torn from the hubs and a large amount of bracing was necessary to prevent its being destroyed. The wheel is set on A-frames that rest on rafts anchored in the river in such a way that the wheel revolves in flowing water between them. The wheel consists of two parts, each having 16 bamboo spokes set in a hub 24 in. in diameter. The hubs are set 9 ft. apart on a 6-in. axle, and the spokes are nearly 8 ft. apart in the perimeter of the wheel. The paddles are formed of 12x$\frac{3}{4}$-in. boards 8 ft. long. The buckets are of bamboo set diagonally and alternately between the paddles, so that there are eight in the wheel.

Measurement showed that the wheel lifts about 25 gal. per min. or 40,000 gal per day, when operating in water flowing at 3 mi. per hr. Each bucket carries 1 gal. of water, and the wheel makes a complete revolution. A revolution requires 70 sec.



THIS DESIGN WAS DEVELOPED AFTER VARIED EXPERIENCE, AND IS RECOMMENDED FOR LIGHT IRRIGATION WORKS

Experience has demonstrated that future wheels for this service must be more strongly constructed. A bamboo wheel is soon torn to pieces by the current. The wheel shown in the sketch is of more substantial design than the one described, and is recommended to rice growers. It has eight buckets, is strong enough to stand a 3-mi. current and should irrigate about 4 hectares of land on a 10-ft. lift instead of 1.5 hectares on a 17-ft. lift, as did the older wheel.

⁂

Mill Creek Sewer Tunnel Alignment Survey

By R. C. Gans*

The Mill Creek relief sewer in St. Louis, just completed, is a 16½-ft. lined tunnel through solid rock. Following an irregular street layout, it is very tortuous, having in its 18,000 ft. of length a total curvature of 905° with radii varying from 85 to 400 ft., most of them less than 200 ft.

The shafts on this tunnel vary from 1,600 to 4,000 ft. apart, and the length of shaft in the direction of the tunnel was rarely over 12 ft. It was therefore necessary to employ unusual precautions to secure accuracy of alignment.

The final survey was made in August, September and October, 1914. The survey party consisted of the engineer in charge, an instrumentman, three tapemen and a helper. The transit used was a Buff & Buff theodolite, the vernier reading to 10″. The 100-ft. steel tape was a Keuffel & Esser flat-wire "standard" tape without intermediate graduations. The tape was always made level, and passed over adjustable supports at the middle and quarter points. Temporary station-marking tables were used. These were 4-lb. cast-iron disks on three short supporters and bearing an adjustable point. After the head table was set, the rear table was carried forward and used as the head table.

In order to obtain an unbiased check measurement a stationary point was set only every 1,000 ft., or at a change of direction. After trial an allowable error in chainage of 0.02 ft. in 1,000 ft. was adopted, and we had comparatively little difficulty in keeping within this limit. At curves the work was checked by triangulation. In many instances the center line passed under buildings or car tracks, thus making important points inaccessible, which required extra checks.

The survey was marked by permanent monuments (Fig. 1) placed at convenient intervals, such as summits, intersection of tangents at reverse curve, near the shafts.

The center line was first established in the tunnel by means of two plumblines in the shaft and maintained by means of screw-eyes set in plugs in the roof of the tunnel. When the heading had been driven about 300 ft. from the shaft, the center line was again established by setting one plumbline in the shaft and one in a drillhole near the heading, which had been previously drilled for this purpose. Fig. 4 shows the relative location of shafts and drillholes. Fig. 3 shows two views of the plumbing device and reel as placed at a drillhole. At a shaft they were usually placed on the shaft timbers. The plumb-bobs were 11½-lb. cast-iron weights suspended in oil. The plumbline was No. 12 piano wire. For underground work a transit of Berger & Sons manufacture was employed.

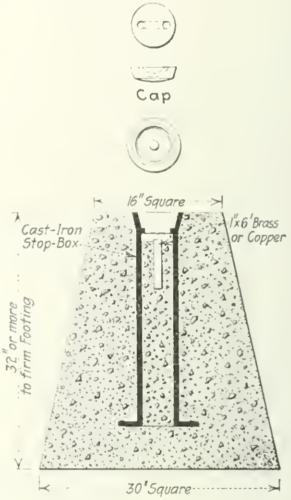


FIG. 1. PERMANENT SURFACE MONUMENT

The drillholes above mentioned were 12-in. cased to solid rock, and 10 in. uncased through the rock. The contract for these holes required that they clear a plumbline. Seventeen holes were ordered drilled; the contractor lost three through failure to meet the above requirement, and two others were abandoned on account of failure to shut out water with the casing. The holes were tested by suspending a candle in a funnel reflector, or a flashlight, near the bottom of the hole.

The results shown in the adjoined table of survey-line closures prove the value of the precautions taken.

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*Assistant Engineer, Department of President of Board of Public Service, St. Louis, Mo.

FIG. 2. SURFACE MEASUREMENT FOR MILL CREEK SEWER TUNNEL, ST. LOUIS

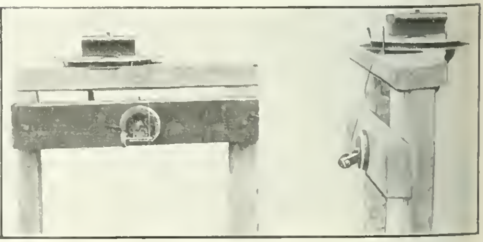

FIG. 3. PLUMBING DEVICE WITH SCREW ADJUSTMENT USED AT DRILLHOLES

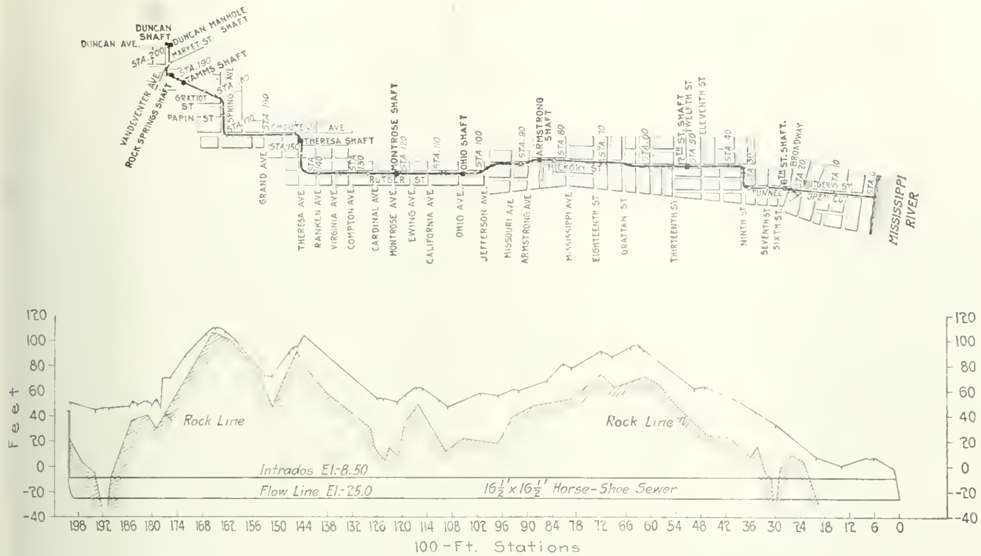

FIG. 4. LOCATION MAP AND PROFILE OF MILL CREEK SEWER OF SHAFTS AND DRILLHOLES

SURVEY-LINE CLOSURES AT JUNCTION OF HEADINGS

Headings	Lengths of Tunnel, Ft.		Error at Meeting Point, Ft. In Line	In Distance
Sixth St. and 12th St.	1,400	1,400	0.002	Not measured
12th St. and Armstrong ..	2,000	1,500	0.015	0.03
Armstrong and Ohio	1,300	600	0.12	0.08
Ohio and Montrose	500	1,100	0.05	Not measured
Montrose and Theresa ...	1,500	1,500	0.16*	Not measured
Theresa and Tamm	1,900	1,900	0.025	0.005
Tamm and Rock Spring.	270	130	0.025	0.03.
Rock Spring and Duncan	40	800	0	0.035

*In the heading south and east from Theresa shaft an error was known to exist when we passed a drillhole on Rutger east of Theresa. This error was not expected to exceed 0.2 ft. at the meeting point, and no attempt was made to eliminate it.

⁂

Methods of Enlargement Work in Rogers Pass Tunnel

By H. P. Tracy*

The ingenious drilling and blasting system used in the Rogers Pass tunnel of the Canadian Pacific Ry. had much to do with the phenomenal speed of advance attained by the enlargement excavation. The following description supplements the accounts of the Rogers Pass work given in *Engineering News* of Nov. 11, 1915, p. 920; Jan. 6, 1916, p. 42; Feb. 24, 1916, p. 382; June 1, 1916, p. 1031, in which articles the use of the pioneer tunnel and crosscuts to the line of the main tunnel was fully set forth.

The tunnel, now nearing completion, is 26,100 ft. long and provides for two tracks. Pioneer tunnels were driven from each end 50 ft. to one side of the main line and were stopped when they were 5,202 ft. apart. From these small pioneer drifts, crosscuts were run to the main line at intervals of 1,500 to 2,000 ft., thus affording numerous points of attack along the main-tunnel line. From the crosscuts a heading 11 ft. wide and 9 ft. high was opened up, on a level 6 ft. above the completed tunnel floor. From this heading the work of enlarging to full size was conducted.

In the enlargement the method followed was to drill a ring of holes (Fig. 2), the rings being drilled 5 to 6½ ft. apart. To determine the correct angle for drilling the holes, a clinometer was employed when pointing the drills. This clinometer board, or "clock," as it is called by the drillers, is made of $\frac{3}{16}$-in. sheet iron 12 in. square, with a handle riveted on the upper edge. As shown in the sketch, there is a pendulum hanging from one of the upper corners. Graduations on the board show the angle at which each hole must be drilled, and at the lower end of each graduation is a number showing the length of steel to be used in finishing that hole. After setting the board on the shell or drill, the drill was tilted until the pendulum reached the proper angle, when the drill was clamped. A different board was used for each arm of the drill column. When enlargement work was first started, the rings were drilled 6 ft. apart. It required

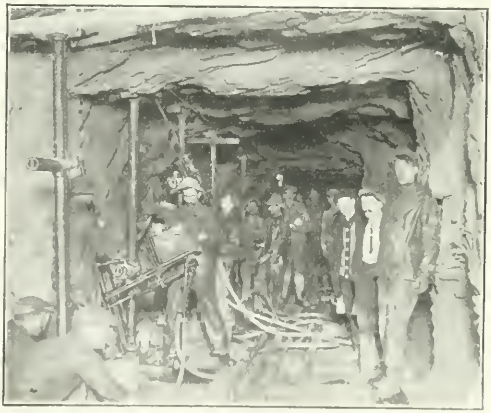

FIG. 1. RING DRILLING IN MAIN HEADING

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*Denver Rock Drill Manufacturing Co., Denver, Colo.

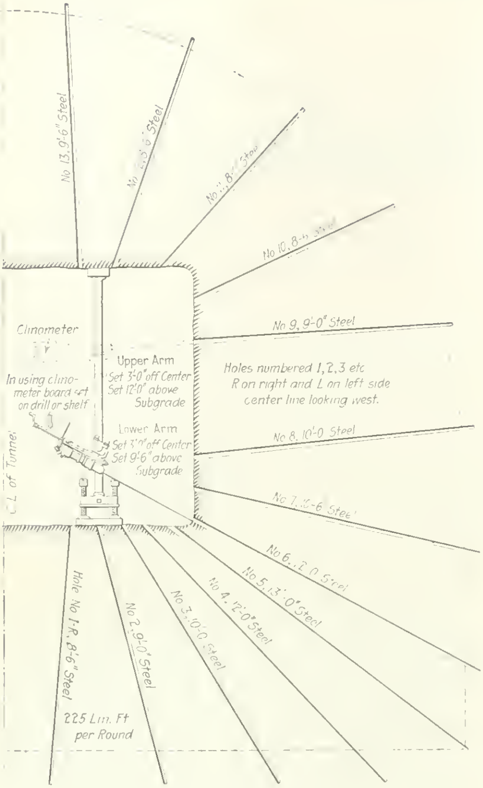


FIG. 2. COLUMN AND DRILL SETTING IN RING DRILLING, ROGERS PASS TUNNEL

The use of the clinometer board is an essential feature

a great deal of powder to spring the holes, and therefore the distance between rings was reduced to 5½ ft. This necessitated less springing; when later on they reduced the distance between rings to 5 ft., they found they could dispense with springing entirely, with a corresponding large saving in powder.

One of the clinometer boards in use is shown in Fig. 1. The drill runner with the machine on the second column in the foreground is shown pointing his drill with the aid of one of these boards. Denver "Dreadnaught" valveless water hammer drills were used.

This method of enlarging permits the employment of a large battery of drills all along the line of the tunnel. It has resulted in remarkably rapid progress, not only as to drilling, but also as to mucking, for it facilitates the use of the shovel by blasting out the tunnel to full section with every ring of holes fired.

The tunnel being large enough to accommodate two standard-gage tracks, the shovel operated from one track while the muck cars were backed in alongside on the other. Two high-pressure compressed-air locomotives in each end took care of the haulage. They have a storage capacity sufficient to carry them one mile with a regular load, and 2-in. high-pressure air mains in the tunnel provide air stations about 2,000 ft. apart.

The force for mucking out each end is as follows for each shift: 6 men scaling, trimming and loading rounds ahead of shovel; 1 engineman and 1 craneman on the mucking shovel; 10 to 12 pitmen at the shovel; 1 general foreman; 1 foreman and 12 to 15 laborers for the dump and track work; engineers and brakemen, 1 fireman, 1 steam conductor and 2 repair carmen for the hauling locomotives and cars.

The contractors for the tunnel are Foley Brothers, Welch & Stewart, of Winnipeg; A. C. Dennis is their Superintendent. The work is under the direction of John G. Sullivan, Chief Engineer, Canadian Pacific Ry., and W. A. James, Engineer of Construction.

NOTES

Flat-Cars with False Floors for Dumping have been used in grading an extension of the logging railway of the Crossett Lumber Co., at Crossett, Ark. The arrangement was devised by J. R. Horton, Roadmaster for the company. The construction train consisted of three flat-cars, the middle one carrying a light revolving steam shovel or railway ditcher. Each of the other cars had a 14-ft. floor built up in two longitudinal sections 7 ft. wide. Timbers on the bottom raised the platform clear of short stakes in the stake pockets, and on each side one of these timbers rested just inside the line of stakes

Plumb-Line Reflector—A useful and easily constructed reflector for use in underground surveys or for night work can be made as follows: Take a piece of any good strong wire and bend it in the form of a circle with a handle attached, and fasten a piece of tracing cloth over it, after the manner of a drum head. This device, when held back of a plumb bob and string with a lamp behind it, will diffuse the glare of the light and give a perfect shadow for a sight.—"Coal Age."

A Good Way to Blast Pole Holes is to put down a borehole almost as deep as the pole hole is to be, and tie small charges of dynamite at intervals of several inches to a straight stick or lath, which is placed in the borehole. The topmost charge is primed with a blasting cap or fuse. Forty per cent. or stronger dynamite should be used. It is preferable to spade out the surface to a depth of several inches before firing.

A Road-Patching Machine is used by the Los Angeles County Highway Commission for repairing bituminous-paved roads. The machine consists of a tank and firebox for keeping the oil at such temperature that it can readily be pumped and sprayed with a small hand pump. Three men operate this machine; one pulls it, one operates the small hand pump at the rear and the third handles the spray hose. The oil is first heated in a large vat and carried in buckets and poured into the front end of the machine. Wherever a patch is required the road surface is picked out to a depth of 4 or 5 in. and the hole thoroughly cleaned. Broken stone is then placed in the patch and rolled with a steam roller. Oil is sprayed over the surface, covered with screenings and rerolled.

PATCHING MACHINE FOR BITUMINOUS PAVEMENTS USED BY LOS ANGELES COUNTY

Editorials

Engineers Can Vouch for This

When a private concern wishes to engage an engineer its main concern is to get the best man he can find for the job. With most cities other considerations come first. Only one of these will be considered here and that but briefly. This consideration, which is one of the worst in the lot, is the local residence requirement. How this makes for inefficiency, not merely in the particular city, but also throughout the whole country, is set forth under five heads in a recent number of "The Public Servant." Says Prof. Clyde L. King of the University of Pennsylvania:

> The local residence requirement for public office (1) tends to perpetuate mediocre technical and expert service, (2) means the continuation of party spoils, (3) makes impossible adequate training for all experts and (4) a national supply of xperts, and (5) is therefore one of the biggest obstacles to he American ideal of an efficient democracy.

Even a large city, with an abundance of technical men o draw from, makes a mistake in barring non-residents from public office, because it lessens its range of choice nd deadens the ambition of local men, whether in or spiring to municipal positions. The case grows worse s the size of cities diminishes. It is for the interest of good government and of the engineering and other professions as well that the dwarfing effect of local resience requirements be abolished and that every city be ree to select the best man the country affords for each position to be filled.

⁂

May Peace Be Purchased at Too High a Price?

The nation has witnessed an unprecedented spectacle uring the past fortnight. There have been assembled at Washington the heads of the brotherhoods of railway rainmen and over a hundred railway presidents and managers, discussing with the President of the United tates the demand made by the brotherhoods for an ncrease in wages.

The issues at stake are great for both of the parties to he controversy, but they are greater for the public at rge. The sums immediately involved in the controversy re vast. Estimates vary from $50,000,000 to $100,000,000 per annum; but this sum is small in comparison with he amount which the public will have eventually to pay s a result of the precedent established if the present emands are granted.

For if the railway engine-drivers and firemen and conductors and brakemen, merely by the threat to bring bout a nation-wide railroad strike, can add $50,000,000 o their wages, while they refuse to debate the question hether they are fairly entitled to such an increase or ot, it is safe to say that similar action will be taken by her bodies of railway employees. Such action would e justified, moreover, since these other employees are eceiving lower rates of wages in proportion to the work one and the responsibility carried than are the trainmen.

It has been plainly evident in the negotiations at Washington that the chief party in interest—to wit, the public—is largely ignored. The railway presidents have been reported as willing to grant the demands of the trainmen, provided they could receive absolute assurance from the President and Congress that a rate increase would be permitted sufficient to repay the companies for their added outlay in wages. In other words, if they were allowed to collect from the public the sum demanded by the trainmen, they were willing to give in. They should not be too severely blamed for this, for they have been fighting the public's battles a good while and receiving no thanks.

For one thing the railway officers cannot be too highly commended, and that is for their strong support of the principle of arbitration of industrial disputes. The brotherhood officers, on the other hand, deserve the severest condemnation for their absolute refusal to submit their case to arbitration.

The responsibility of defending the interests of the public in this great controversy has fallen upon President Wilson; and apparently because of his belief that a strike must be prevented at any cost he has failed to realize that peace may be purchased at too high a price. When the railway presidents urged him to accept and apply the principle that all industrial disputes should be submitted to arbitration, he could not of course deny the soundness of the principle, but he declared that arbitration was impossible because the brotherhoods would not accept it!

It is time for men to stop and inquire seriously where we stand, when an organization demands that the public hand over to its members a round fifty million dollars a year, refuses to arbitrate the question whether it has any just claim on such a sum and announces its intention of stopping railway-transportation lines throughout the country unless its demands are granted forthwith. Where shall the interests of the public find a defender when the President of the United States insists that this demand must be granted, not because it is just, but because of the dire results that will follow if the threat is carried out? Can any right-thinking man justify such a threat? It differs from the threat of the highway robber only that it is made on a vastly larger scale, for it is a hundred million persons who are held up instead of one.

Engineering News has for more than 30 years been a prominent and outspoken advocate of better economic conditions for the great mass of the people, and especially for those who labor with their hands. It has taken a leading part in the long struggle to establish Government control of public utilities and measures to prevent public oppression, monopoly and other abuses by combinations of capital. It recognizes the right and the necessity of labor organizations to protect labor from injustice and oppression; but it unhesitatingly condemns the attempt of combinations, either of labor or of capital, to exact from the public, under threat of violence, anything to which they are not willing to prove their right before an impartial tribunal.

Undoubtedly a large part of the public has a false idea of the controversy. They view it as merely an attempt of a certain group of workingmen to get higher wages from their employers, the railway companies. But while there may be temporary loss of railway-company profits if this and other demands for higher wages are granted, it is certain that the railways must continue to be operated, and the public must pay the entire cost of operating them, with enough profit besides to induce people to invest their savings in additional railway facilities. In the long run, therefore, it is the public and not the railway stock and bond holders who must give up the millions which the trainmen demand, if the railway presidents yield.

The public is sadly astray, too, on another aspect of the controversy, and for this also President Wilson is chiefly responsible. It is he who has beclouded the public mind with the idea that what the men are fighting for is the eight-hour day. He said in his statement to the public on Aug. 19:

> I have recommended the concession of the eight-hour day because I believe the concession right. The eight-hour day now undoubtedly has the sanction of the judgment of society in its favor, and should be adopted as a basis for wages.

In this statement, destined to be widely quoted everywhere for years to come, whenever a controversy over the hours of labor arise, the President says *in words* that he supports the eight-hour day in order to settle the dispute; but the proposition which he has asked the railroads to accept has *nothing whatever in it to establish the eight-hour day.* What he asks the railways to do is to increase the hourly rate of wages so that they would pay as much wages for eight hours' work as they now pay for ten hours. He omitted the brotherhoods' original demand for a time-and-a-half rate for overtime work. Hence under the arrangement which he proposes, the railways would have no incentive whatever to reduce the present working hours of the trainmen.

An elementary arithmetical computation shows that increasing the hourly rate so that a man earns as much in eight hours' work as he formerly earned in ten hours' work is equivalent to an increased wage rate of 25%.

If President Wilson believes that the eight-hour day is the real question at issue, then he must believe that a large proportion of the trainmen who are making these demands are working much longer than eight hours and would therefore be entitled to this large increase in their wage rate. Yet he demanded that the railways should put his proposition in force and give it a trial because, forsooth, no one is wise enough in advance of such a trial to determine whether the cost to the railways would be material!

President Wilson declares that society favors the eight-hour day. If he means by that statement that the majority of voters favor the general principle of the eight-hour day as a movement toward bettering the conditions of the workingman generally, he is very likely right. It is true also that the best experts on efficiency in production are generally agreed that where employees are working day in and day out the year round, in industries requiring intense use of nerves and muscles, such as factory work under modern high-pressure industrial conditions requires, eight hours is as long a working day as the average employee can stand and continue efficient work. But the railway brakeman, while he is on duty, has little or nothing to do so long as the train is in motion. He has not as strong a claim for the eight-hour day as the workman in the car shop or the laborer in the section gang.

If President Wilson means that society favors the universal eight-hour day as a practical working proposition, he is on unsafe ground. Everyone concedes the desirability of a shorter working day if the greater leisure it affords is rightly used; but most people prefer to work longer hours in order to earn more money and be able to buy more of the things they want. The railway trainmen themselves do not want shorter hours, but larger wages for their present working hours.

In deciding the momentous question whether or not to grant the demand of the railway brotherhoods it is proper of course to forecast the results if the demand is refused. The body of railway officials in Washington is best qualified to judge as to the extent of the difficulties which will result if the brotherhoods carry out their threats. It is very doubtful whether other classes of railway employees would sympathize with and support such a strike. The Pennsylvania R.R. claims to have a list of volunteers from other classes of its employees sufficient to fill the vacancies in the train service twice over if all the men threatening to strike should go out.

There is some reason to believe, also, that a large proportion of the members of the trainmen's brotherhoods have regarded the whole matter as a big game of bluff on the part of their officials to get something for them, which of course they would be very glad to have; but when it actually comes to the pinch, they will be slow to actually forfeit the lucrative positions they have so long held.

If the strike comes, there will be in all probability, for a few days and perhaps for weeks, much disorganization of train service and resulting hardships and suffering of innocent persons. Yet is not the sacrifice justified? Shall any organization be permitted to exact contributions from the public in proportion to its ability to cause disaster if its demands are refused? That way lies anarchy.

How the Misfits in Professional Education May Be Avoided

Many readers will recall the admirable article condemning over-specialization in engineering education, written by Prof. W. A. Wilson, of the University of Illinois, and published in *Engineering News* of Dec. 23, 1915. Elsewhere in the present issue Professor Wilson discusses the question of how professional misfits in engineering may be avoided.

It is unfortunately the case, as most engineering teachers of experience are aware, that a very considerable percentage of the boys now studying in engineering schools, although they may go through the prescribed routine of studies and pass the required examinations, are not naturally fitted for engineering work. This is of course no new condition; but in the early days of engineering education it could be said with a fair approach to truth, that if the youth did not follow engineering he was getting a good training and education which would be of advantage to him in any occupation he might take up.

It must be admitted that this is not true at the present day. Engineering courses have become more technical and specialized. The demand for the inclusion of the technical and the special has resulted in cutting down the time devoted to culture studies. For these reasons it is difficult to believe that the boy who spends four years in a first-class engineering school but does not thereafter follow some branch of engineering uses his time to the best advantage.

Professor Wilson calls attention to a grave defect in ur educational system, but it is doubtful if the remedy e proposes for it is sufficiently radical. So long as he American public implicitly holds to the belief that he business of higher education is to impart specialized nformation on every subject under the sun, from computing bridge stresses by the latest short cut to training hen to lay 200 eggs a year, or writing advertisements for ver pills—so long will the higher education prove a huge isappointment to many of those who invest time and oney in it. This does not mean that there is not room nd place for the vocational school, but that the first im of higher education should be to fit the student for hatever occupation he may have to follow in life, and ot for the one particular niche that he may never be ble to fit.

ocations for the Government Nitrate Plant

A number of cities located in different parts of the untry are each bringing to bear all the influence they n command to secure the location in their vicinity of e Government nitrate plant authorized by the National efense Bill which became a law on June 3. Apparently, wever, the selection of a site or sites for the plant is not ely to be made for some time yet. The Bureau of rdnance of the War Department, in conjunction with a mmittee of the National Academy of Sciences, is investigating the different processes for the production of trate and the final selection of the process may influence e choice of a site.

At the outset it appeared to be generally assumed that e Government would concentrate the entire nitrate oduction authorized by Congress at one plant. Further dy of the problem, however, indicates that there would material advantage in scattering the production among number of plants located in different parts of the untry. The primary object of the plants is national fense, and there would be an obvious advantage in ving a sufficient number of these plants so that the pture of one or two of them by an invading enemy, or ir accidental or premeditated destruction, would not sufficient to entirely destroy the country's facilities for ducing explosives.

While the production of material for explosives for use national defense is the primary purpose of these plants, y will have sufficient capacity so that except in the nt of actual war at least nine-tenths of their output probably be marketed in the form of artificial fertil- r. In this form, however, the price at which the duct can be sold will be largely governed by the cost transportation to the final users, and half a dozen nts in different parts of the country each supplying farms in the territory surrounding it, would yield a better commercial return and would be far more eficial to the agricultural interests than if the entire put of nitrate were produced at one plant.

There is indeed a possibility that such considerations as proximity to raw materials or to markets which could take the product for use in connection with other fertilizer materials or other chemical industries might determine the location of the plant at a site where power could be developed from cheap fuel. The more likely supposition, however, seems to be that a site or sites will be chosen where the Government owns water power produced through the improvement of rivers for navigation.

Eliminating Cost of Transfers on Through Routes

In *Engineering News* of July 20 an explanation was given of the fight which cities on the New Jersey side of the North River are making before the Interstate Commerce Commission against being compelled to pay for lightering freight across the North River, as shippers in New York City have to do.

Through the courtesy of Frank L. Neall, of Philadelphia, we have been favored with a copy of a letter written in 1889 by the late Col. Joseph C. Potts, of Philadelphia, a prominent civil engineer and financier of that day, to Hon. James A. Logan, at that time Assistant General Solicitor of the Pennsylvania R.R. In this letter Colonel Potts reviewed the gradual elimination of transfer charges on through east and west traffic as follows:

> There was a time when all goods movement between New York and the West passed, necessarily, through the hands of forwarders at Buffalo, and when all similar movements between Philadelphia and the West had a similar experience at Pittsburgh. Forwarders at both points were originally improvements. They effected transfers and dispatching of goods, with less cost and friction than the owners of the goods could themselves have done. But as carriers advanced in skill and scope, they combined their operations, so that transfers with their delays and outlays began to disappear. A new economy arose, and the forwarder at many transfer points lost his value and became a costly excrescence. His business had been honorable, profitable and useful. He looked upon its excision as an oppressive outrage, and fought against such an issue with all his power. This contest has ended at Pittsburgh, and so far as traffic carried all-rail is concerned it has also ceased at Buffalo.
>
> At Erie, Penn., it was not the forwarder, but the whole population, who fought. In this case it was ostensibly to preserve a difference in gage, but really to preserve the small increment of profit arising from the services which the transfer enforced by this break of gage made necessary.
>
> It still rages to some extent in Chicago, and virulently now in New York. To the latter city, traffic passing between foreign countries and this has, for many years, flowed without much municipal effort and without much effective opposition to heavy local taxation in wharf hire, cartage and in numberless other forms, not illegitimate but fast becoming unnecessary.
>
> As inland and ocean carriers have now commenced the same forms of beneficent union which have grown up within the limits of this country, and with the same useful results, the forwarder and all who, while really merchants, are also quasi-forwarders, naturally wage the same sort of fight which inland transfer points have witnessed. But this new phase in New York is no reflection upon the past of those who now oppose the change. They lived useful lives and earned well their profits
>
> Through rates and through bills of lading, however, are in the nature of new inventions. If they make commerce easier and cheaper, and thus lessen barriers to movement, they are valuable inventions, and the old methods must end. Their close will not be sudden, the two methods always work for a while side by side, but the improved method will increase, while the poorer one must decrease. This is inevitable.
>
> It is to be hoped the Interstate Commerce Commission will not ignore this great and controlling tendency. It cannot help but prevail One of the most valuable functions of this commission is to perceive, sooner and more clearly than others who look from lower planes, the leading facts and motives around which all regulations of commerce, and the transportation branch of commerce must shape and fit themselves.

Letters to the Editor

Repetitious Road Discussion

Sir—Hearty approval must be accorded your recent editorial comment and the letter of one of your correspondents on the failure of many of the papers read at road congresses to do more than deal with generalities.

At these meetings, whose great usefulness in many respects must be acknowledged, one can frequently predict from an inspection of the program the contents of many of the papers. There is always the discussion which begins with the statement, "The importance of good roads to a community is now very generally recognized," followed by an appeal to the engineers present to discover the perfect road which shall not wear. There is never missing the ingenuous soul who proclaims his discovery that maintenance is equally as important as care in original construction, and somewhere in the program is the practical man who casts ridicule on all written knowledge.

Last year, in outlining to a meeting of engineers some of the problems of paving in large cities, the writer commented on the difficulty of finding a highway discussion that did not start with, "Great changes have been effected by the introduction of the automobile, which has apparently come to stay."

Returning from an enforced pedestrian inspection, under the auspices of our War Department, of the possibilities of protecting our national Southern frontier, where streets are paved with only mud and cactus, the writer casually took up copies of the proceedings of some recent road congresses and opened them at random. On the earliest pages turned over were his old acquaintances, the standard platitudes; and in the first part of one volume, mainly devoted to serious discussion of construction methods, was our old unavoidable friend, "There is no longer any question but that the motor vehicle has come to stay."

But admitting the truth of your destructive criticism, it does not seem as if your constructive conclusions are as complete. It must be remembered that most of the road congresses serve at least two purposes. They are not only gatherings of technical men, interchanging ideas on road construction, but they depend very largely for their support, outside of that which they get from the supplymen, on the nontechnical public interested in good roads. Consequently there is justification for a good many of the generalities which strike the technical man as unnecessary. The papers of the latter should undoubtedly be improved by the elimination of the long statements of elementary principles of which you complain, but they should not thereafter be limited merely to a discussion of comparative details, valuable as these are.

There is plenty of room left for improvement in matters of organization, the larger policies of road construction and general questions of comparative merits of different types of pavement, and much of the very technical matter which would be all that would remain under your editorial restriction is of a nature too difficult to discuss in open meetings and more suitable for written comment.

The writer does not in any respect disagree with your comments. He believes that there should be more open publication and chance for discussion on mistakes, as well as on good work, but he believes also that there is much in general matters not sufficiently standardized to be still open for debate and to contain elements for discussion at future road conferences.

The suggestion made by your correspondent in the issue of Aug. 10 as to the importance of papers directed toward the standardizing of asphalt specifications is very timely and brings attention to the fact that if it were possible for those interested in such types of pavement as sheet asphalt and wood block to get together and spread scientific information in the way it is done by those interested in the construction of brick and concrete pavement, there would be less possibility for some of the accusations that have been made in the past in regard to the relations between paving interests and pavement designers.

HENRY WELLES DURHAM,
County Engineer, Bergen County, New Jersey.
Hackensack, N. J., Aug. 14, 1916.

*

Bituminous Materials Tests for Sheet Asphalt

Sir—In Mr. Forrest's comments on my article entitled "Bituminous Materials Tests for Sheet Asphalt," which appeared in your issue of Aug. 3, 1916, he states that he fails to find any reference to solubility in carbon disulphide in the American Society of Municipal Improvements' sheet asphalt specifications under the head of Refined Asphalt. Clause b of paragraph 4 of these specifications reads as follows:

> Ninety-eight and one-half (98½) per cent. of the total bitumen of all refined asphalts shall be soluble in carbon tetrachloride.

The definition for bitumen adopted in 1912 by the American Society for Testing Materials is as follows:

> Bitumens are mixtures of native or pyrogenous hydrocarbons and their nonmetallic derivatives, which may be gases, liquids, viscous liquids or solids, and which are soluble in carbon disulphide.

The method adopted by the A. S. T. M. for the determination of bitumen calls for the use of carbon disulphide as a solvent, which of course accords with their definition and also accords with the standard practice throughout the country and in Mr. Forrest's laboratory.

In other words, Clause b of the A. S. M. I. specifications calls for the determination of the total bitumen (which must be and always is made by determining the solubility of the material in *carbon disulphide*) and also the determination of the percentage soluble in carbon *tetrachloride*, otherwise the relation between the two as called for by this clause could not be established.

Paragraph 22 of the A. S. M. I. specifications describes the method for the determination of total bitumen in *refined asphalts* and asphalt cements and specifies the use of *carbon disulphide*. (The italics are mine.)

It appears strange, in view of the foregoing, that anyone with Mr. Forrest's experience in asphalt analysis should have been unable to see that this clause called for a solubility test in carbon disulphide.

I fail to fathom the connection between my article and the special committee (of which I am a member) appointed by the A. S. M. I. to investigate and develop methods of testing paving bitumens, but as Mr. Forrest has referred to it I may be pardoned for quoting from pages 768 and 769 of the "Proceedings" of the 1914 Convention of the A. S. M. I.

> Mr. Tillson: I have a resolution I would like to present. I was asked to present it by Mr. Smith, of the Asphalt Committee.
>
> Moved: That a technical committee be appointed by the president, consisting of five members, whose function it shall be to invite and direct the coöperation of all chemists dealing with bituminous materials for the purpose of further standardizing present methods of testing and for the purpose of encouraging and developing additional methods and appliances for valuating paving bitumens. This committee shall be permanent for a period of four years and shall report to the general organization at each meeting.
>
> Mr. Tillson: I believe this is a good resolution, and would move its adoption.
>
> Mr. Howard: I will second that. Asphalt testing has practically stood still for seven years, and I think this is a splendid thing.
>
> Carried.

The thought behind this resolution was that the Society should endeavor to promote research along the lines indicated, to the end that whenever new tests of value were established they might be incorporated in the various specifications for bituminous materials adopted by the Society.

By his statement that it was appointed "despite the specifications which Mr. Smith supports so feelingly," Mr. Forrest would seem to intimate that this committee was suggested by some one outside of the Sheet Asphalt Committee. F. P. SMITH.

131 E. 23rd St., New York City, Aug. 11, 1916.

⁂

Pile Formula for Double-Acting Hammer

Sir—In an article entitled "Pile Formula Modified for Double-Acting Hammer," appearing in your issue of July , a rule is stated for a general guide in determining he numerator of a formula for a double-acting hammer, erived from the *Engineering News* pile formula for a ravity drop hammer, as follows:

> Ascertain as nearly as possible the foot-pounds represented y the blow delivered by the hammer. This can be done by dding to the foot-pounds represented by the free fall of the ammer the foot-pounds obtained by multiplying the mean ffective pressure by the area of the piston and the length f stroke in feet. The result is the numerator of the formula.

While this statement in itself is entirely logical, it is not asy to apply with so high a degree of accuracy as one ight infer after casually reading it. The formula given n the conclusion of the article, if stated

$$P = \frac{2(W + Ap)h}{s + 0.3}$$

the 2 in the numerator was probably omitted unintenonally), is exactly what I had in mind in my letter ublished in your issue of Feb. 21, 1916.

The values of the terms p and h more than likely vary onsiderably at different times under different conditions or the same hammer, and it would therefore seem unwise to arbitrarily use the same value for these terms under these circumstances on account of variable conditions of practice.

The actual mean-effective steam pressure in the cylinder of the hammer depends upon the steam pressure at the boiler and the loss in the steam line during transmittal, the adjustment of the steam valves in the hammer and the back pressures allowed in order to have a slight lead to the valve to maintain the maximum number of strokes per minute, etc. On account of the last condition stated, there must be a variation in the actual length of the stroke of the ram for various speeds of operation.

It is assumed in the article in your issue of July 6 that the mean effective steam pressure in the cylinder is 25 lb., which may be approximately right, although most manufacturers rate their hammers on the pressure of 60 lb. The only means of determining what the actual effective pressure is is by indicator card readings, and it would not be practical to take these readings when driving piles in actual practice or to determine the actual stroke of the ram.

If, however, the effect of the combination of the steam pressure and length of stroke of the ram and the fall of the weight of the ram could be observed in some way, it would serve the same purpose.

It is evident that the work done by a double-acting steam hammer per blow or per minute in driving a pile should vary, not considering the effect of the fall of the weight of the moving parts, directly as the mean effective pressure; and upon the mean effective pressure and the weight of the ram depend the number of blows per minute, length of stroke and the velocity of the moving parts at the end of the stroke.

It would seem therefore that if the rating of a hammer (work per blow or per minute) was established by tests which would include the effect of the weight of the ram, either by some means of measuring the work done or calculating it from actual effective steam pressure shown by an indicator diagram, and the number of blows per minute or the velocity of the striking parts recorded for various speeds of operation of the ram, all it would be necessary to do to determine the actual work done on any pile by that particular hammer, provided its adjustments, etc., were the same as when rating was established, would be to count the strokes of the ram per minute which would correspond with an established amount of work done for that particular hammer, which divided by factor of safety six would represent the numerator in the formula.

Although the constant used in the denominator depends somewhat on the character of the soil through which the pile is driven, it also is supposed to depend on the rapidity with which the blows are delivered. If, therefore, in the steam gravity drop-hammer formula a constant 0.3 is considered proper as compared with 1 for an ordinary drop hammer, then it would seem entirely logical and proper to concede that a still lower constant should be used for the double-acting steam hammer, since the double-acting steam hammers deliver from 100 to 500 blows per minute, not allowing the pile to stop moving, while the gravity drop steam hammer delivers only about 60 to 100 blows per minute. How much this constant should be reduced could only be determined by comparative tests.

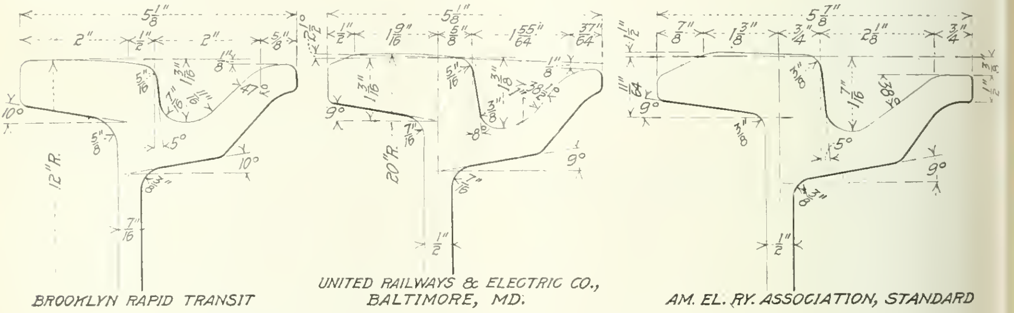
A. M. KNOWLES,
Asst. Engineer of Bridges, Erie R.R.
50 Church St., New York City, Aug. 18 1916.

New Grooved Girder Rails

The recent introduction of round-topped girder rail sections on some large street-railway systems calls attention to interesting developments in the problem of the relation of wheel tread to rail head under street-railway conditions.

A few years ago the American Electric Railway Engineering Association adopted for grooved rails a flat-top head. But instead of making this level and using cylindrical wheels (as has been proposed for railway T-rails), it gave the top of the rail head an inclination of 1½° (ascending from the gage-line corner) in order to approximate that of the standard wheel tread: 1 to 25. Among the reasons for this were the claims of the manufacturers that it was difficult to roll large grooved girder rails with curved heads, except at increased cost, and that it was difficult to make this curve when grinding rail joints.

Results very different from those expected have been obtained in some cases, though it cannot be stated just how extensive these conditions are. On the Brooklyn Rapid Transit Ry., trouble developed with early corrugation in new rails, and particulars of the investigation have been made public by R. C. Cram, Assistant Engineer. It appeared that instead of uniform wear from the approximately identical contours of rail and wheel, the wear was concentrated along the inner edge of the head, adjacent to the top corner. A careful study of wheels then showed that the average tread was hollow, with a curve of about 16 in. radius on an incline of about 1°.



BROOKLYN RAPID TRANSIT UNITED RAILWAYS & ELECTRIC CO., BALTIMORE, MD. AM. EL. RY. ASSOCIATION, STANDARD

SECTIONS OF GIRDER RAILS WITH CURVED AND FLAT-TOP HEADS

The rail head being inclined only 1½°, the wheel was practically clear of the rail except for a narrow strip along the gage side. The concentration of load, under heavy cars, resulted not so much in ordinary wear as in a cold-rolling which caused the metal to flow, this flow being both longitudinal and transverse. The latter movement was assisted by the angular pressure of the wheel tending to force the metal out on the corner and on the unsupported gage side of the head, where it was cut or ground off by the wheel flanges. This irregular displacement of the metal resulted in the development of corrugation of the rail head.

While similar loading and flow occurs on T-girder rails and ordinary T-rails it does not appear to cause corrugation, as in grooved rails. The explanation of this is that in T-rails the head is centered over the webs, while the head (not being stiffened laterally by the horizontal flange formed by the groove and guard of a girde rail) is more flexible and is free to move under th lateral movements and blows of the wheels.

As a result of the investigation, the rail manufacturers agreed to roll curved-head rails without increas in cost, no other change being made from the standar section. The mills have had no difficulty in rolling thes rails with a uniform head contour, nor has there beer difficulty in grinding the joints, even at compromis joints where the curved-head rails connect with flat-hea rails.

The rail head thus adopted is shown in the accompanying drawing. According to a statement receive from Mr. Cram, it was designed to reproduce as nearl as possible the average curved contour of the worn rai heads of this company's lines. In the first place, th object was to secure a greater range in the contact, wit the view of spreading it out more quickly over the entir width of the rail head, and preventing its concentratio continuously along definite areas.

It was also desired to have the wheel contact so located on the rail head that it would be farther back fron the gage line and approximately over the center lin of the web. The object of this was to prevent the flowing of metal over the gage line at the fillet or top corne of the head on the groove. It was thought that wi this design, rail corrugation would not make its appearance so soon and might be prevented entirely. So fa these objects seem to have been attained, but as yet n definite conclusion can be made, since these rails hav been in use only eight months, and rails are sometim in service for two years before corrugation begins t develop.

As a result of his investigations, Mr. Cram arrive at the conclusion that the design of the inclined-plan form of rail head was based on a misconception of th conditions, and that the curved-head design meets th conditions by providing a wider zone of contact and s avoiding excessive pressure adjacent to the unsupporte metal at the gage side of the rail head. The curved hea will also eliminate the unnecessary wear which otherwise takes place while the rail and wheel are coming t a proper bearing. It is of special interest to note tha he suggested that wheels might be made with a hollow tread to approximately fit the curved rail head. This is an interesting variation from the older suggestion of a cylindrical or flat-tread wheel to fit a flat-topped rail.

A rail of the same type, but differing in some details has been introduced for similar reasons by the Unite

Railways and Electric Co., of Baltimore. This also is shown in the accompanying drawing, and information regarding it has been furnished by Mason D. Pratt, Chief Engineer. The early experience was that owing to the coning of the wheel treads (about 2½°), the new wheels on most rails had a bearing only adjacent to the gage line. Consequently the wear was excessive for the first two or three years, or until the wheels and rails were worn to a wider bearing.

To overcome this difficulty the top of the rail was inclined to fit the wheel tread, but the slope was about 2½°, instead of 1½° as in the design previously described. This inclined surface was flat, in accordance with the standard of the American Electric Railway Association. It was then found that owing to the fact that a large percentage of traffic on the suburban lines was carried by T-rails, the tendency of the wheel wear on the girder rails of the city lines was to slightly hollow the tread. This objection was met by giving a curved surface to the inclined top of the rail. This is shown in the drawing, which represents the company's present standard 7-in. girder rail. The wheels now have full bearing, and there is a material lessening of the early occurrence of corrugation which was due to insufficient bearing of the wheel upon the rail. There will be also some increase in the life of the rails.

In this Baltimore rail the top radius is 20 in. (instead of 12 in. for the Brooklyn rail), on an inclination of 2½° (instead of 1½°), and the top corner radius is ⅝ in. (instead of ⅜ in.). The Baltimore rail also has a ½-in. web, 5½-in. base and 8° slope for the gage side of the head. The Brooklyn rail has a $\frac{7}{16}$-in. web, 6-in. base and 5° slope on the rail head. Both rails are 7 in. high and weigh 105 lb. per yd. The A.E.R.A. standard -in. rail, which is also shown, has a 6-in. base and ½-in. web, but the wider guard to the groove increases he weight to 122 lb. The horizontal distance from the age line to the center line of the web is ¾ in. in the A.E.R.A. rail, ⅝ in. in the Baltimore rail and only ½ n. in the Brooklyn rail; one of the special objects in he design of this last rail was to reduce this distance s a means of checking rail corrugation.

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Electric Pumping Plant for Land Drainage*

The electrification of a steam pumping plant is an nteresting development on the Spring Lake Drainage and Levee District, in Illinois. The district has an area of bout 12,500 acres, with 18 mi. of leveed frontage on the llinois River and with a width of ½ mi. to 3 mi.

The drainage water is pumped over the levee to the ver by a plant at the lower end of the district, about 15 n. from Canton, Ill. This was installed in 1909. It nsisted of two R. D. Wood 48-in. centrifugal pumps rect-connected to two Russell cross-compound engines, nd a 24-in. Worthington pump direct-connected to a ngle-cylinder Russell engine. The speeds were 170 to 15 r.p.m. for the large pumps, and 250 r.p.m. for the nall pump. Steam ejectors were used for priming the umps. There were two water-tube hand-fired boilers of 00 hp., with a steam-driven induced-draft outfit. The fficulties in obtaining coal, keeping good operators and making emergency repairs led the commissioners of the district to adopt electric power.

Each of the large pumps is now driven by two 25-in. silent-chain belts from a Westinghouse 440-volt induction motor of 300 hp. The small pump is driven by a 10-in. chain from a similar motor of 100 hp. The sprocket wheels are placed on the pump shafts in the positions occupied originally by the flywheel and eccentrics. The controlling equipment consists of auto-transformers and three oil circuit-breakers of the switchboard type. For priming the pumps there is a small compressor used as a vacuum pump.

Power is furnished by the Canton Gas and Electric Co. over a 3-phase 60-cycle 13,000-volt transmission line. The wires are carried across the river (about 2,000 ft.) on four steel towers having four posts on concrete piers, the base of the tower being 3 ft. above high-water line. The substation at the pumping plant consists of four 25-ft. poles with lightning arresters, disconnecting switches, choke coils and fuses.

The specifications required that the pumps should be capable of being operated at two different speeds. This condition is met by providing two sets of motor sprockets to be fitted to the shaft in accordance with changes in the head against which the pumps have to work. The lower speed is used with low heads, and the high speed when the lift is near its maximum. (Two other chain-driven pumping plants for drainage work, in which speed-changing devices are used, were described in *Engineering News*, Sept. 23 and Nov. 11, 1915.)

The Spring Valley plant does not operate continuously, its work depending largely on the season and the rainfall. Heavy pumping is required for only about three months, 65 to 75% of the annual work being done between Mar. 15 and June 15. The remaining work is distributed about evenly through the other months. The usual load on the plant is 250 kw., and during a part of the year this load is on the lines about 10 or 12 hr. per day. During the time of heavy pumping the motors are operated sometimes 18 to 20 hr. daily. In extremely wet periods all the pumps have been in simultaneous operation for a few hours, taking about 600 kw.

The preliminary work on the electrification project was done by Hoppin & Rich, engineers, of Peoria, Ill., who made an investigation for the Canton Gas and Electric Co. At that time the company had no schedule of rates which could be applied to this class of service, and the schedule now in effect was devised by the engineers after a study of existing rates and the cost of power at the company's switchboard. The power is sold at a rate per kilowatt-hour per acre per month, depending on the amount of land served and the amount of power used. The cost of operation is said to compare favorably with that of the former steam operation, while the certainty and freedom from interruption have made the service satisfactory to the commissioners.

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Warning Signals at Grade Crossings consisting of banjo signals tied into the main track circuit are being installed by the New York, New Haven & Hartford R.R. at numerous crossings in Connecticut. Following a recent wreck the State Public Utilities Commission ordered the removal of a number of these signals from the track signal system and they are now being utilized as highway warnings. While these are at present located at the track it is thought probable that in some locations, where specially dangerous conditions exist, they will be installed as distant warning signal.

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*From information furnished by the Westinghouse Department of Publicity, East Pittsburgh, Penn.

Quebec Suspended-Span Hoisting Details Completed

By A. J. Meyers*

SYNOPSIS—Outline of program and details of equipment for floating to position and hoisting into place between cantilever arms the 640-ft. 5,000-ton suspended span of the Quebec Bridge.

The detailed arrangements for floating the great suspended span of the Quebec Bridge are now practically finished, and the completion of this task rests on favorable meteorological conditions. This span is 640 ft. long, 88 ft. wide and weighs, in floating-in condition, about 5,000 tons. It was erected at Sillery, about 3 mi. below the bridge site, over the shallow waters of Victoria Cove. During erection it was supported on staging under each panel point; afterward the intermediate supports were removed. As shown in Fig. 1, the suspended span, after it had been completely assembled and riveted up, rested on the end staging bents at L0 and L18. The scows for floating the span to the main bridge site, about 3 mi. up the river, were floated into the positions shown in the diagram under panel points L1, L2, L3, L15, L16 and L17, and as the tide lowered they came to a bearing on their concrete and timber beds. In the bottom of these scows, valves are provided which were opened and will be left open until the span is to be floated, so that the scows and the span will not be disturbed by the daily rise and fall of the tide.

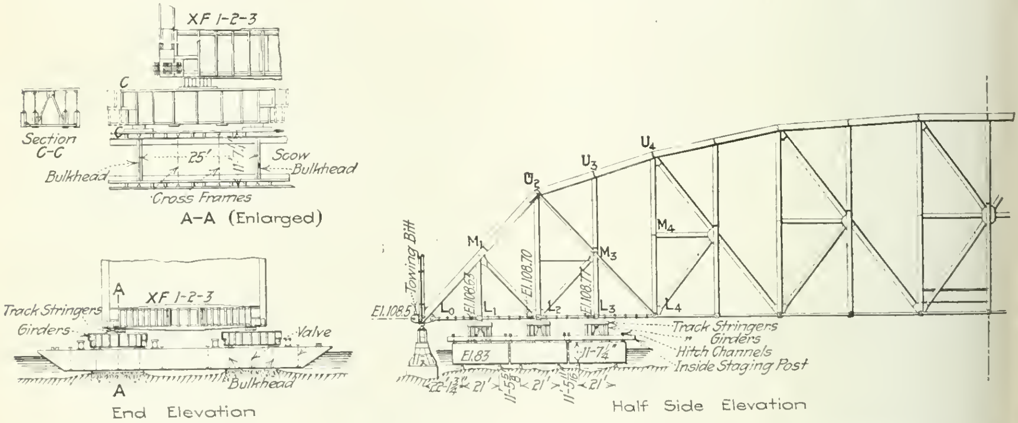

FIG. 1. ARRANGEMENTS FOR FLOATING THE SUSPENDED SPAN OF THE QUEBEC BRIDGE

Scows for Floating-In

The design of the scows was governed by the arrangement and requirements of loading and the possible condition of the surface of the river during floating-in operations; also so that they might have some commercial value after their work of floating-in the suspended span was completed. The average length from crest to crest of wave at the bridge site is about 40 ft.; the wave height is 4 ft. This unevenness of the surface of the river produces unequal upward pressures at the four corners of the span and consequent stresses in the sway and lateral bracing. The unequality of pressure is proportional to the horizontal cross-section of the loaded scows near the surface of the water. To reduce wave effect as much as possible, long, narrow scows with a deep draft would preferably be used. With the design of scow adopted the oscillation of the span from wave action produces only stresses in the sway and lateral bracing, which these systems are well able to resist.

The scows as built are 32 ft. 5½ in. wide, 164 ft. 6 in. long and 11 ft. 7½ in. draft over bilge timbers. Each has a steel frame made up of three longitudinal trusses, spaced 10 ft. 6 in. c. to c. and braced transversely by four water-tight steel bulkheads with intermediate cross-frames between the bulkheads, spaced 8 ft. 4 in. c. to c. No special longitudinal bracing in the horizontal planes is provided, as the 11½x5½-in. cross-timbers, spaced 2 ft. 9 in. c. to c., are bolted directly to the steel framework of the scow; and the 4-in. timber covering is spiked to these cross-timbers with 8x$\frac{7}{16}$-in. boat spikes, three at each intersection, providing an efficient resistance to any transverse or longitudinal horizontal-shearing and bending forces that may arise.

The load of the suspended span is transferred to the bulkheads by means of the cross-girders and I-beams shown in Fig. 1. The bulkheads transfer this load to the longitudinal trusses, which distribute it over the length of the scows.

In addition to the scows being designed to carry the load of the suspended span, in order that they may be used for freight-carrying purposes after their work of floating-in the span is completed, they are built to carry a load of 1,100 tons uniformly distributed over a length of 123 ft. and symmetrically placed about the transverse and longitudinal center lines of the scows, or a load of 1,075 tons uniformly distributed over a length of 50 ft. at each end of the scow and symmetrically placed about its center lines. These two conditions of loading give the largest stresses in the web members of the three longitudinal trusses. The largest stresses in the chords of these trusses are caused by a loading of 280 tons uniformly distributed over a length of 50 ft. on either side of, but immediately adjacent to, the transverse center line of the scow, or a load of 180 tons uniformly distributed over a length of :0 ft. at the center of the scow and symmetrically placed ıbout its center lines.

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*Chief Draftsman, Board of Engineers, Quebec Bridge, Montreal, P. Q.

It was assumed that the weight of the scow itself ›roduced no stresses in the longitudinal scow trusses and :hat the total superimposed load was ·arried equally by these three trusses. [n calculating the maximum bending ·tresses in the chords of these trusses a ·oefficient of 0.75 was used to allow or continuity over the panel points. The allowable unit stresses provided or a safe unit stress in these trusses ·ith the suspended span carried on our instead of six scows. The scows re placed under the suspended span nd shimmed against the bottom anges of the floor-beams. To make ure of favorable weather conditions ·hile the span is floating, it should e lifted from its supports at L0 and .18 only immediately before its journey to the bridge site. In order to revent the lifting of the span by the ·ows when the weather conditions are ot favorable, there are a number of -in. disk bottom valves in each scow, nd these are left open. The elevations the beds of the scows were so chosen ıat the scows will be emptied through ıese bottom valves during the last low de before beginning the journey to ıe site of the main span. The valves ıve a total area of one five-thousandth ıe clear area of the scows. All interior ·eas of the scows are given unobstructed access to some ıe of the valves, and it is estimated that the water will ·ain out practically as fast as the tide falls.

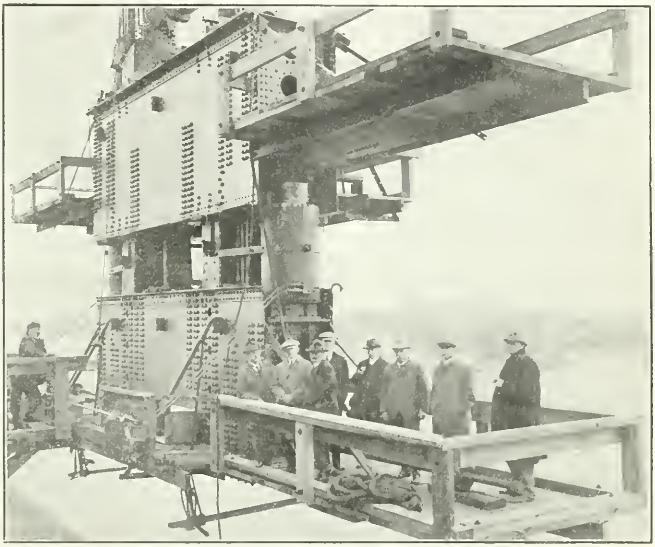

FIG. 2. UPPER AND LOWER JACKING GIRDERS FOR HOISTING QUEBEC SUSPENDED SPAN

The two 1,000-ton hydraulic jacks and operating platforms in place. On the platform—Messrs. Duggan, Mitchell, Porter, Johnson and Fortune, of the St. Lawrence Bridge Co.

SCOW LOADING

.As illustrated in Fig. 1, the load of the suspended span transferred from the floor-beams at each of the panel ›ints L1, L2, L3, L15, L16 and L17 to the bulkheads the scows by means of eight 24-in. 80-lb. I-beam track ringers, with their end-connection angles interlocked at e ends, and four track girders braced together by sway-acing frames and top laterals. These I-beam stringers d track girders are part of the permanent floor material the span—all the floor steel and the railway track floor, cept the main floor-beams, being left off the span during e operation of floating-in and hoisting. (This floor aterial will be placed afterward by means of derrick rs.) The total load carried by one scow under these nditions is 970 tons, distributed over four bulkheads. he draft of the unloaded scow is 1 ft. 6 in., and when rrying the load of 970 tons the draft is 8 ft. 2 in.

The stresses in the truss members of the span while it is being supported entirely by the scows are such that a tension connection had to be provided at the joint U2; and the bottom-chord eye-bars between the panel points L0-L4 and L14-L18 had to be stiffened temporarily, as indicated in Fig. 1, with longitudinal timbers and transverse blocking and bolts. The subtension verticals and the subcompression diagonals directly over the scows had also to be specially designed and stiffened to take reversal of stress while floating the span.

The three scows at each end of the span are braced and connected together, as shown in Fig. 1, by using the inside staging posts from the falsework of the anchor arm as continuous connecting girders. Four of these posts are used for each set of three scows and are spaced 42 ft. c. to c. These posts were connected to the scows by means of a pair of cross-channels, pin-connected to vertical angles which were in turn bolted to the transverse bracing frames of the scows. Wedges were driven between the posts and the scow decks. These connections and the connecting girders were calculated to resist the bending and shearing stresses arising from the action of a 4-ft. wave.

Just before the span is lifted off the supports at L0 and L18 the load is nearly all taken by the scows, and the span could be easily displaced from its position by the current and wind, unless it is anchored against their combined effect. It is desirable to prevent this shifting off before the actual moment of starting arrives, inasmuch as it may happen that after deciding to raise the span preparatory to moving out, a change in the weather conditions may make it desirable not to proceed on the journey and the span would have to be returned again to its bearings on the staging bents, to await the next favorable opportunity for making a trial.

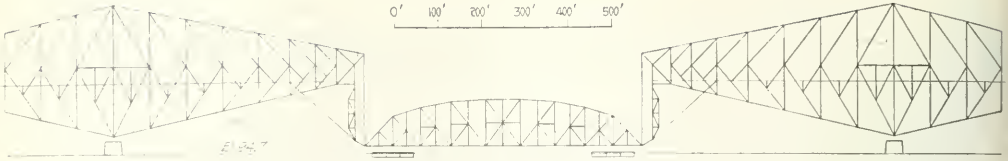

FIG. 3. GENERAL SCHEME FOR HOISTING THE QUEBEC BRIDGE SUSPENDED SPAN

To keep the span in its position until the final decision to float away has been made, timber bents will be placed between the points L0 and L18 and the adjacent scows and also bents on the shore side of the span, against which the scows will guide themselves as the span is raised or lowered on its supports.

Weather and Tide

The bottoms of the scows are placed at El. 83, where they rest on bearing timbers. The bed of the river over which the scows must pass will be cleared off to El. 82. The draft of the loaded scows will be 8 ft. 2 in. In order to float the span, a high-tide elevation of at least 92 ft. will be required, and in order to drain the scows at the previous low tide an elevation of low tide of not more than 82 ft. would be expected.[1] Inasmuch as elevations of high and low tide, as calculated from the tide tables, may vary at the erection site of the span ± 2½ ft., in order to be sure of floating off, a tide must be chosen whose elevation, as given by the tide tables, will correspond to a high-tide elevation of 94.5 ft. and a low-tide elevation of 79.5 ft., giving a range of tide of 15 ft.

Four or five days in succession, when the elevations and range of tide would be suitable for draining the scows and floating the span, occur at intervals of about two weeks' time. The first favorable tide period, after the preparations for floating the span are complete, is about Sept. 12. If the weather conditions are not favorable during this period, it will be necessary to await the next favorable height and range of tide, and so on until suitable tide and weather conditions coexist.

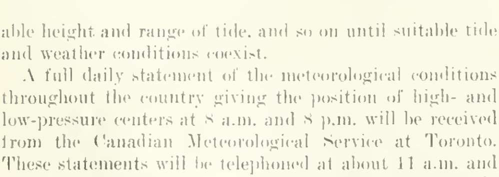

FIG. 4. LINES FROM CENTER SPAN TO MOORING TRUSSES

A full daily statement of the meteorological conditions throughout the country giving the position of high- and low-pressure centers at 8 a.m. and 8 p.m. will be received from the Canadian Meteorological Service at Toronto. These statements will be telephoned at about 11 a.m. and 11 p.m. respectively, with a prediction of the possible wind velocity. By barometric observations at the bridge site it can be estimated whether any threatening centers of low pressure, indicating strong winds, at a great distance on the previous day, have moved more quickly or slowly than was expected. The appearance of the sky, the velocity and direction of the wind just before starting and the indications on an electric storm detector will also be well considered before deciding whether or not to start. It is estimated that any winds which will exert a greater pressure than 2 lb. per sq.ft. can be foreseen, and in that event no start will be made. The current velocity at the bridge site is a maximum, one hour before high tide, and is flowing westward at a rate of 6.3 to 7.3 mi. per hr. in a direction which will carry the span toward the main bridge site. At high tide the current velocity is less by about 1 mi. per hr. The change of current from a westward to an eastward direction, when the velocity is zero, occurs about 1 hr. after the time of high tide.

Towing the Span

The span on its journey to the bridge site will be towed and controlled by tugs, assisted by the westward current and influenced by the coexisting wind of unknown direction, but exerting a force of not more than 2 lb. per sq.ft. With tugs having a pulling capacity of 100,000 lb. in a 4-mi. current, a velocity of the span of 4 mi. per hr. can be produced relative to the water, and at the same time overcome the effect of a 2-lb. wind on the span.

About 50 min. before high tide the span will be floated away from its erection site, with a westward current having a velocity of about 6 mi. per hr. At first the tugs will be used mainly for guiding the span. While on its journey to the bridge site the rate of progress will be observed by means of a series of ranges placed 0.2 mi. apart within 1 mi. of the bridge and ½ mi. apart from 1 to 3 mi. distant from the bridge. The span should arrive at the bridge with a velocity of current of about 4 mi. per hr. With such a current and a wind velocity of not more than 2 mi. per hr. the tugs will have no difficulty in stopping the span before coupling up to the mooring trusses.

The time of arrival will be controlled by the tugs so that the span will be in position about half an hour after high tide, when, for a period of 1 hr., the current does not exceed 3 mi. per hr. and during which it changes direction. The tugs will hold the span against the wind and current while the 1¼-in. steel mooring lines are being connected, as shown in Figs. 4 and 5. The span will then be pulled directly under its final position in the bridge by means of these 1¼-in. mooring ropes, eight in number, two connecting at each corner of the span. At the end of each rope is a loop which, as soon as the span has come within reach and the speed is controlled, will be thrown over a double-headed cast-steel snubbing block or towing bitt, bolted to a seat provided at the joint XL0 of the suspended span. Each 1¼-in. rope is calculated to take a pull of 75,000 lb. The ropes pass through sheaves at he lower corners of the mooring trusses and from there un vertically to the trusses, where they connect to a nine-art ¾-in. wire-rope tackle, which leads back to the rums of the derrick hoists, situated on the floor at the nds of each cantilever arm.

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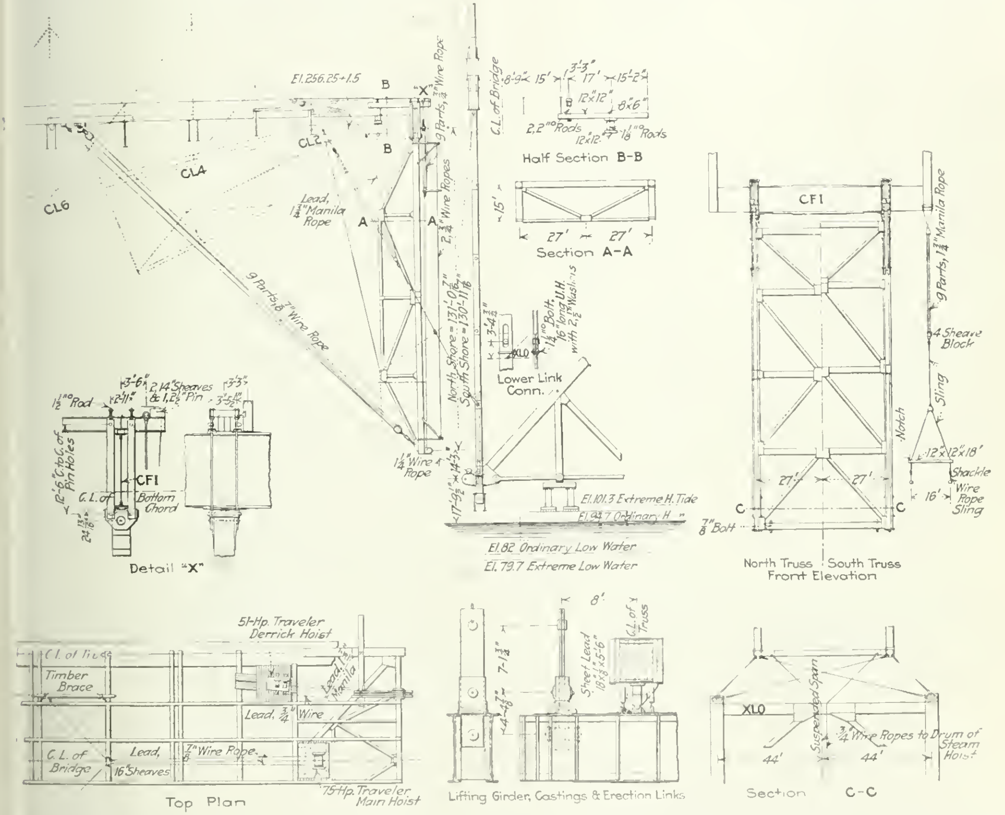
[1] In order to obtain the relation between the Quebec elevations of tide, as given in the Dominion Naval Service tables, to the elevations used at the bridge site, it is necessary to add to the high-tide elevations 80 ft., and to the low-tide elevations 79.25 ft. Observations, extending over a considerable time, have shown that the deviation from the elevation for the bridge site of high tide will amount to a maximum of ±2 ft. for high tide and for low tide +2.05 ft. At the erection site of the suspended span the deviation from the elevation as calculated from the tide tables is ±2½ ft. for high and low tides.

With one line out on each end, the load for a 7-mi. urrent and 1-lb. wind (77,500) would be carried. With vo lines cut (second position, Fig. 4) the upstream pull f 145,000 lb. would provide for a 7-mi. current and a -lb. wind (145,000 lb.). With all four out at each end, 220,000-lb. force could be exerted to overcome a 7-mi. urrent plus an 11½-mi. wind (219,000 lb.). In final oisting position the upstream force becomes 121,000 lb., hich is good for a 7-mi. current and a 4-lb. wind. By ansferring line 1 to bitt 2 in the third position a 7-mi. rrent and a 17-lb. wind (293,000 lb.) would be overme; by transferring line 4 to bitt 2 in the final position 7-mi. current and a 9-lb. wind (186,000 lb.) could be ovided for.



G. 5. DETAIL OF ARRANGEMENTS FOR MOORING AND HOISTING THE SUSPENDED SPAN OF THE QUEBEC BRIDGE

The mooring frames, as shown in Figs. 3 and 5, are de of two steel trusses with bracing and are suspended om the cantilever-arm floor-beams at panel point CF1. ey are hung at the upper ends so that they can be ung back, in order not to obstruct the channel unnecesrily, practically up against the plane of the bottom chords of the cantilever arms, by means of a nine-part ⅞-in. wire-rope tackle leading from the lower corners of the trusses to the connection to the floor between panel points CF5 and CF6 of the cantilever arms and from there to the main hoists, situated at the floor level of the cantilever arms and on the center line of the bridge. These trusses and their connections throughout were designed to take a transverse pull from the suspended span of 300,000 lb.

Work of Hoisting

As soon as the span is pulled into position, before being lifted from the scows, the hanger chains will be swung down and connected through the slotted holes at the lower end to the pins at the top of the short hanger link, shown in Fig. 6, connecting to the supporting girders under the joint XLO.

These hanger chains at each corner of the span are made up of four strings of slabs to each chain. Each slab is built up of two 30x1⅛-in. carbon-steel plates. The allowable working erection unit stress through the pin holes was 20,000 lb. per sq.in., which included the stress from 20% of the lifted load as impact. No reinforcing pin plates were used around the pin holes, and special tests made showed that this apparently high working stress through the pin holes was perfectly safe for this type of connection. The slabs were manufactured and shipped in lengths of about 30 ft. c. to c. of end pin holes. They were controlled after being suspended from the jacking girders by means of a two-part tackle connecting to the cantilever-arm trusses at panel point CL2.

The hanger chains connect at the lower end to supporting girders, shown in Fig. 6. These supporting girders are 6 ft. 11½ in. back to back of angles and 25 ft. long. They are built up of two plate girders, connected together by bearing, stiffening and pin connection diaphragms and also by cover-plates. The load of the suspended span is transmitted to the girders by means of a cast-steel rocker joint, designed to allow turning about the transverse and longitudinal axes of the bearing.

The upper supporting girders at the CU0 joint of the cantilever arm are designed in a similar manner to the lower supporting girders, the rocker bearing for the girders and the pin connection for the vertical hangers allowing turning about both the transverse and longitudinal axes of the supporting girders. With bearings of this design the suspended span may move in any direction under the influence of whatever external forces from wind or current may act on it during the hoisting of the span.

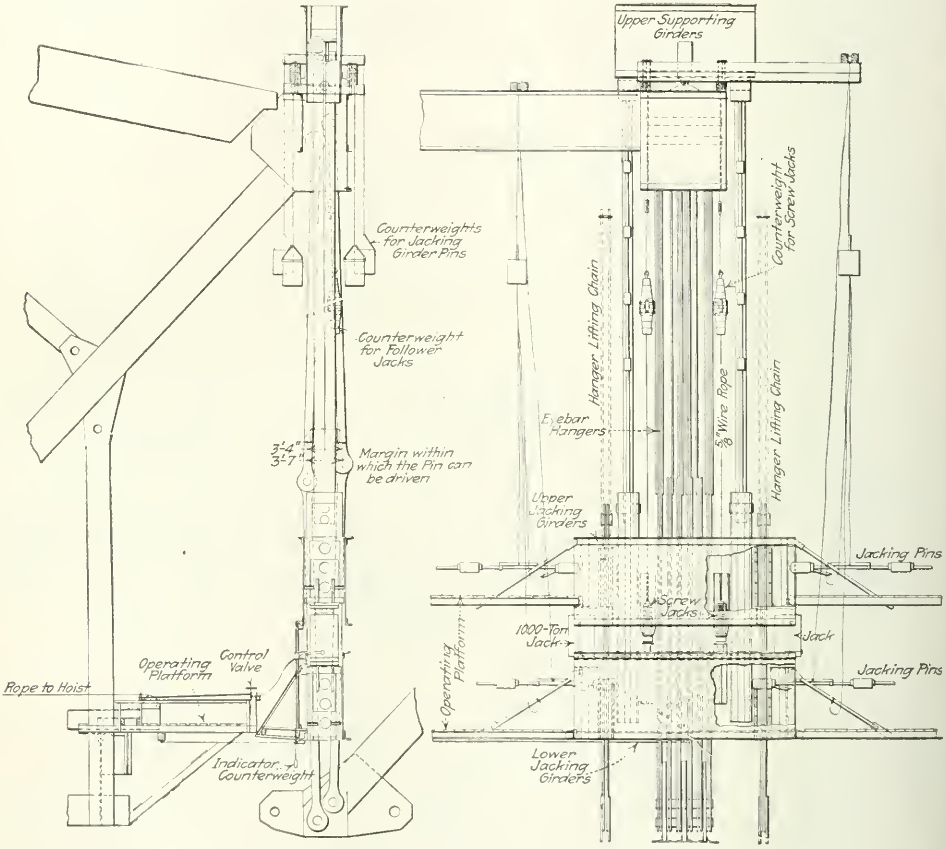


FIG. 6. JACKING EQUIPMENT FOR HOISTING THE QUEBEC SUSPENDED SPAN

The total load carried by the hanger chains while lifting the span is 5,147 tons. The supporting girders, hanger chains, jacks and jacking girders and all their connections are designed throughout to carry this lifted load plus 20% impact.

As shown in Fig. 6, the jacking girders are located at the same elevation as the floor of the cantilever arm. They are hung from the upper supporting girders by stiff hangers that are pin-connected at the upper and lower ends. At the lower ends these stiff hangers are attached to guides built of plates and angles that pass through the upper jacking girders and are riveted into the lower jacking girders. The position of the lower girders is therefore fixed, and their distance from the panel point CU0 does not change during the jacking operation. The upper girders are the movable girders, and they slide up and down the guides as the 1,000-ton jacks are operated. These jacks are placed between the upper and lower jacking girders, two at each corner of the span, and do the work of lifting the span. In order to avoid binding of the jacks, due to the deflection of the jacking girders under load, the jacks are provided with rocker seats at their upper and lower bearings. They are located at the extreme ends of the jacking girders, where they bear against transverse diaphragms riveted into the jacking girders.

In addition to the hydraulic jacks, following-up screw jacks are provided as a safety device in case anything should go wrong with the pumping system for the hydraulic jacks or the jacks themselves, so that they should fail to maintain the pressure of about 4,500 lb. per sq.in. necessary to hold the weight of the suspended span while being lifted. These screw jacks also react against cross-girder diaphragms in the jacking girders. The screw itself is counterweighted so that practically all the friction due to its own weight is eliminated, and the operator of the screw jacks will be able to turn the screw without difficulty and follow the operations of the hydraulic jacks with equal speed and very little exertion.

The hanger lifting chains are guided between cross pin-bearing diaphragms riveted into the jacking girders. These chains are bored every 6 ft. c. to c. to receive a 12-in. pin while the cross-diaphragms have holes for the same diameter of pin bored at 2-ft. centers. The clearance provided in the pin holes of the hanger chains is ½ in. ransversely and ⅞ in. longitudinally, and in the pin holes of the cross-diaphragms 1 in. transversely and 1¾ n. longitudinally. This clearance is considered ample to llow the pins to be driven, no matter what position the pan may take while hoisting, due to the action of current nd wind. Having the pin holes in the cross-diaphragms t 2-ft. centers enabled the pin holes in the hangers to e bored at 6-ft. centers and at the same time accommoated the 2-ft. stroke of the jacks.

Each operation of the jacks will lift the span 2 ft. During the lifting or upward stroke, the 12-in. pins ngage the hanger chains through the diaphragms in the pper jacking girders. At the finish of the stroke the ns are entered in the diaphragms of the lower jacking rders to engage the hanger chains. The upper pins are hen removed, the jacks and upper girders lowered, the pper pins again entered, the lower pins removed and the cks again operated. As each 30-ft. length of hanger hain passes up through the upper jacking girders it is sconnected and removed. The jacking pins are counterighted and balanced to enable them to be handled with cility by the men on the operating platform.

The jacks are supplied with water under pressure of out 4,500 lb. per sq.in. by a pair of direct-acting doubleunger pumps, operated by compressed air and located the center line of the bridge floor at the ends of the ntilever arm. By means of a pair of control valves stalled in front of the pumps the supply of water sent to h corner of the span can be regulated, and in this nner with the aid of a simple counterweighted-line licator in front of the valve operator, which will show y difference in level between the lifting girders on each e of the bridge, the two corners of each end of the span n be kept at the same elevation. Another set of valves h a similar indicator is placed on the operating platm in front of each set of jacking girders to control the ter-supply to each separate jack, so that the ends of the king girders, during jacking operations, can be kept el. The feed-pipe line is connected to the jacks by ans of two ⅜-in. copper pipes which are sufficiently ible to allow for any swaying motion of the span while ng hoisted.

Tests of the complete water-feed pipe lines and hydrau- jacks were made under a pressure of 6,000 lb. per sq.in. The jacking girders were tested with a load on the jacks equal to 5,000 lb. per sq.in. pressure. The working load on these jacks would be about 4,500 lb. per sq.in. Each individual scow was tested for leakage after the scows were in place, by closing the bottom valves of one scow at a time and allowing it to react against the weight of the span as the tide rose.

The vertical distance through which the span will be hoisted depends upon the varying elevation of the water level, but will be approximately 145 ft. Each operation of the jacks hoists the span 2 ft., and a cycle will take about 15 min. to complete. Altogether there will be approximately 73 separate lifting operations, and the time consumed from the moment of coupling up to the hanger lifting chains to the moment of driving the last pins connecting the two portions of the permanent eye-bar suspenders will be approximately 20 hr., provided no unforeseen delays occur.

The work is being carried out under the supervision of the Board of Engineers, Quebec Bridge, composed of C. N. Monsarrat (Chairman and Chief Engineer), Ralph Modjeski and H. P. Borden. The St. Lawrence Bridge Co. is the contractor for the superstructure, of which company Phelps Johnson is President; G. H. Duggan, Chief Engineer; George F. Porter, Engineer of Construction; S. P. Mitchell, Consulting Engineer of Erection; and W. B. Fortune, Erection Superintendent.

Enlarging the Engineering Societies' Building

The August *Proceedings* of the American Society of Civil Engineers contains the final agreement between the governing board of that society and the United Engineering Society, under which the former becomes one of the founder societies and acquires the ownership of a one-fourth interest in the Engineering Societies' Building at 29 West 39th St., New York City, with the ground on which it stands.

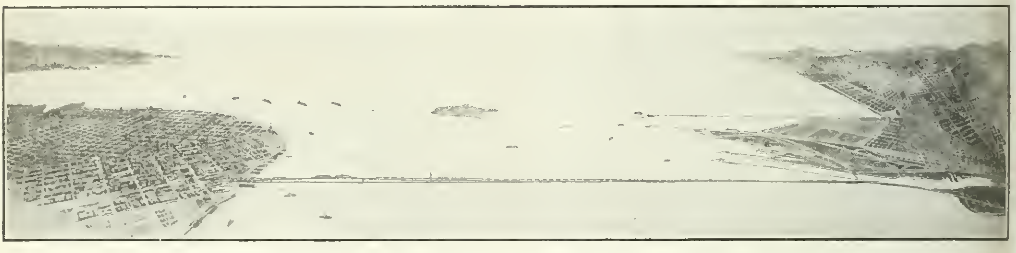
The building is to be enlarged by the addition of three more stories, making a total height of 15 stories. The building committee in charge of this work is made up of one member from each of the constituent societies, Messrs. H. H. Barnes, Jr., H. G. Stott, Charles Warren Hunt and Charles F. Rand. The committee has awarded the contract for the preliminary structural work, and the contractor began work on Aug. 1.

The American Society of Civil Engineers is to pay the cost of adding these three additional stories, provided the cost is not in excess of $250,000, in which case the balance will be paid by the United Engineering Society. The library now owned by the American Society of Civil Engineers is to be added to the Engineering Societies' library, the whole to be conducted as one public library under the management of the United Engineering Society. The representatives of the American Society of Civil Engineers in the United Engineering Society are Clemens Herschel, Charles Warren Hunt and J. V. Davies. Suitable changes have been made in the constitution and bylaws of the United Engineering Society so that the four societies stand on an equal footing in it, exactly as would have been the case had the American Society of Civil Engineers joined the other three societies in the building enterprise twelve years ago.

Planning for a Bridge Across San Francisco Bay

All traffic, both freight and passenger, entering San Francisco from the east has to be transferred across San Francisco Bay, a body of water nearly five miles in width. The cities of Oakland, Alameda, and Berkeley, situated on the east side of the bay, contain the residences of many thousands who work in San Francisco. The steady growth of traffic across the bay has caused the agitation of plans for constructing bridges or tunnels to give direct passage across the bay. On account of possible interference with navigation, the construction of such a bridge requires the approval of the War Department.

A public hearing was held at San Francisco Aug. 15 and 16 and in Oakland on Aug. 17 by a Board of Engineers made up of Col. Thomas H. Rees of San Francisco, Col. Charles L. Porter of Portland, and Major George B. Pillsbury of Los Angeles. Three plans for bridging the bay were presented. The first was offered by a firm known as the Associated Bridge Engineers, composed of Wilbur J. Watson & Co. of Cleveland, Wm. Russell Davis of Albany, and Harlan D. Miller of Albany, N. Y., and Oakland, Calif. A photograph of the design submitted is reproduced herewith. These engineers propose to cross the bay at a point farther south than the bridge sites hitherto considered. Practically all the piers on the San Francisco water front used by ocean shipping are located north of the line of the bridge so that the interference with navigation would be a minimum. The bridge is therefore placed at a comparatively low level, the vertical clearance above mean high water being 20 to 90 ft. Near the San Francisco shore there are two 575 ft. spans with a vertical clearance of 115 ft. To admit the passage of occasional vessels which might require even a greater height, a drawspan is located about one mile from the San Francisco shore having a length of 250 ft. This could be of either the bascule or the direct-lift type, and in the latter case a clear height of 200 ft. would be afforded. A similar provision would be made for the benefit of navigation where the bridge crosses the Oakland channel. The span here would have a vertical clearance of at least 60 ft. above high water when the bridge was closed and at least 200 ft. with the bridge open.



"ASSOCIATED BRIDGE ENGINEERS'" BRIDGE ACROSS SAN FRANCISCO BAY

The total length of the structure would be approximately 30,200 ft., of which 17,400 ft. would be of steel spans. There would be sixty steel spans 250 ft. long and twenty-three 100 to 200 ft. long. As designed, the bridge would have a double deck, the upper one carrying two roadways for slow moving vehicles and a double-track roadway for high speed automobiles. The lower deck would carry two railway tracks for overland trains and two railroad tracks for interurban trains.

On the eastern side of the bay the water is very shallow for a long distance out from the shore. The present terminals on the eastern side of the bay for the ferries running to San Francisco are located between one and two miles out from the mainland, being carried partly by a fill and party by pile trestles across the mud flats and shallow water. The Associated Bridge Engineers base their estimates for the bridge on pier foundations made by driving piles, cutting them off below the clay line so that they would be in no danger from the teredo, sinking interlocking cellular caissons of reinforced concrete upon the cluster of piles and filling the chambers of the caissons with concrete deposited through a tremie. Where the spans are placed high above the water this construction would be varied by constructing steel towers on piers carried 10 ft. or more above high water.

The estimated cost of construction of the bridge is $18,700,000, and the estimated cost of land damages, interest during construction, engineering and incidentals is $5,200,000 making a total of $23,900,000.

The plan for financing the Associated Bridge Engineers' project is to organize a bridge assessment district, made up of San Francisco and the cities on the western side of the bay which would assume responsibility for the cost of construction. It is estimated that by charging a toll of 2½c. per passenger and suitable rates for trains, automobiles, etc., the bridge would earn an annual revenue sufficient to meet operating expenses, maintenance, interest and sinking fund charges.

Plans for a long span cantilever bridge were presented by Charles E. Fowler of Seattle. The site on which he proposed a bridge is from Telegraph Hill in San Francisco to Goat Island, and thence to Oakland. He proposed a clear height of 150 ft. and steel spans of a total length of 2,950 ft., with one cantilever span 800 ft. long. The estimate of cost was $75,000,000. Mr. Fowler proposed that a corporation be organized to build the bridge and operate trains over it in connection with the operation of the street railways on the east side of the bay. Plans for a suspension bridge with 2,000 ft. span, and a height of 180 ft., were presented by Alan C. Rush. The estimate of cost was $32,000,000.

On the following day plans for tunnels under the bay were presented by Taggart Aston, Jerome Newman, John G. Little, and Carl F. Reuter. A serious objection to the tunnel plan is that a tunnel would not be satisfactory for automobile traffic across the bay, which is very heavy constantly increasing, and which will stand a high rate of toll and therefore be very profitable for a bridge

News of the Engineering World

New Providence Water-Supply to be Filtered

Plans for filtering the new water-supply of Providence, R. I., prepared by Frank E. Winsor, Chief Engineer, were adopted by the Providence Water Supply Board on Aug. 23. The question has been under consideration for some time whether the water-supply should be filtered at the outset, or whether the site of the new Scituate reservoir should be stripped of surface soil before it is filled. Reports on the matter have been submitted by he consulting engineers, Allen Hazen, F. P. Stearns, and Samuel M. Gray.

Chief Engineer Winsor in his report to the board tated that "while it might be possible to obtain water of fairly satisfactory quality from the Scituate reservoir without filtration, he was strongly of the opinion that t should be the aim to procure the best water reasonably obtainable and that this cannot be secured in any other way than by efficient filtration." The reservoirs in which he water is stored after filtration will be covered to xclude the light and prevent the growth of algæ.

Concerning the proposal to strip the bed of the reservoir f surface soil, Mr. Winsor stated that the cost of stripping the bed of the entire reservoir has been estimated t not less than $700,000, and might very likely be a onsiderably larger sum. In his opinion the advantage o the quality of the water to be gained from stripping he reservoir would not be sufficient to justify such an xpenditure, since after a period of uncertain duration the ater conditions in an unstripped reservoir become he same as if the reservoir had been stripped. He recommended therefore that the area stripped should be onfined to that necessary to obtain a proper amount of impervious material for use in building the dam. Such rea may be from 10 to 25% of the total area of the reservoir. The height of flow line of the new reservoir as been fixed at El. 284.

⁂

Disposal of Packing-House and Stockyards Refuse

The disposal of packing-house wastes and stockyards ewage at Chicago has become a serious problem, owing o the enormous amount of such material and the large roportion of water required for the dilution of this pecial class of refuse as now discharged into the Drainge Canal. Experiments have been conducted, including reening and the activated-sludge process, and some efinite action is soon to be taken. At a recent conference between the packers and the Sanitary District of hicago a commission was appointed, consisting of W. . Richardson, chief chemist of Swift & Co., and Langon Pearse, of the engineering department of the Saniry District. They were instructed to determine whether he wastes originating in the stockyards and packing ouses can be practically treated by the activated-sludge rocess, at one plant or a community plant, so as to produce an effluent proper to be discharged into the channels of the Sanitary District. If their conclusion is affirmative, they are to report what works and appliances are necessary for collecting and treating the wastes; where these works should be located; and what will be the approximate cost for installation, operation, maintenance and repair of such a plant.

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Montreal Aqueduct Combined Bridge and Headgates

Three large Stoney gates and a highway bridge combined in one structure form Contract 3 of the Aqueduct Enlargement of the Montreal Water-Works, for which bids are to be opened on Sept. 6. Each of the Stoney gates will be 58½ ft. long by 18 ft. high, overall, and will have a lift of 17 ft. under a 23-ft. head. They will be made up of five horizontal girders and two vertical end girders, properly braced, and a ⅜-in. steel skin plate on the water side. Each gate will have a clear waterway of 57 ft. between the bridge piers and abutments and the latter will be carried up as towers to house the lifting mechanism of the bridge. The jackshafts will be inclosed in horizontal members of the combined structure.

The bridge will be 251 long, including abutments, and will have a roadway 36 ft. wide (designed for street-railway tracks ultimately) and two 5-ft. sidewalks. The combined structure, except for the gates, will be of reinforced concrete.

The detailed plans for the headgates were made by the Dominion Bridge Co. and of the bridge by L. G. Mouchel and Partners, both of Montreal. Frederick E. Field is resident engineer and Frank Dorrance is assistant engineer of the filtration and aqueduct works, and T. W. Lesage is engineer and superintendent of the Montreal water-works.

⁂

War Department Hearing on Allegheny Bridge Raising

The latest development in the long-standing controversy over the raising of the Allegheny River bridges in Pittsburgh is the report of Gen. William M. Black, Chief of Engineers, to the Secretary of War, concurring in new recommendations made by Lieut.-Col. Francis R. Shunk. These recommendations reduce the final clearance under the bridges by 1 ft., thereby reducing the approach grades. They also allow the changes to be made at the rate of one bridge every two years, until 1929. On receipt of Gen. Black's report Secretary of War Baker set Aug. 31 for a hearing at Washington on this report.

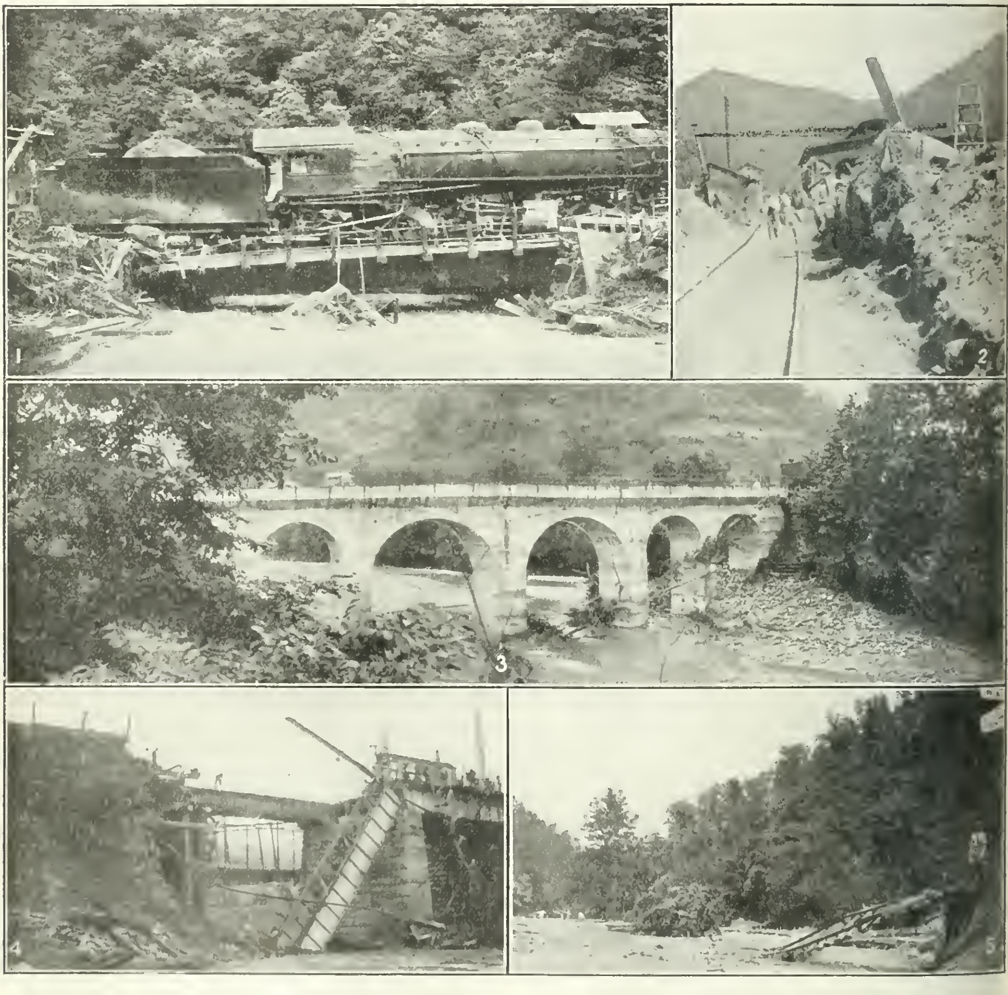
The city authorities of Pittsburgh and the Allegheny County officials are unanimously opposed to the order, which would mean the rebuilding of the six publicly owned structures. It was their contention during the hearings that the bridges, which are many of them main arteries of traffic, could not be reconstructed with the 5%

grades needed by the clearance originally suggested by the U. S. Engineers, and that the damages consequent to moderate grade approaches in the Pittsburgh downtown district would add several millions to the cost of reconstruction of the crossings themselves. The War Department does not agree with this, and in his report Lieut.-Col. Shunk stated:

> It is my opinion that the alleged cost of $13,752,049 simmers down to the following: The county will be required to spend $2,814,717 (which I think a liberal estimate), for which it will get full value in new bridges, and will be out of pocket a sum not to exceed $1,091,559, which is already paid. To offset this, improved navigation on the Allegheny River will be a benefit.
>
> To sum up, it is my opinion that these bridges are obstructive to navigation; that the improvement of the Allegheny will be nullified unless they are modified, and that the advantages which will result from the modifications will outweigh the disadvantages. I therefore recommend that the necessary modifications be ordered by the Secretary of War. In consideration of the expense entailed upon the county it seems just to give them plenty of time to do the work.

West Virginia Flood Damage

It is now very doubtful if any complete meteorological data will be obtained from the Aug. 9 floods in the Coal River, Cabin Creek and Paint Creek watersheds in West Virginia, notes on which have appeared in the last few issues of *Engineering News*. It has been established that there were no rain gages in the district, and so far no determinations have been made of the discharge of any of the three streams, so that it is impossible to state accurately the rainfall and runoff. All manner of estimates as to the amount of rain have been given, but none of them are at all reliable except possibly one that was taken by a retired mine fireboss at Kayford, who claims that he measured the rainfall in an ice cream freezer and that in three and a half hours 5.8 in. fell. While the water was higher on Coal River, property damage was less as it is less thickly settled.



FIGS. 1 TO 5. DAMAGE TO STRUCTURES IN FLOODS IN WEST VIRGINIA

Fig. 1—Heavy locomotive holding short bridge in place. Fig. 2—Cut through débris in railway yard. Fig. 3—Concrete bridge which withstood flood. Fig. 4—Steel bridge which failed. Fig. 5—Typical railway washout

The estimates of the damage are still somewhat inaccurate, but it appears now that 520 houses were washed ut and destroyed on Cabin Creek alone. The damage to railroad property, including rights of way, rolling stock, tc., will probably be not less than $500,000. The county oads on both Coal River and Cabin Creek have been enirely washed out, and a considerable amount of money nust be expended to build new roads. Some of the minng towns are so completely destroyed that the coal comanies may stop running entirely. The majority of the owns, however, will be rebuilt and the mines put in opration again as rapidly as possible. Labor will be scarce s there has been a general exodus from the creek on ccount of the flood. It is estimated that there is less han one-third the normal population on Cabin Creek at he present time.

The flood damage to bridges and railway embankments as almost complete. The accompanying views show ome of the conditions after the flood. The reinforced-oncrete bridge in the view is only 300 ft. upstream from e Chesapeake & Ohio Ry. bridge destroyed as shown in ig. 4. The concrete bridge, however, stood intact alough it had to take the full head of the flood. The ashout of railway embankments is well illustrated in ig. 5. There are miles of railway track taken out in is manner. In many places the creek has shifted its d 100 yd., leaving the bridges high and dry. Fig. 1 ows a large Mallet compound engine which was on a idge at Cane Fork to prevent the bridge from being shed out and to deflect the water away from the maine shops there. The shops were saved by this method the river broke through and formed a new channel d great damage was caused to the town of Eskdale by e extremely high water thus occasioned. The railway rds at Cane Fork were covered 5 or 6 ft. deep with e débris from the flood and the tracks had to be exvated as shown in the view in Fig. 2.

The State Department of Health, under the direction Mayo Tolman, Director of the Division of Sanitary ngineering, was very active in sanitary regulation of e district after the flood. Immediate steps were taken prevent the outbreak of typhoid fever from polluted ter and all wells were disinfected as soon as possible and sted with a sign "This well probably safe for drinking." ti-typhoid vaccine was furnished free to doctors in the od district and it is estimated that nearly 5,000 persons eived the treatment. Several carloads of lime were ipped into the district so the people could have all they sired for sprinkling about their homes. Coal companies were very quick to appreciate the coöperation of state and did everything in their power to alleviate suffering among the miners' families.

⁂

nother Cantilever Bridge for the Mississippi

The latest addition to the bridges spanning the Missippi River will be a cantilever bridge at Burlington, va. There is a low-level railway bridge at that point, t the new bridge will be for highway traffic, and will e its channel span at such a height as to give 56 to ½ ft. clearance above high water. This will allow for igation and thus avoid the necessity of a draw span. e approaches will have 1% grades. The main part of bridge consists of cantilever trusses giving a channel span of 480 ft. c. to c. of piers, and two shore spans of 260 ft., or a total length of 1,000 ft. over the trusses. The central suspended span is to be 216 ft. long, carried by 132-ft. anchor arms. At the west (Burlington) end, there will be eight deck I-beam and plate girder approach spans on steel bents, and a 140-ft. deck-truss span to the shore arm of the cantilever. At the east end there will be six plate-girder spans and four truss spans of 120 to 175 ft.; all these will be deck spans on cylinder piers.

The total length of steelwork will be 2,463 ft., with a masonry abutment and short fill at the west end, and a short fill at the east end to connect with a river-front levee on which a highway is located. The foundations of the main piers are of concrete, on piles driven into hardpan. The bridge connects the city with a county road, and tolls will be charged. The project is being financed jointly by the city and the Commercial Club, the latter's interests to be bought out eventually by the city. There will be a 21-ft. roadway and a single 5-ft. sidewalk, and provision is made in the floor system for a future track for an electric railway. The bridge was designed and is being built by the Wisconsin Bridge & Iron Co., of Milwaukee, Wis. Work is now in progress on the substructure and the approaches.

⁂

The Boston Dry Dock Coffer-Dam. which failed some weeks ago, as noted in "Engineering News," is to be reported on by Joseph Ripley and Mortimer G. Barnes, Consulting Engineers, of Albany, N. Y.

A New Union Station at Jacksonville, Fla., is to be started soon. The Jacksonville Terminal Co. under an arrangement just completed will erect a station which will cost with the trackage change necessary for its erection about $3,000,000. Definite plans for the station are still under discussion.

Damage to Roads and Bridges in the recent floods in North Carolina is estimated by Dr. Joseph Hyde Pratt, State Geologist and head of the State Highway Department to amount to $1,500,000. In some instances, it is stated, the roads will have to be entirely relocated. Surveys are already under way. Efforts are being made by the counties to salvage parts of bridges which remain intact, and Dr. Hyde estimates the saving will be from 25 to 60% in this way.

A Competition for Plans for the rebuilding of Dublin, Ireland, has just been completed. Announcement was made that the first of $2,000 offered by Lord Aberdeen for the best set of plans for the building and grounds of the city government of Dublin has been awarded jointly to Prof. Patrick Abercrombie, of Liverpool University, and Sydney A. Kelley and Arthur J. Kelley, both of Liverpool. F. A. C. Smith, Assistant Director of the Civic Extension Service of the Massachusetts Agricultural College, the only American contestant, received honorable mention.

Grade-Crossing Work at Detroit Is About To Be Undertaken—An agreement has been signed between the city officials and the railways contemplating the separation of grades on the west side of the city. This work will involve an expenditure of about $2,000,000, and will be started as soon as possible. The present grade separation work is nearing completion at Holden, Lincoln, Trumbull and Commonwealth Ave., and work has just been started at Kirby and Wabash Ave., 12th St., so it is not regarded as probable that the west side work will be taken up before next spring.

A New Bridge Across the Kaw River at Osage Ave., Kansas City Kan., is contingent on the acceptance by the railroads involved of the 200-year franchise recently voted. This bridge is for the Kansas City Terminal Railway Co If the franchise is acceptable to all the railroads, construction work amounting to $5,000,000 or $6,000,000 will be started immediately. The first piece of work will be the building of a four-track, two-deck bridge over the Kaw River to replace the present single-track structure. The new bridge will be built on the present piers and have a 300-ft. center truss span. The upper deck will not be used until after completion of the new high line viaduct crossing the bottomland on each side of the river Contract will be awarded for the construction as soon as the new franchise is assured.

A Tropical Storm Swept Over the Coast of Texas on the night of Aug 1[illegible] and caused considerable damage to property and killed a number of people. The storm seemed to center at Corpus Christi, where the intensity of wind and tide height were unprecedented there or elsewhere on the Texas coast At some distance inland from the gulf all timber structures along the water front, including the pleasure piers and wharves at San Antonio and the Aransas Pass trestle, and the cheap cottages along the beach were all badly damaged or destroyed. The causeway at Corpus Christi, which was described in "Engineering News," Mar. 30, 1916, p. 628, was also affected. About two-thirds of the fill approaches were destroyed, but the concrete bridge section is absolutely undamaged although swept by waves.

A Five-Story Tenement under construction on Marion Ave. and 187th St., the Bronx, New York City, collapsed on Aug. 23 and carried down in the fall a number of workmen, two of whom were killed and 15 were injured. The structure was of the brick and frame wall bearing type, and from testimony before a preliminary coroner's and district attorney's examination was a fine example of jerry-building. The contractor, for instance, testified that he had heard there was such a thing as a Building Code, but that he had never had time enough to read it. Violations of the code and of the design were made in substitution of stone for cast-iron templets, reduction in the strength of the mortar and in the general quality of the construction. As a result of the preliminary investigation three members of the contracting firm and three inspectors in the building department of the Bronx were arrested on a charge of criminal negligence.

Failure to Submit Falsework Drawings for the approval of the United States Engineer Office at Pittsburgh, in advance of starting construction of a reinforced-concrete arch bridge across the Allegheny River at Warren, Penn., will cause a delay in completion of several months and an estimated added cost to Warren County of $20,000 in a $125,000 structure. The contractor, the C. H. Fath Construction Co., of Cleveland, Ohio, had practically finished driving piles according to the arch centering layout shown on the design drawings when the Engineer Office reminded it that falsework plans had not been sent for approval, and after receiving them, issued an order calling for two 50-ft. openings. This was later modified to two 30-ft. openings, of 20 ft. height, for the maintenance of navigation under the River and Harbors Act of 1899. Local papers state that no craft requiring openings of this size have been seen on the river there for 20 years and that a mile below the bridge a boy can wade the shallow stream.

The Joint Conference Committee representing the National engineering societies adopted several weeks ago a resolution urging legislation by Congress to enable the development of water power ("Engineering News," June 29, p. 1254). A copy of the resolution was sent to President Wilson and he has just sent the following reply to the Secretary of the Joint Conference Committee, Charles Warren Hunt:

> The White House, Washington, Aug. 25, 1916.
>
> My Dear Mr. Hunt:
>
> I find to my great chagrin that I have omitted to acknowledge your communication of June 28 conveying to me the resolution adopted by the Joint Conference Committee of National Engineering Societies at its meeting held on June 15, with regard to the development of the water power of the country. I the more regret the oversight because the resolution in fact made a deep impression upon me as the declaration of a body whose opinions carry the greatest weight, and I can only beg that you will present my apologies and also an expression of my sincere appreciation.
>
> Cordially and sincerely yours,
>
> WOODROW WILSON.

The Project for a Railway Tunnel under the English Channel at the Straits of Dover is again receiving attention in Great Britain. A committee made up of members of the House of Commons who favor the construction of the tunnel entertained a party of distinguished French visitors on July 28. The length of the tunnel would be, with approaches, about 25 mi. According to "The Engineer" of London, Baron Emile D'Erlanger, in a speech at the conference, stated that the estimated cost of constructing the tunnel was £16,000,000. The probable revenue from the tunnel is estimated as follows: Taking the annual passenger traffic across the Channel in both directions at 2,000,000 passengers, it is estimated that 65% would use the tunnel route, and at an average charge of 10s. this would produce an income of £650,000. To this is added £65,000 for baggage, £40,000 for postal service, and £800,000 for freight traffic. From the total gross earnings of £1,555,000, the operating expenses estimated at £420,000 are deducted, leaving net earnings of £1,135,000, or a little over 7% on the investment.

Sewage Pollution of Chicago's Water Supply due to flooding of some of the pumping stations on the south side with sewage last spring is to be investigated. The Department of Public Works and the Health Department have claimed that this pollution was caused through improper operation of the sewage pumping plant which handles sewage from the intercepting sewers. It is thought however, that one prominent reason for this trouble may be found in the rapid growth of that part of the city since the interceptors were built, so that these may be overtaxed during heavy storms. The Sanitary District of Chicago, which has charge of the operation of the sewage pumping stations, has appointed a special commission to make an investigation of the 68th St. and 39th St. pumping stations and the south-side intercepting sewer system. This commission is composed of the following members: George G. Earl, Chief Engineer and General Superintendent of the Sewage and Water Board of New Orleans, La.; Isham Randolph, Consulting Engineer, of Chicago; and Lyman E. Cooley and Langdon Pearse, of the engineering department of the Sanitary District of Chicago. Mr. Randolph was for many years Chief Engineer of the Sanitary District, and Mr. Cooley has been connected with the Drainage Canal project since its inception.

PERSONALS

George H. Ruhling, of Pittsburgh, Penn., has joined the staff of E. C. Shoecraft, City Engineer of Flint, Mich.

T. H. Ratliff has been appointed Engineer of Maintenance-of-Way of the Indianapolis Union Ry., Indianapolis, Ind.

M. P. Northam, Assoc. M. Am. Soc. C. E., Office Engineer, Southern Ry., Washington, D. C., has been promoted to be Supervising Engineer.

F. H. Tapley, Assoc. M. Am. Soc. C. E., has been appointed Assistant Engineer of the Canadian Government Rys., with headquarters at Moncton, N. B.

Nelson F. Tift has been made Superintendent of the Water, Electric Light and Gas Departments of the City of Albany, Ga. He has served as Mayor, member of the Council and member of the Police Commission of the city.

Harry S. McKibben, Assoc. M. Am. Soc. C. E., City Engineer of Warren, Ohio, has resigned. Mr. McKibben is reported to have said that his resignation was made because he lacked sufficient authority to make his department efficient.

Ira G. Hedrick and Victor H. Cochrane, M.'s Am. Soc. C. E., Consulting Engineers, Kansas City, Mo., have dissolved partnership, and the firm of Hedrick & Hedrick has been formed. The junior member of the new firm is A. L. Hedrick.

Hudson F. Layton, M. Am. Soc. C. E., Consulting Engineer Pittsburgh, Penn., has retired from active practice and has sold all his plans, notes and records to Blum, Weldin & Co. Engineers and Surveyors, St. Nicholas Building, Pittsburgh

P. J. Freeman, Assoc. M. Am. Soc. M. E., has resigned as Assistant Professor of Applied Mechanics at the Kansas State College, Manhattan, Kan., and is now with the Pittsburgh Testing Laboratory, Pittsburgh, Penn., as Engineer of Tests

H. J. Lockwood, Assoc. M. Am. Soc. C. E., Vice-President and General Manager of the New Iberia & North R.R., New Iberia, La., has been appointed Vice-President and General Manager of the Apalachicola Northern R.R., with office at Port St. Joe, Fla.

F. M. Masters, Assoc. M. Am. Soc. C. E., for several years Chief Inspector in the Pittsburgh (Penn.) district for Modjeski & Angier, Consulting Engineers, Chicago and Portland, Ore has resigned to enter private practice as Inspecting Engineer, with headquarters at Harrisburg, Penn.

Dr. William McClellan, F. Am. Inst. E. E., Consulting Engineer, New York City, has been appointed Dean of the Wharton School of Finance and Commerce of the University of Pennsylvania. Dr. McClellan is a native of Philadelphia and was graduated from the University of Pennsylvania in 1900. For two years, 1911-13, he was Electrical Engineer of Public Service Commission of the Second District, New York State.

George F. Weighardt, Assistant Engineer of the Pennsylvania State Water Supply Commission, has resigned to become Assistant Water Engineer for the City of Baltimore, Md. Mr Weighardt became connected with the Pennsylvania Commission in 1913 and was stationed at Cotesville, where he supervised construction of a large dam. He succeeds Robert I Clement, who resigned after being connected with the Baltimore water department for 30 years. Mr. Weighardt is a graduate of Cornell University. He assumes his new duties Sept. 3.

The American Industrial Commission to France, organized by the American Manufacturers' Export Association, includes several men prominent in engineering; among them are John R. MacArthur, of MacArthur Brothers, General Contractors of New York City; Dr. C. O. Mailloux, F. Am. Inst E E

Consulting Engineer, New York City, N. F. Hoggson, President of Hoggson Brothers, Inc., Contractors, New York City; Ambrose Swasey, M. Am. Soc. M. E., President of Warner & Swasey, Cleveland, Ohio; George B. Ford, of George B. Post & Sons, Contractors, New York City, and James E. Sague, M. Am. Soc. M. E., Poughkeepsie, N. Y., former Vice-President of the American Locomotive Co. The Chairman of the commission is William W. Nichols, M. Am. Soc. M. E., Assistant to the Chairman of the Board of Directors of the Allis-Chalmers Manufacturing Co., of New York City. The commission sailed Aug. 26 for France where it will make a scientific study of the industrial conditions, to determine the most advantageous method of assisting in the reconstruction that will follow the war.

OBITUARY

Henry Clay Malott, a retired civil engineer and contractor, ied recently at his home in Bedford, Ind., aged 72 years.

Archibald Case, a young civil engineering employee of Snare & Triest, contractor for the completion of the concrete ower tops of the Hell Gate arch bridge, New York Connecting R.R., was killed Aug. 25 by a box falling upon him from the ridge superstructure.

Edward Canfield, M. Am. Soc. C. E., General Superintendent f the New York, Ontario & Western R.R., died Aug. 19, at his ome in Middletown, N. Y. He was born in 1848 and was raduated from Hobart College at Geneva, N. Y., in 1869. He egan his engineering experience with the Erie & Genesee alley R.R. the same year. He served as Assistant Engineer nd as Division Engineer of various Eastern railways until 882, when he entered the operating department of the New ork, Ontario & Western R.R. as Division Superintendent. or seven years, 1887 to 1895, he was Chief Engineer of the ailway, and since then General Superintendent.

Sinclair J. Johnson, a civil and mechanical engineer, died at is residence in Montclair, N. J., on Aug. 11, aged 64 years, fter a lingering illness. He was a native of Wayne County, hio. After graduation from Wooster College he studied vil engineering at the Thayer School of Dartmouth College, anover, N. H. He was engaged for a number of years in vil engineering work, including water-works construction nd the design and erection of steel buildings. He had much riginality as an inventor and developed a number of devices hich he patented for use in railway-car construction and a ydraulic system of power transmission. A wife and five aughters survive him.

John Dean, a retired civil engineer and contractor, died ug. 17, at his home in Chicago, Ill. He received his engineerng education at Owens College, Manchester, England. He ame to this country in 1885 and was engaged in engineering ork for several Middle Western railways. Later he was ngineer of Parks of St. Louis, Mo. As a contractor he did xtensive work in grading and concrete bridge building uring the early nineties. Afterward he had construction conracts on the Grand Trunk Ry. and for the cities of St. Louis, o., Manistee, Mich., and Des Moines, Iowa. He was for many ears a member of the Engineers' Club of St. Louis and of he American Railway Engineering Association. He is surved by a widow and one son, Stanley Dean, Assoc. M. Am. oc. C. E., a civil engineer of Chicago.

John Noey, one of the pioneers of the Pennsylvania steel ndustry, died Aug. 23, aged 65 years. The following is from he Pittsburgh "Gazette-Times" of Aug. 25:

> He was born in Johnstown, Penn., a son of John Noey, Sr., nd came naturally by his skill in mechanics, his father aving been one of the pioneer employees of the old Cambria ron Co.'s plant at Johnstown, now the Cambria Steel Co. ohn Noey, Jr., entered the employ of the Cambria Steel Co. nd was a protege of the late Capt. William R. Jones, the uilder, with Andrew Carnegie, of the Edgar Thomson Works nd Mr. Carnegie's first partner in the steel business. When aptain Jones went to Braddock in 1874 to build the Edgar homson mills he took Mr. Noey with him. At the time of s death Mr. Noey was superintendent of the boilers and of otive power at the Thomson steel works and blast furnaces. hen Andrew Carnegie established his "junior partners'" nd 16 or 17 years ago, before his retirement, in recognition the loyalty and service given by his employees at the first ant, Mr. Noey was made one of the "junior partners."

Stehman Forney, an officer of the United States Coast and eodetic Survey since 1865 and a veteran of the Civil War, ed in New York City, Aug. 8, in the 71st year of his age. e was born at Lancaster, Penn., Apr. 22, 1846, and was ducated at Lebanon, West Chester and Lititz academies, in ennsylvania. He entered the Coast Survey as Aid, Jan. 1, 65, was promoted to Subassistant July 1, 1868, and was ppointed an Assistant Apr. 1, 1871. Mr. Forney's service in the Coast and Geodetic Survey was of a varied nature. He served with Prof. George Davidson in Alaska when that Territory was transferred to the United States by Russia in 1867. He served on both the Atlantic and Pacific coasts and in Porto Rico in charge of parties engaged in triangulations, topographic and hydrographic work. The last fieldwork upon which he was engaged was a revision of the surveys in the vicinity of Oyster Bay, Long Island, N. Y. For a time he was in charge of the engraving division of the Coast and Geodetic Survey office.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio

AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW YORK STATE ASSOCIATION OF COUNTY SUPERINTENDENTS OF HIGHWAYS.
Sept. 13-14. Meeting at Syracuse. George S. Tibbits, Chairman of Executive Committee, Oneida, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

AMERICAN CHEMICAL SOCIETY.
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The New York State Association of County Superintendents of Highways will hold its annual meeting in Syracuse, Sept. 13 and 14. The chairman of the executive committee is George S. Tibbits. The secretary is Dwight B. Coleman.

The Traveling Engineers' Association has decided to postpone its convention scheduled for Sept. 5 to 8 on account of the serious labor conditions on the railways. The secretary is W. O. Thompson, general offices, New York Central R.R., Cleveland, Ohio.

A Good Roads Congress in San Antonio, Tex., was held Aug. 17 to 19, under the auspices of the Texas Good Roads Association. D. E. Colp, secretary.

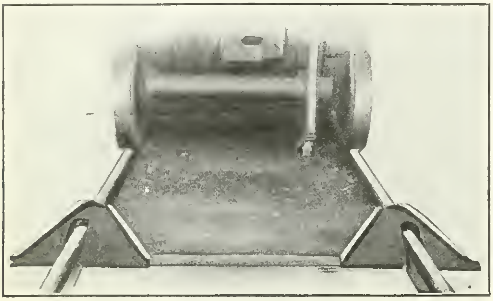
National Paving Brick Manufacturers Association has arranged the details necessary for a study and conference of brick-pavement construction, to take place Friday, Oct. 6, at Paris, Ill. The headquarters of the conference will be the Deming Hotel, Terre Haute, Ind., from which place those participating will go via the Interurban Ry. to Paris—an hour's ride—where a demonstration of construction will take place. This demonstration is designed to show the economy of building a brick pavement by laying the brick in green mortar (so-called monolithic construction). Members of the

American Society of Municipal Improvements on their way to the annual meeting of the Society at Newark, N. J., can spend Oct. 6 at this conference and reach Newark the following Monday. All those expecting to take part in this conference are requested to notify the Secretary of the National Paving Brick Manufacturers Association, Will P. Blair, Cleveland, Ohio, in order that they may be fully informed of the program, arrival and departure of trains, etc.

Appliances and Materials

Rerailer for Dump-Cars

A contractor's utility, known as the "Johnson Car Replacer," is now made by the Johnson Wrecking Frog Co., of Cleveland. It is intended particularly for putting dump-cars back on the track. The use is obvious from the accompanying view. The device is an openhearth-steel casting, ground smooth at the places of contact with the rails. It is sold by Clapp, Norstrom & Riley, 12 South Canal St., Chicago.

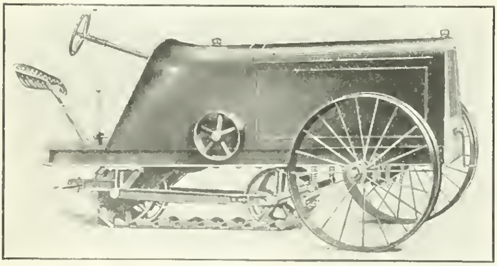


JOHNSON CONTRACTOR'S CAR REPLACER

* * *

A Tractor for Light Contract Work

The tractor illustrated herewith is guaranteed to develop 20 hp. on the belt and 12 hp. on the drawbar. It is manufactured by the Tom Thumb Tractor Co., of Minneapolis, bears the same name as the company and is designed primarily for farm work. The motor is of Waukesha make, having four vertical cylinders, a 4½-in. bore, 5¾-in. stroke and a speed of 800 r.p.m. The tank can contain 20 gal. of gasoline. The speed of the tractor is 2.7 mi. per hr. on high and 2.1 mi. on low gear. The steering wheels are 42 in. in diameter with 8x⅜-in. tires.



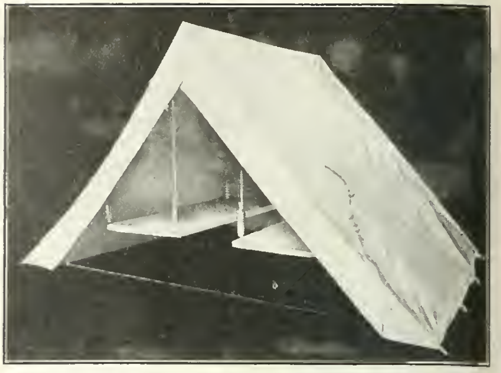
TOM THUMB TRACTOR FOR SMALL CONTRACTOR AND FARMER

The machine complete weighs 5,000 lb., which figures to about 5½ lb. per sq.in. of contact surface. The machine can be turned either way, both backward and forward, in a 15-ft circle.

* * *

Portable Tent and Bed Outfit

A new A-tent frame with two hanging bunks is being made by the Gosso Co., of Chicago, for survey and construction camps. The tent is 8½ ft. long, 11 ft. wide and 6½ ft. high. The frame consists of angle-iron A-ends connected by an angle ridge and fitted with round knee braces and wire ties around the bottom. Canvas bunks are swung by wires and springs from the end-frame legs. They fasten back against the sides when not in use. Legs, ridgepole and bottom sides are hinged, so that all can be folded to 4 ft. 8 in. in length.



GOSSO TENT WITH BUNKS

* * *

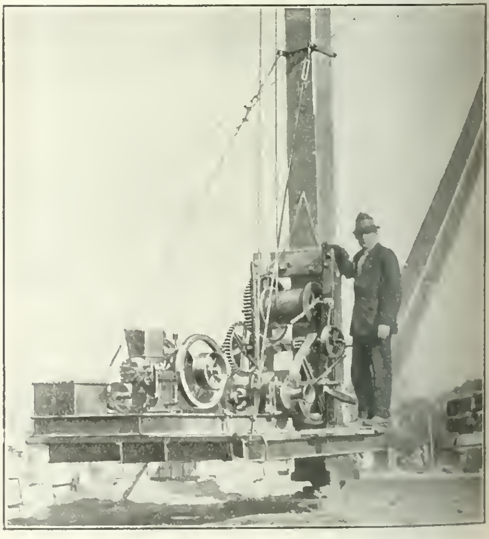
"Daylight" Electric Lamps

For special service where a color quality of illumination approximating daylight is required, as in displays, color printing shops, textile mills, etc., small nitrogen-filled tungsten-filament electric incandescent lamps, requiring 40 and 60 watts input, are being made with "Lunar" blue glass bulbs. They are being put out by the Lux Manufacturing Co., Hoboken, N. J.

* * *

Power Hoist for Attachment to Hand Guy Derricks

Hoisting outfits for taking the place of manual labor on guy derricks are sold in three sizes—3½, 5 and 7 hp.—by the Domestic Engine and Pump Co. of Shippenburg, Penn. The unit consists of engine, jack-shaft with clutch, two winch-heads and a platform that can be attached to the mast as a mounting for the hoist. The outfit can erect both itself and the derrick.



POWER HOIST ON HAND DERRICK

The smallest unit is intended for use with derricks having 12-in. or 14-in. masts; the larger units with 14- or 16-in. masts. The prices of the complete rigs are $372, $412 and $462 respectively.

Engineering News

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SEPTEMBER 7, 1916

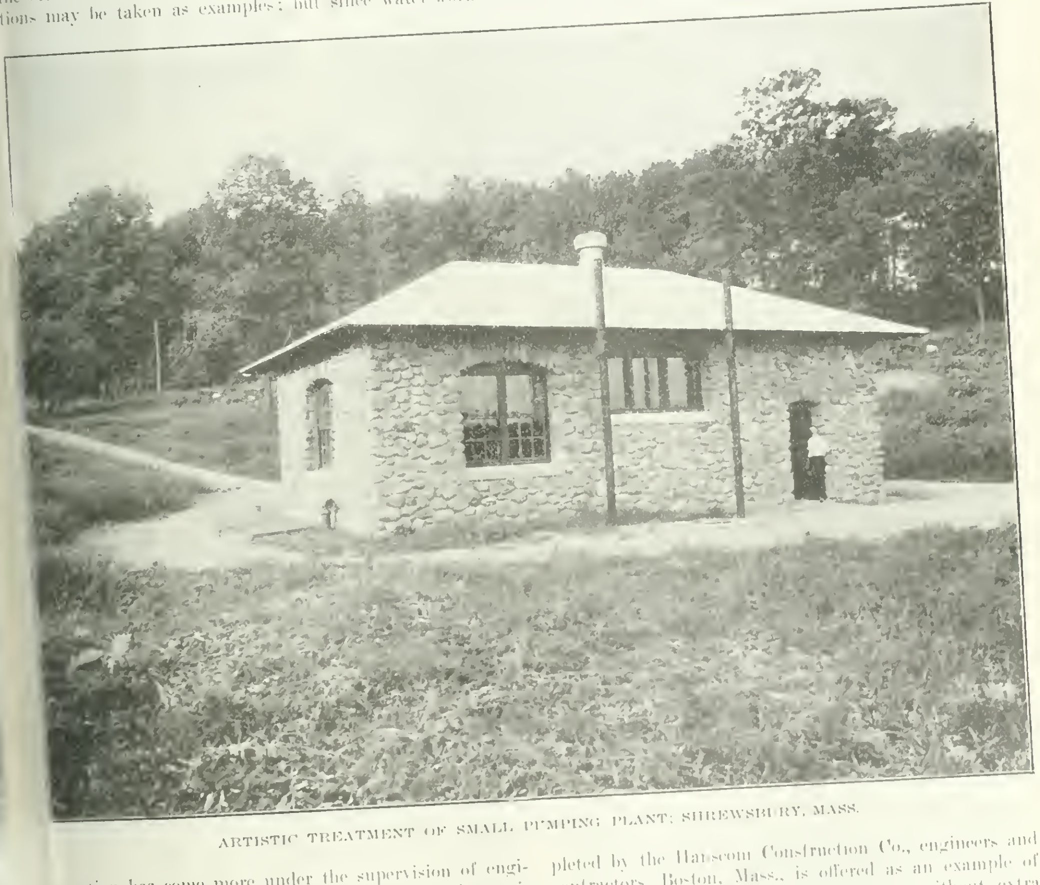
OLUME 76

Artistic Touches for Simple Water-Works Structures

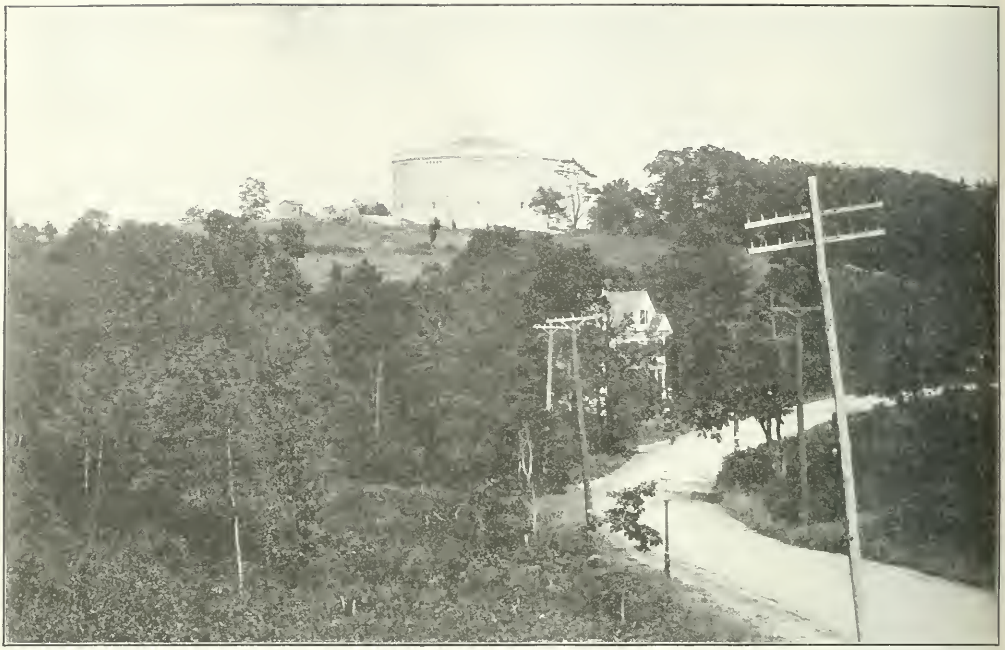
Architectural treatment, or perhaps better, artistic treatment of pumping plants is a worthy subject for the water-works engineer to consider. In the early days of water-works construction, when pumping stations were designed by architects, considerable pains were taken with the ornamental features—if many old city pumping stations may be taken as examples; but since water-works ɪeration has come more under the supervision of engi-ɪers, new structures have often been designed by engi-ɪering departments with little consideration of other ɪan utilitarian features.

Almost every city engineering or water-works departɪent has sooner or later to design gatehouses, auxiliary pumping stations and other small structures too unimportant to require the services or advice of an architect; yet with a little forethought such structures may be made ornaments rather than eyesores in landscapes which generally are naturally pleasing.

The accompanying view of the little pumping station of the Shrewsbury, Mass., water-supply, recently completed by the Hanscom Construction Co., engineers and contractors, Boston, Mass., is offered as an example of what may be accomplished in this way without extra expense. It is regrettable, however, that the æsthetic instincts of the designer were not followed far enough to find a way of eliminating the rather too conspicuous



ARTISTIC TREATMENT OF SMALL PUMPING PLANT; SHREWSBURY, MASS.



ARTISTIC TREATMENT OF STEEL WATER TANK: COMPLETED BELLEVUE RESERVOIR OF THE METROPOLITAN WATER-WORKS, BOSTON, MASS.

vent and exhaust pipes shown in the foreground. This pumping station is 40x20 ft. and has an interior height of 13 ft. front floor to wall plates. Concrete foundations are provided for two units of 300 gal. per min. each. The cobblestone walls are 18 in. thick, laid in 1 : 2 cement mortar. The mortar was mixed with one part lampblack and 5% hydrated lime. The interior face of the walls is finished with a smooth coat of cement mortar, waterproofed by the addition of hydrated lime. Window sills are dressed granite. The roof is covered with green asbestos shingles.

The second illustration shows another field for art in water-works construction, and one which has, in various instances, received considerable attention. In the case of water tanks, towers and standpipes, however, architectural treatment always means extra expense, which may or may not be justified, depending on the prominence of the structure and the neighborhood. Concrete for such structures is quite often used in the hope of increasing artistic effect at small increase of expense, and the hope is sometimes realized.

The 2,500,000-gal. steel tank on Bellevue hill, in the West Roxbury district of Boston, is perhaps the last word in this branch of hydraulic architecture. The work of inclosing this structure in granite masonry was described in *Engineering News*, Jan. 20, 1916. Since then the granite covering has been cleaned by sand blast and the adjoining observatory has been removed, so that the granite cylinder with its conical roof is now the most prominent and pleasing feature in the landscape.

The late Dexter Bracket was chief engineer of the Metropolitan Water-Works when this tank was designed and the work begun. It was finished under the direction of the present chief engineer, William E. Foss.

Asphalt Paving History

Were the average paving engineer asked the origin of the present method of constructing bituminous macadam pavements—a layer of macadam coated with hot asphalt, a layer of stone chips rolled in, another coating of hot asphalt (seal coat) and a surfacing of screenings rolled in—it is pretty safe to assume that he would say it was of very recent date, probably not more than ten years old, anyway. An engineering antiquarian finds the following item in the *Journal* of the American Institute, March, 1839. No record can be found of the effect of the communication on the Common Council.

> Mr. Walter, architect, just returned from Europe, has addressed a letter to the committee of the Philadelphia Common Council on the subject of pavements. . . . Mr. Walter presents an interesting paper on the use of asphaltum pavements, which have only been recently introduced in Europe for carriageways. About 80,000 ft. have been made on a road to Versailles and in several courtyards.
>
> Two experiments made in Liverpool, England, are thus described by Mr. Walter: The first consisted in making an ordinary M'Adamized road having its surface regulated about one inch below the intended finish of the street. This surface was then covered with asphalte in semi-fluid state and before the material had time to cool a layer of finely broken stone was strewed over it and brought to an even surface by means of a large iron roller. Another thin coat of asphalte was then put on and the surface covered with fine gravel stone, well sifted and washed, after which it was again rolled. This unquestionably makes a beautiful road and there can be no doubt of its durability.

Here, then, is an asphaltic macadam road constructed by the most approved modern methods more than three-quarters of a century ago. It would be interesting to determine if during the latter part of that 78 years a pavement of this type had been patented in our own United States.

Melted Snow Supplies Water to Arid District

Supplying arid desert land with water obtained from the melting snows of a neighboring mountain range and stored in old volcanic craters utilized as reservoirs is an interesting engineering work now being carried out in Arizona. The district to be served is in Coconino County, and extends nearly 50 mi. south from the Grand Cañon of the Colorado. The Atchison, Topeka & Santa Fe crosses it (east and west) about 50 mi. from the cañon. The country is almost entirely waterless, except for a light rainfall averaging only 10 in. per year. It is good grazing country, except for scarcity of water.

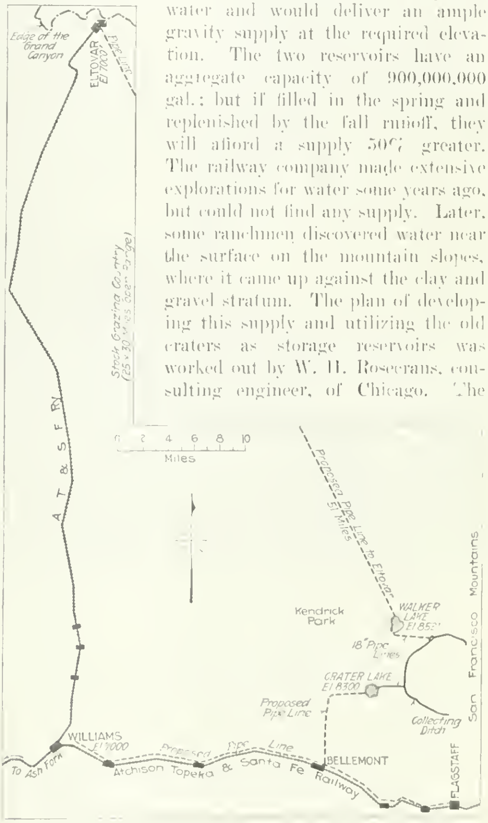
To the east of this district is San Francisco Mountain, whose slopes are heavily timbered below timber line and whose summit is about 12,000 ft. above sea level. It is always covered with snow, but the water flowing down its slopes is lost in the deep beds of light soil which form the plains. At an elevation of about 8,500 ft., however, an impermeable stratum of clay and cemented gravel approaches the surface, and here a collecting ditch has been excavated to intercept the flow, the bottom being in the impermeable stratum. This ditch is about a mile in length and has branches at elevations of 8,650 to 8,800 ft. It is 4 ft. wide on the bottom, 1 to 6 ft. deep, with a slope of 2 on 1 for the upper, or mountain, side and 1½ on 1 for the lower side. The excavated material is thrown out on the lower side. A larger ditch 8 to 12 ft. deep, of bout the same length, will extend around the northern lope. The drainage area serving these ditches is about 2,000 acres on the west and 6,000 acres on the northwest side of the mountain. The annual precipitation on this area is 36 in., with 33% runoff, occurring mainly in the spring. The three months of spring, therefore, would give a runoff of 4,000 acre-ft. and 2,000 acre-ft. for the two sides, or about 1,960,000,000 gal. in all.

Within about a mile from the ditch is Crater Lake, an ld volcanic crater, which normally has a little water. It was decided to utilize this as a reservoir, and a pipe line 3,000 ft. long was laid to it from the collecting ditch. This is of 8-in. sheet-iron pipe in 20-ft. lengths, with eaded joints. Each length of pipe has a bead, or ridge, tamped around each end. The end of one pipe is heated in a mixed gasoline and coal-oil furnace so that it will ip over the adjacent pipe, its hollow bead fitting over the edge of the other, so that when cool the pipes are locked together. This pipe is made by the Western Pipe and teel Co., of Los Angeles, Calif. The pipe line is about ft. below the surface.

The lip of the crater rises 50 ft. above the surrounding ground, and the pipe line is in effect an inverted phon. There is an outlet tunnel from the crater reservoir. This is 600 ft. long, 4x6-ft. section, and is driven through clay, volcanic ash and basalt. The crater is 2,000 . in circumference and 60 ft. deep, forming a reservoir of about 280,000,000 gal. capacity at 8,300-ft. elevation. The flow in the ditch was about 22 ft. per sec. until the reservoir was filled, this being completed (after 90 days' flow) in May, 1916.

From this reservoir it is proposed to lay a pipe line to Bellemont (9 mi.) and then along the railway east to lagstaff (12 mi.) and west to Williams (20 mi.). Besides the towns and the railway there will be numerous ranches to be supplied.

A further development of the project provides for another 18-in. pipe line, 6 mi. long, to Walker Lake (El. 8,521). This is another but larger crater, 100 ft. deep, with a capacity of about 640,000,000 gal. at 8,400-ft. elevation. From this a supply pipe line is proposed to El Tovar (at the Grand Cañon), about 50 mi. This resort has a large number of tourists and employees, and the railway company has to haul in water by tank-cars for the supply of the hotel, station and grounds and also for the locomotives and cars. This water is brought nearly 100 mi. either from Del Rio or Flagstaff. The cars deliver the water into a track pit from which it has to be pumped to an elevation about 100 ft. higher than the railway. The new pipe would eliminate this costly method of supplying water and would deliver an ample gravity supply at the required elevation. The two reservoirs have an aggregate capacity of 900,000,000 gal.; but if filled in the spring and replenished by the fall runoff, they will afford a supply 50% greater. The railway company made extensive explorations for water some years ago, but could not find any supply. Later, some ranchmen discovered water near the surface on the mountain slopes, where it came up against the clay and gravel stratum. The plan of developing this supply and utilizing the old craters as storage reservoirs was worked out by W. H. Rosecrans, consulting engineer, of Chicago. The work is being carried out under his direction for Charles H. Spencer and Herbert A. Parkyn, of Chicago.



PLAN OF WATER-STORAGE AND DISTRIBUTION SYSTEM FOR AN ARID DISTRICT IN ARIZONA

The work is being done on day-labor account, with about 30 men and teams on the ditch excavation and about the same outfit on the pipe line. The pipes are hauled to the site on wagons and handled by derricks at the trench. At present the Crater Lake reservoir has been filled, at a cost of about $50,000. Work is in progress for the Walker Lake reservoir, which will cost about $20,000, and this will be filled in the fall. The cost of the pipe line to Williams and Flagstaff is estimated at $50,000 and that of the line to El Tovar at $130,000.

Railway Terminal Built Over Large Drainage Channel

By Charles C. Hurlbut*

The Lehigh Valley passenger terminal, now nearing completion at Buffalo, N. Y., is built over a large drainage channel, the case being somewhat similar to that of the Werder building, which was built over a railway tunnel in Pittsburgh, as described in *Engineering News* of June 8. The Lehigh terminal has four stories with self-supporting walls of limestone ashlar and brick, and fireproof floors supported on steel columns.

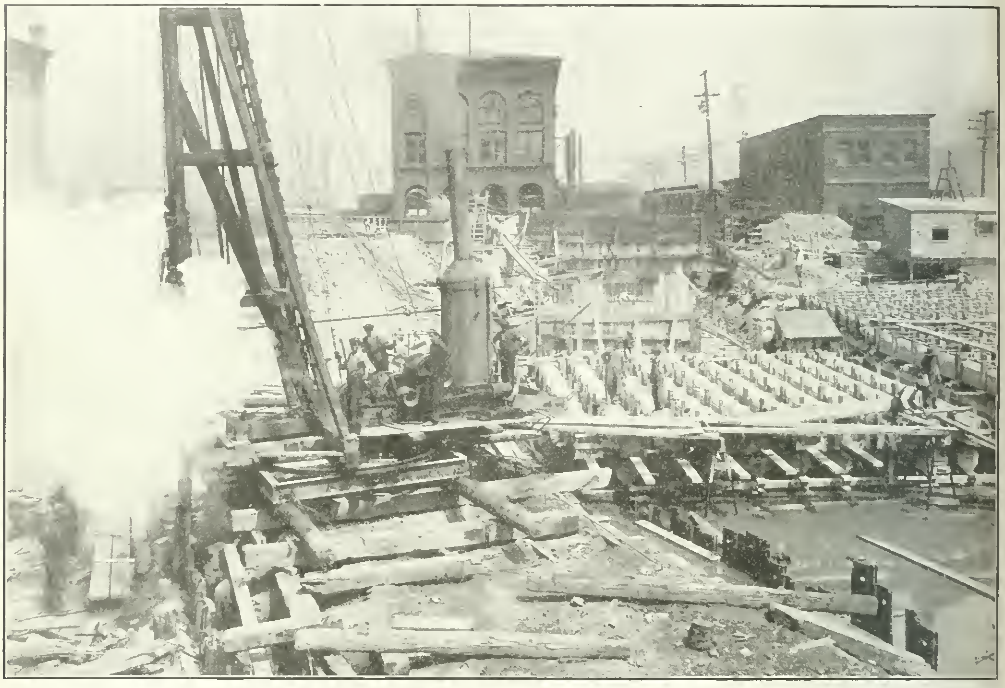


FIG. 1. SITE OF NEW PASSENGER TERMINAL OF THE LEHIGH VALLEY R.R. AT BUFFALO, N. Y.
Photograph taken July 15, 1916; sheetpiling in place and concrete piles in their forms

The old Hamburg canal, which some years ago was roofed over and converted into a sewer, flows directly across the site, as indicated in Fig. 3. The sewer is 16 ft. wide inside and has rubble masonry walls 6 ft. thick. It is roofed over with steel beams and concrete and supported on a floor of concrete laid on a stone bed. Two walls of the building cross the sewer and several of the interior columns are located over it. The top of the sewer is level with the basement floor, being about 10 ft. below the surface of the ground.

Owing to the very poor workmanship of the sewer walls (Fig. 2) and the poor quality of the ground, it was deemed inadvisable to put any additional load on the construction. The building itself is founded on concrete piles driven to rock and the expedient was adopted of building concrete piers on piles as close to the sewer walls as possible and spanning the sewer with heavy steel girders. The latter are placed on the lines of columns, which cross the sewer diagonally 18 ft. on centers and support the walls, floors and columns of the building. The girders which support the columns are 7 ft. 8½ in. deep (back to back of flange angles) while those which support only floors are 4 ft. ½ in. The girders are all set flush on the bottom a few inches above the top of the sewer, and the bottom flanges support reinforced-concrete slabs. The first floor-beams and the columns rest on the tops of the girders. In the case of the shallow girders there is a strut under the ends of each pair of beams.

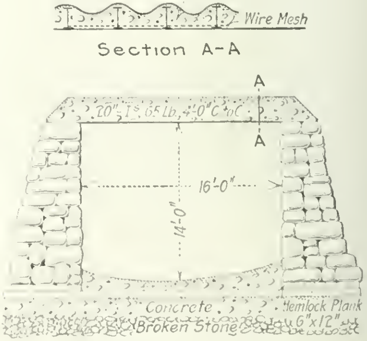


FIG. 2. CROSS-SECTION OF HAMBURG SEWER, BUFFALO, N. Y.

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*With Kenneth M. Murchison, Architects Building, New York City.

The rubble walls of the sewer are porous and the water passes through them freely. As the top of the tunnel is below the high-water level of the Buffalo River, into which it flows, it was necessary to waterproof the cellar floor against a head of several feet. This was done with 6-ply tar and felt, which was secured against upward pressure by reinforced-concrete slabs spanning between the bottom flanges of the plate girders and held down by brick casing. The waterproofing and reinforced-concrete slab construction extends over the entire basement floor as well as over the sewer, but in the other parts of the building the reinforcement is laid diagonally and is held down by the brick column casing. Before driving any piles a sheeted exploration pit was sunk close to the sewer. The condition of the sewer wall and the unstable condition of the ground under it, made it seem unsafe to drive piles close to the wall as was originally contemplated, especially as the piles were to be jetted. It was therefore decided to isolate the sewer section, which was done by driving steel sheetpiling on both sides of the sewer. The piling was driven as close as possible to the bed of riprap underlying the sewer, without disturbing the riprap. Considerable dificulty was experienced in driving the sheeting and also the piles. The line of he sewer foundation was somewhat rregular and had to be felt out. In ome places the line of sheeting was nterrupted by obstructions and the ocation of pile groups had to be hifted. The main obstruction unoubtedly was the remains of the orignal canal wall, and this gave trouble. As it would have been difficult to remove this ruin, the locations of some f the piers were shifted to suit the conditions. Consequently, the girders could not be ordered until the piles were in place and in some cases sevral feet had to be added to the length f the girders. The length as built varied from 42 ft. 6 in. to 44 ft. 3 in. Three of the stone portico columns, hich are 4½ ft. in diameter, came er the sewer. Instead of on plate girders, these were upported on three 30-in. 180-lb. girder beams 12½ ft. ng.

The work was carried out under the direction of E. . Ashby, Chief Engineer of the Lehigh Valley R.R., sisted by F. E. Schall, Bridge Engineer. The architect the building was Kenneth M. Murchison, of New ork City. The steelwork and foundations were designed the architect's office by the writer. The contractor was Henry Miller, Inc., of Baltimore, Md.

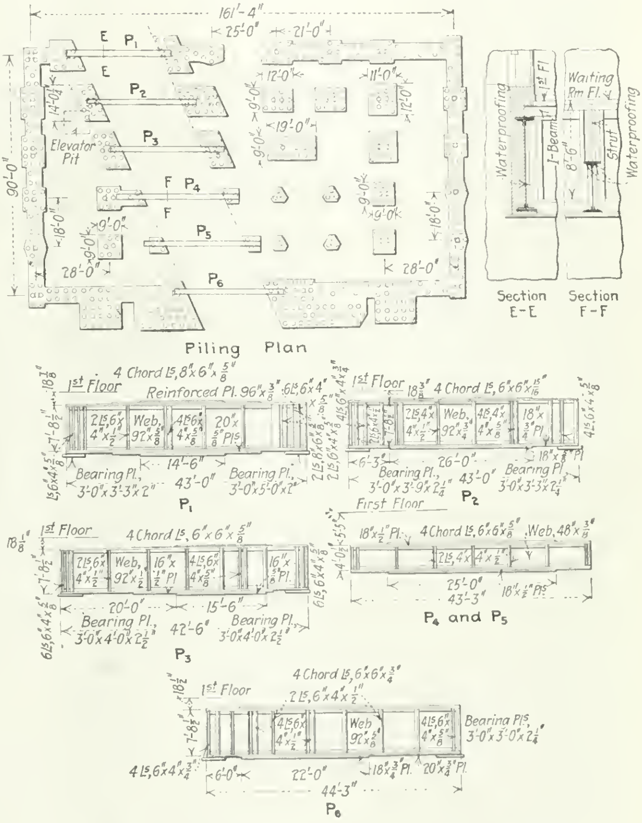

FIG. 3. PLAN OF LEHIGH VALLEY STATION, SHOWING METHOD OF DISTRIBUTING LOAD OVER LARGE COVERED CANAL

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The Output of Liquid Chlorine in the United States in 1914 as 12,217,000 lb., valued at $472,836, according to the United ates Census Bureau. It was made at seven plants, of which ree were located in New York, two in Michigan and one ch in Illinois and Georgia.

Registering Kicks at the City Engineer's Office

The Alton (Ill.) *Telegraph* heads an article, "The City Kicking Post: An Observer Thinks the Engineering Department Has Much to Do to Keep Temper," and summarizes the observations of a citizen, who has been in the office of the city engineer frequently, as follows:

> If you've got a kick a-coming, go thither without fear, and make the kick a lusty one—at the City Engineer. No matter what it is about, or if as mud as clear, the man to blame and cuss a few is the City Engineer.
>
> According to a citizen, the City Engineer's office appears to be the official kick-receiving bureau of the city, and many of the complaints made have no more to do with the Engineer's office than Teddy Roosevelt just now has to do with the Bull Moose.
>
> They kick about neighborhood disputes as to line fences, about chickens running at large; about catchbasins catching everything but overflow water; about telephone poles being plastered with election posters; about the river water getting muddy when it should be clear.
>
> If a neighborhood has too many dogs and the dogs have too many fleas and the fleas have the wanderlust and leap savagely upon human beings, why should not the City Engineer be blamed for it? The dogs ought to be chained up, and the Engineer uses chains in his business; the fleas ought to be impressed some way that they must not go beyond the "dead-line" fixed by the City Engineer The City Engineer should be the one to remedy any existing wrong or cause of complaint

Chlorinating the Water-Supply of Greater New York

By T. D. L. Coffin*

SYNOPSIS—The largest chlorine-control plant in the world is that used for the water-supply of the City of New York. Use of multiple-unit equipment and duplicate lines; details of injection apparatus. Daily output 1½ tons of chlorine per day—for 400 million gallons of water. Control within 1% of desired quantities. Bacterial reduction to 12 per c.c.; B. coli in only 10% of 10-c.c. samples.

Besides being the largest installation of liquid chlorine control apparatus in the world, the Dunwoodie chlorinating plant of the New York City Department of Water Supply, Gas and Electricity is of unusual interest because of novel methods of application and the arrangement of duplicate apparatus and distributing lines. Installed to treat a maximum of 100,000,000 gal. of water daily flowing through the old and new Croton aqueducts this plant has a total output capacity of a ton and a half of chlorine per 24 hr.

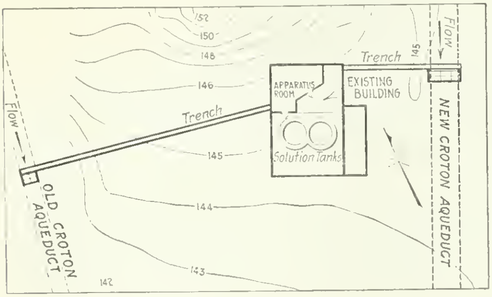

FIG. 1. LAYOUT OF DUNWOODIE CHLORINATING PLANT

In 1911 the advisability of installing some means of water purification to offset a possible pollution of the Croton supply was evident and a plant to apply calcium hypochlorite as a sterilizing agent was erected at the Croton Gate House. This plant was subsequently moved to shaft No. 9 on the new aqueduct and then to Dunwoodie, New York, where a permanent building was erected, provision being made for applying the sterilizing chemical to both the new and the old aqueducts from the same structure.[1] The marked increase in the price of hypochlorite, during the late summer and fall of 1915, suggested the necessity of installing a liquid chlorine plant, as under the conditions then existing a saving in the cost of operation would result and a shortage of either material would not prevent the treatment of the Croton supply. Contract for the necessary apparatus and accessories was awarded to Wallace & Tiernan Co., Inc., of New York City. In planning the equipment consideration was given to the construction of special apparatus with capacity much greater than the standard chlorinator. It was decided, however, to install the manufacturer's standard equipment so that any repair or renewal parts required could be taken from stock and avoid the necessity of carrying a supply of special parts just for this installation.

The problem was presented of having one set of apparatus for the new aqueduct, a second set for the old aqueduct and reserve units so connected that they could be used either on the new or old aqueduct as required. The whole installation was to be in duplicate to eliminate any interruption in the flow of chlorine.

The existing hypochlorite house at Dunwoodie presented an excellent location for the chlorinators and nine manually controlled direct-feed units were installed. Each unit has a maximum capacity of 325 lb. of chlorine per 24 hr. One unit is normally in service for the old aqueduct, five units in service for the new aqueduct and the remaining three are held in reserve, the distributing lines being so arranged that they are applicable to either aqueduct as required. The chlorinators, being built on the unit system, are interchangeable and can be transferred from one location to another simply by removing the supporting screws. In order to feed the required amount of chlorine without too rapid withdrawal from the chlorine cylinders and the consequent refrigeration and resulting drop in pressure of the gas, manifolds were provided for connecting ten cylinders of chlorine to each apparatus.

Each apparatus was provided with a separate check valve to maintain constant back pressure and uniform

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*Assistant Engineer, New York Department of Water Supply, Gas and Electricity, Katonah, N. Y.

[1] Described by the author in "Engineering News," Feb. 27, 1913.

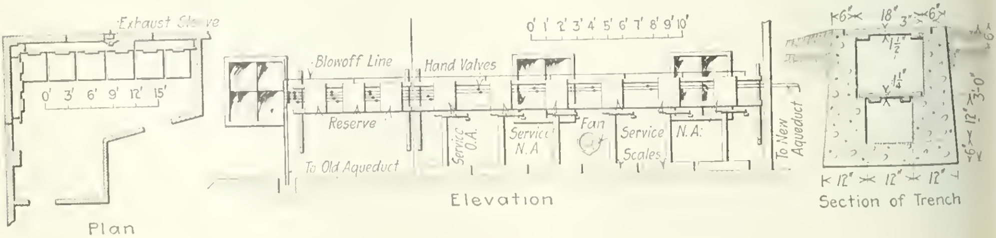

FIG. 2. APPARATUS ROOM AND PIPE TRENCH AT DUNWOODIE PLANT

density of the chlorine, and these valves were fastened directly to the apparatus panel. The usual procedure of having one check valve for each distributing line would not have been sufficient for the Dunwoodie installation on account of the large volumes of chlorine required. The accompanying sketches and views indicate the arrangement of the different units and show the distributing lines and valves and cross connections. There is a common blowoff or "chlorine relief line" to which each unit is connected.

The chlorine is conducted from the apparatus room to the aqueducts through $\frac{3}{4}$-in. extra-heavy galvanized iron pipe, the lines being in duplicate, passing through a ncrete pipe vault as indicated. This arrangement of plicate lines, readily accessible, is a further safeguard ainst any enforced interruption in the flow of chlorine. e lines were laid with extra-heavy fittings and litharged nts, and were tested with chlorine under pressure at quent intervals during construction. In each aqueduct cious concrete manholes were constructed at the end the pipe trenches. Heavy iron covers were provided, th substantial locks to close the openings.

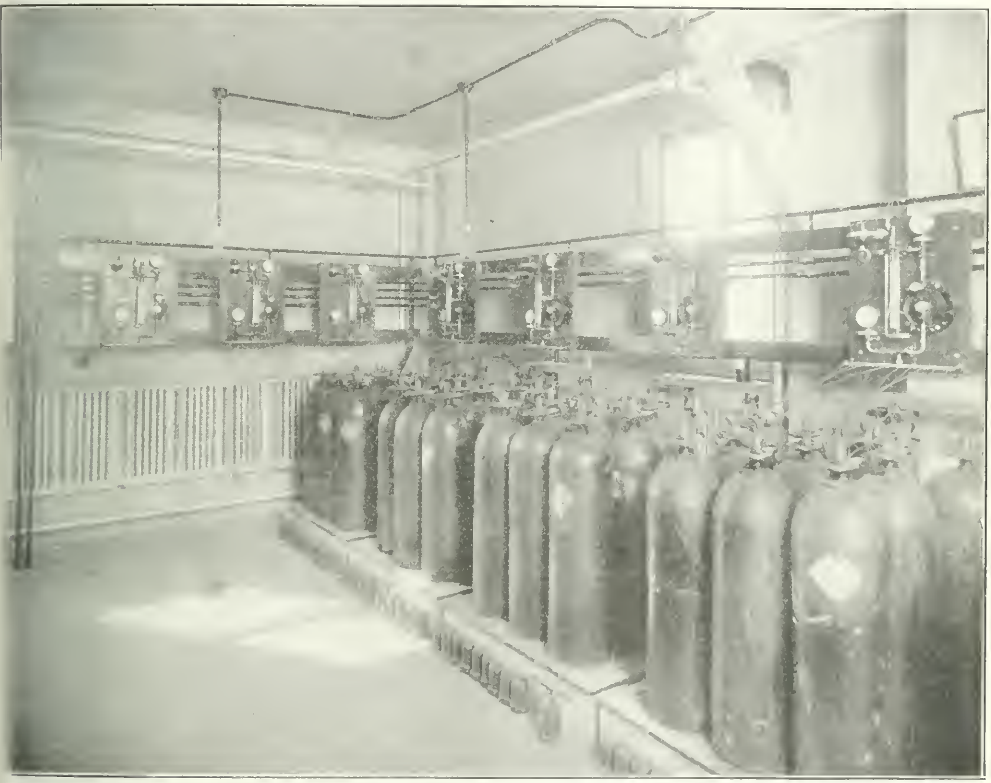

FIG. 3. INTERIOR OF DUNWOODIE APPARATUS ROOM

Chlorine diffusors, composed of a special carborundum nge in an earthenware casing, were used to apply the orine to the water. Forty-five of these diffusors are continuous service in the new aqueduct and ten in t old. The necessity of holding the diffusors rigidly in place to withstand the very considerable velocity of water, and at the same time to provide means for the ready removal of a defective diffusor without interrupting the flow of chlorine called for unique features of design. The drawings presented herewith indicate the adopted arrangement. The diffusors, ranged across the aqueduct at the invert, give a very complete mixture of the chlorine with the water, eliminating all necessity for baffles.

In the new aqueduct three grids, each holding 15 diffusors, were installed. The grids were made of $1\frac{1}{2}$x$1\frac{1}{4}$-in. black iron with a yoke of 2x$\frac{3}{8}$-in. and a pulling bar of 1-in. square black iron, galvanized after assembly. Each yoke is fitted with a 2-in. bronze roller 1 in. thick which slides on a 3x1-in. black-iron bar set with least dimension exposed to the current. These bars are fastened at the base in the concrete foundation of the aqueduct and are rigidly held in the concrete manhole at the top, thus serving as guides for the diffusor grids. To the pulling bars $\frac{3}{4}$-in. extra-heavy galvanized iron pipe is fastened by a $\frac{3}{4}$ in. union and serves both as a rod to pull up the grids and as a protection for the silver chlorine-distributing tubing. This construction may be seen from Fig. 3.

From the galvanized distributing lines in the manholes the chlorine passes through auxiliary valves into $\frac{1}{4}$-in. silver tubing which is threaded through the vertical pipe

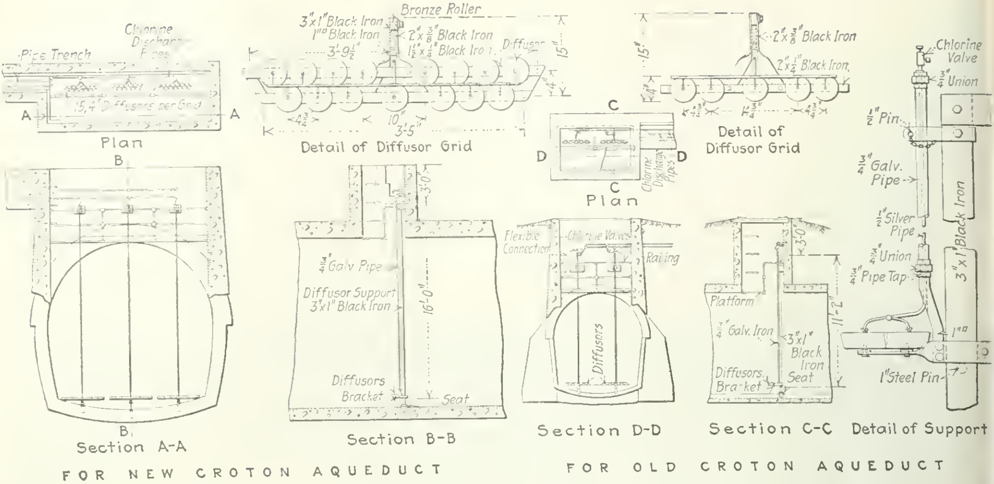

FIG. 4. DETAILS OF DIFFUSOR ARRANGEMENT AT DUNWOODIE, N. Y.

rods supporting the grids. At the grid the $\frac{1}{4}$-in. tubing connects with a manifold of $\frac{3}{16}$-in. silver tubing, there being one connection to each diffusor. At the top of each pipe rod is a valve controlling the flow of gas to the attached grid and these valves are connected by flexible tubing to shut off valves in the galvanized distributing lines. In this manner any grid can be instantly cut out of service or connected to either gas line as desired. Normally all three grids are in service. The multiple valves and connections make it possible to shut off a grid, draw it up to the manhole platform and make such examinations or adjustments as may be required, continuing the application of gas during this period through the other two grids. Fig. 4 shows the arrangement with the diffusors withdrawn for examination at the manhole platform. The arrangement in the old aqueduc is similar, but on a smaller scale—only two grids o five diffusors each being in service.

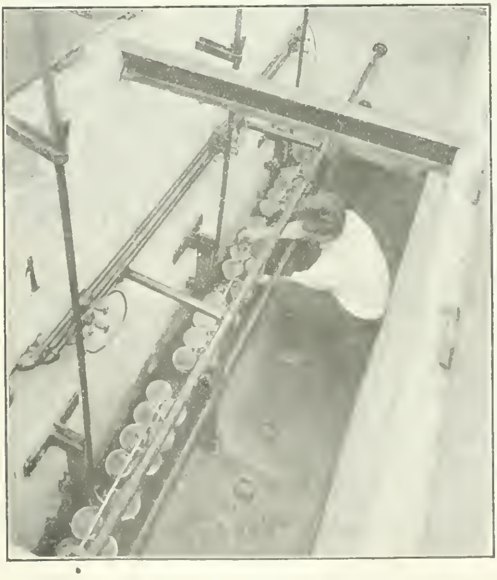

FIG. 5. DIFFUSOR GRIDS RAISED, NEW AQUEDUCT

The apparatus room is constructed of $\frac{7}{8}$x$3\frac{1}{2}$-i tongued-and-grooved yellow pine on 2x4-in. spruce stud and is 24 ft. 6 in. long and 20 ft. 9 in. wide, constructe with ceiling, and is entirely within the former hypo chlorite house. It is heated by a hot water heatin system and lighted by 110-volt alternating current Ample storage capacity is provided for heating th cylinders prior to service. Six platform scales, wit platforms 41x32 in., each with capacity for ten cylinder of gas are provided to check up the delivery of th chlorinators. The booth is fitted with a 14-in. disk fa driven by a 220-volt motor, discharging to the outer ai and controlled by a switch outside of the booth so tha the apparatus room can be readily ventilated.

The installation has been in service since Apr. 4, 191 The apparatus was guaranteed to deliver within 5% o the indicated weight of chlorine. On actual test it wa found to have less than 1% error. Between the date of Apr. 1 and June 30, the newly installed liqu chlorine plant has treated 29,541 million gallons, usin 48,590 lb. of liquid chlorine or slightly less than 0.2 parts per million of chlorine. The water after treatmen has averaged 12 bacteria per cubic centimeter as deter mined upon gelatine plates at 37° C. and B. coli has bee absent in the 0.10-c.c. and 1.0-c.c. samples, and presen in only 10% of the 10.0-c.c. samples. The apparatu was installed under the direction of Merritt H. Smith Chief Engineer, and T. C. Culyer, Engineer, Watershed Division, acting for the Bureau of Water Supply. C. F Wallace directed the installation for Wallace & Tier Co., Allan M. E. Johnstone being the resident engineer

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Construction Material in South America—The Bureau o Foreign and Domestic Commerce of the Department of Commerce and Labor is sending William W. Ewing, M. Am. Soc. C. E., to visit the principal cities of the United States for the purpose of conferring with manufacturers of construction materials and machinery. This work is in preparation for an exhaustive report on the markets for these products in South America, and Mr. Ewing after talking with the American manufacturers will make a tour of all the southern republics for a thorough study of conditions in this branch of trade.

Pumping Six Million Gallons Daily by Water Power

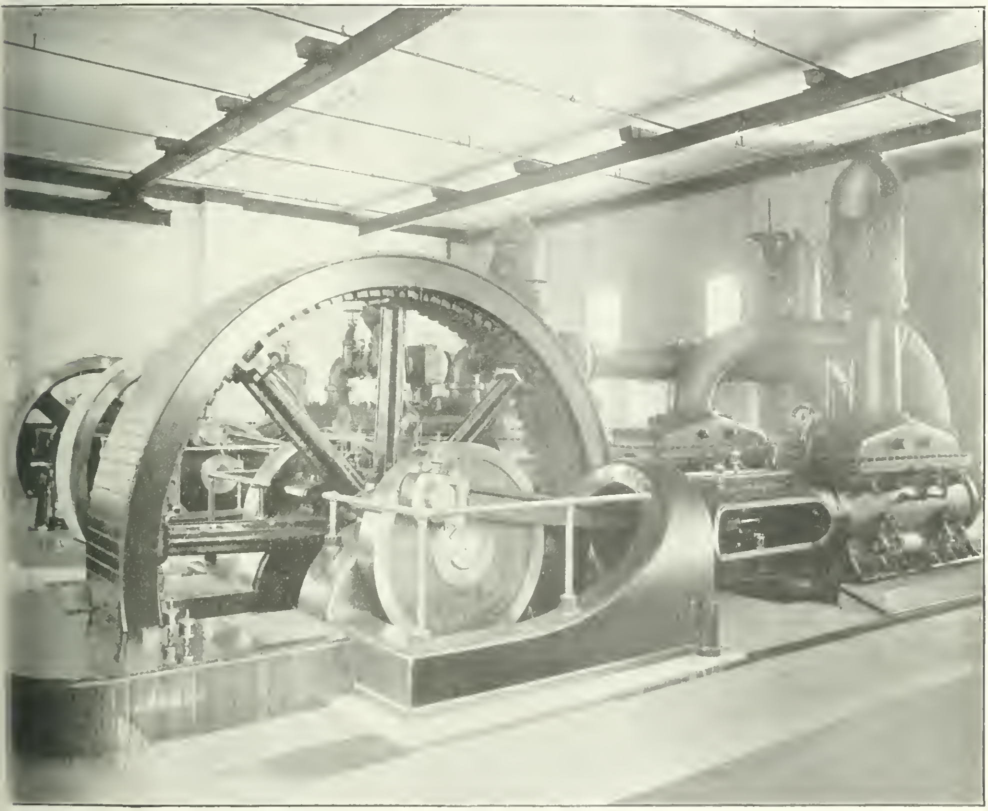
The City of Lewiston, Maine, about 40 mi. north of Portland, has one of the most interesting water-works pumping stations in New England. This plant is probably one of the largest all-water-power pumping stations in the country. The average daily pumpage is 5,000,000 gal., but the plant has a capacity of about double this amount.

The city is on the Androscoggin River, which furnishes water power for practically all the manufacturing industries of a city of 30,000. The water rights are controlled the Union Water Power Co., from which the city rchased, several years ago, 600 hp. The wheels are ft. below the level of the power canal and have draft bes of 10 ft., making a total head of 25 ft.

The original plant was built in 1878 and consisted of o Worthington duplex pumps of 3,000,000 gal. daily pacity each, driven at 11 to 16 r.p.m. by Risden turbines. bsequently a 3,000,000-gal. Deane duplex pump was talled, driven by a Hercules turbine. Originally the able water-supply was taken from the river above the ver-canal inlet. The water now used comes from burn Lake, about 3 mi. north of the city, and is ivered to the pump well by gravity.

In 1914 the two old Worthington pumps were rebuilt by the Deane Steam Pump Co. These are now driven from a single shaft by two 380-hp. 33-in. Hercules turbines, one a right-hand and the other a left-hand. The teeth in the pinions of the old pumps were wood. In the rebuilt pumps they are cloth—"Fabroil," a patented product of the General Electric Co.—and at the time of their installation in the fall of 1914 were claimed to be the largest gears of this type in existence.

The pinions are 29.6 in. outside diameter, 1¼ in. diameter pitch and have 18¼ in. of cloth face between shrouds. They transmit 225 hp. at 80 r.p.m. The pressure on each tooth amounts to about 16,200 lb. The rebuilt pumps have a capacity of 4,000,000 gal. daily and have been in continuous operation for nearly two years. The plant is one of the quietest to be found where gear-driven pumps are in use.



WATER-WORKS PUMPING STATION, LEWISTON, MAINE

The new driving gears are 113½ in. outside diameter, and each has 110 steel teeth. They weigh approximately 8 tons each. They are designed to be driven at 24 r.p.m., while the fastest the old pumps could be driven was 19 or 20 r.p.m. In actual operation the speed of the old pumps seldom exceeded 11 or 16 r.p.m., as the din and racket above this speed was unbearable. The Deane pump in the foreground of the accompanying view is still driven by a pinion with wood teeth. Its capacity is about a third less than that of either rebuilt Worthington. The reconstruction of the pumps and the installation of "Fabroil" gears are estimated to have increased the capacity of the station 50% without altering the power equipment.

The water is pumped into the mains and to a 14,000,000-gal. distributing reservoir under a pressure of 100 lb. per sq.in. The normal consumption of the city is about 6,000,000 gal. daily. The minimum meter rate is 3½c. per 1,000 gal., which the superintendent of water-works, J. B. Longley, estimates is about the operating cost of the plant. There are few meters, and the use of water is generally unrestricted.

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Typhoid Fever from Drinking Water Is Accident

The United States Circuit Court of Appeals, Ninth Circuit, recently handed down a decision (229 Federal Reporter, 552) which laid down the principle that the contracting of typhoid fever by employees as the result of drinking impure water furnished by the company is an accident arising out of the conduct of the business. The main parts of the decision, by Judge Ross, are as follows:

The defendant in error, the Pacific Gas and Coke Co., being engaged in the construction of a gas plant and having employed in the work a large number of men, secured from the Aetna Life Insurance Co., the plaintiff in error, a policy entitled by the latter "contractor's employers' liability policy," by which, in consideration of certain premiums which the case shows the defendant in error paid, it agreed to indemnify the assured (within certain amounts within which the present case falls) against loss and expense arising or resulting from claims upon the assured for damages on account of bodily injuries or death accidentally suffered, or alleged to have been suffered, by an employee or employees of the assured by reason of the business as described and conducted at the locations named in the policy, with certain exceptions not applicable here. In the course of the work certain of the employees of the Gas and Coke Co. contracted typhoid fever from the water furnished them by the latter, on account of which that company was compelled to pay damages to such injured employees, to recover the aggregate amount of which from the insurance company the present action was brought. And the sole point here presented is whether the harm so done to the workmen constituted a bodily injury accidentally received or suffered by them, within the meaning of the policy in question.

Of course it is not and cannot be doubted that the workmen were bodily injured by the drinking of the water in the course of the work, for it contained typhoid germs, which gave them typhoid fever; but it is insisted on the part of the plaintiff in error that in drinking the water they were but satisfying a natural want, and that in doing so there was no accident about it. It is readily conceded, of course, that there could be no accident in merely drinking water; but it is just as certain that the men would not have drunk it had they known that the water contained typhoid germs. The accident consists in that unexpected happening. Among the definitions of the word "accidental," in most, if not in all, of the dictionaries, is the happening of "something unexpectedly, unintentionally." Suppose, instead of containing typhoid germs, as in the present case, the water that the employees of the assured consumed had contained some of the most virulent poisons, would anyone contend that the injuries resulting therefrom could not be properly held to have been accidently inflicted? We think not, and yet, in our opinion, there is no substantial distinction between the case supposed and the case at bar.

The policy involved in the case of H. P. Hood & Sons vs. Maryland Casualty Co. (206 Mass., 223, 92 N. E. 329) was similar to that involved in the present case. There one Barry, who was employed by the plaintiff in that action as a hostler in its stables, had the care of horses which were afterward found to have been suffering from glanders, and Barry was directed to assist in cleaning up the stalls; no notice being given him that the horses had suffered from glanders. Subsequently he was attacked by that disease, and recovered judgment against the assured in that case for damages, which the assured paid, and sued the insurance company to recover the amount so paid, with costs and expenses of suit.

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Inverted Sewer Siphons Under New York Subway*

By S. D. Bleich†

With the completion of the present New York subway contracts, 20 inverted sewer siphons will have been built. Of these, 11 are now in actual service, 4 are nearing completion and 5 will be completed within about one year.

These siphons are distributed in the different boroughs as follows: Manhattan, 3; Brooklyn, 13; Bronx, 4. Five have overflows crossing through the subway roof. The dimensions of these siphons are given in the accompanying table.

A typical inverted siphon on a combined sewer is shown by the drawing here reproduced. This crosses underneath a two-track subway station at Nostrand Ave. and Beverly Road. The complete separation of the dry-weather flow and the storm flow is affected at both chambers. The dry-weather flow is confined to the 14-in. pipe,

DETAILS OF INVERTED SIPHONS, NEW YORK SUBWAY

Location	Size and Number of Pipes — Storm	Sanitary	Overflow	Capacity of Pipes, Cu.Ft. per Sec. — Storm	Sanitary	Overflow	Total Horizontal Length, Including Chambers, Ft.	Depression of Pipes Below Grade Line, Ft.	Difference of Invert Elevation of Chambers, Ft.	Estimated Cost	Date Completed
149th St. and Railroad Ave., Bronx	2— 42-in.	1—14-in.	......	120	6.0	...	66	9.3	0.1	$6,000	Feb. 1, 1902
Fourth Ave. and Dean St., Brooklyn	2— 48-in.	1—18-in.	......	266	11.0	...	135	13.7	0.9	11,100	July 8, 1911
Fourth Ave. and 7th St., Brooklyn	2— 72-in.	1—30-in.	......	330	25.0	...	82	3.4	3.0	4,700	Nov. 25, 1911
Fourth Ave. and 26th St., Brooklyn	2— 54-in.	1—24-in.	......	160	15.0	...	104	2.3	1.1	5,500	Jan. 27, 1912
Fourth Ave. and Butler St., Brooklyn	2—101-in.	1—16-in.	......	680	12.0	...	100	19.5	0.1 & 0.9	11,900	Aug. 17, 1912
Fourth Ave. and 35th St., Brooklyn	1— 24-in.	1— 6-in.	......	19	1.2	...	117	12.1	1.5	3,800	Sept. 21, 1912
Lexington Ave. and 106th St., Manhattan	2— 48-in.	1—24-in.	......	80	9.8	...	159	13.8	0.15±	19,000	Oct. 19, 1912
Lexington Ave. and 110th St., Manhattan	2— 78-in.	1—42-in.	......	356	19.6	...	256	15.5	0.26±	52,000	Jan. 7, 1913
Fulton St. and Hudson Ave., Brooklyn	2— 24-in.	1—10-in.	ft.in. ft.in. 1 2x4 0	45	2.52	15±	141	22.0	0.6	8,500	Jan. 3, 1914
*20th Ave. between 63rd and 64th St.	1— 24-in.	1— 8-in.	......	14	0.7	...	137	11.4	0.45	1,500	Aug. 20, 1914
*65th St. between 21st and 22nd Ave.	1— 16-in.	1— 8-in.	......	68	0.8	...	162	10.4	0.66	2,100	Sept. 22, 1914
Southern Blvd. and 144th St., Bronx	2— 30-in.	1— 8-in.	2 4x5 0	50	0.9	50±	115	15.4	1.0	4,000	....
Southern Blvd. and Longwood Ave.	2— 30-in.	1— 8-in.	......	61	0.65	...	134	11.7	3.5	5,000	....
Southern Blvd. and 149th St., Bronx	2— 48-in.	1—14-in.	......	225	6.5	...	83	11.3	0.83±	11,000	....
Seventh Ave. and 18th St., Manhattan	2— 60-in.	1—24-in.	......	360	20.0	...	212	8.2	0.65	18,000	....
Nostrand Ave. and Hortense St	2— 48-in.	1—12-in.	3 6x4 9	68	1.36	70±	102	14.48	0.07	8,200†	....
Nostrand Ave. and Beverly Rd.	2— 48-in.	1—14-in.	4 2x3 8	153	2.84	100±	152	15.85	0.50	6,400†	....
Nostrand Ave. and Clarendon Rd.	2— 36-in.	......	2—24-in.	49	0.74	25±	86	14.25	0.13	4,200†	....
Nostrand and Foster Ave.	2— 48-in.	......	......	144	...	...	99	18.56	0.10	4,200	....
Nostrand Ave. and Farragut Rd.	2— 63-in.	1—20-in.	......	263	6.82	...	124	12.75	0.10	9,400	....

*Built under P. S. C. supervision. †Includes cost of overflow.

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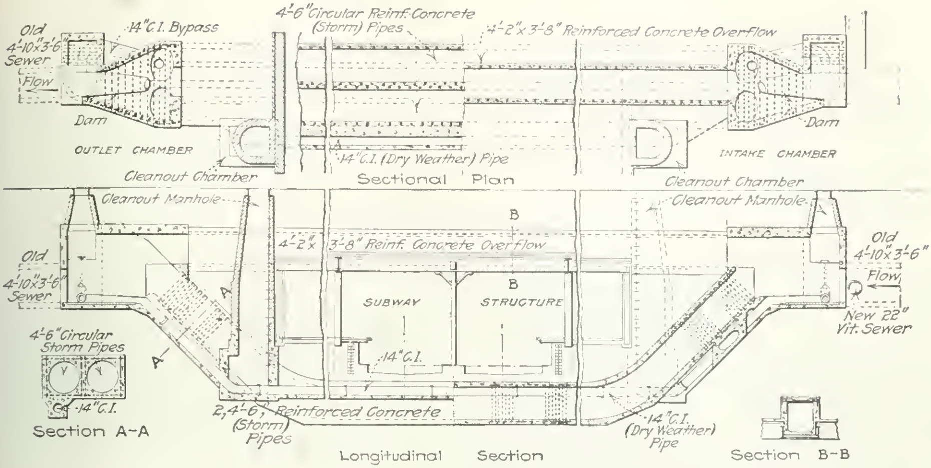
*Slightly condensed from "Public Service Record," April, 1916.

†Assistant Division Engineer, Public Service Commission for the First District, 120 Broadway, New York City.



TYPICAL INVERTED SEWER SIPHON, NEW YORK SUBWAY, AT NOSTRAND AVE. AND BEVERLY ROAD

ınd when a storm occurs, the flow rises above the dam at he intake chamber and enters the two 4½-ft. storm ›ipes. The dam at the outlet chamber prevents the sanitary, or dry-weather, flow from getting into the storm ›ipes.

Two clean-out manholes are provided, one at each end f the horizontal stretch of 14-in pipe. At the bottom f each of these manholes and on a line with the 14-in. ipe is a split pipe, the upper section of which can be emoved, when necessary, for more effectually cleaning nd rodding the small pipe.

A bypass is provided at each chamber for temporarily iverting the dry-weather flow from the small pipe into e outer storm pipe. This would be done at a time when is found necessary to clean the small pipe thoroughly. and-bag dams would then be laid across the chambers tween the walls of the permanent dams, and the sluice ites at the bypasses opened. The sanitary flow would ıen enter through the bypass into the outer 4½-ft. storm ipe and through the second bypass pipe at the outlet ıambers into the sewer beyond, thus cutting off the flow om the 14-in. siphon pipe. This pipe could then be nveniently unwatered, the upper section of the split pe at the cleanout manhole removed and thoroughly eaned of all accumulations and obstructions.

The overflow crossing through the subway roof will act times of very heavy storms and also at such times as e siphon pipes are obstructed.

Louis D. Fonquet is Division Engineer of Sewers, ıblic Service Commission, and the writer is in charge of e office work and design.

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ew York State Road Progress

State road construction in New York during 1915 is ımmarized in a report by the First Deputy, H. Eltinge ed, to Commissioner Edwin Duffey, just made public. ıere were on Jan. 1, 1915, a total of 749 mi. of state ıd under contract and not completed. During the year 173 mi. additional were put under contract, and 760 . were completed and accepted while 321 mi. were npleted too late for acceptance. Of the 1,073 mi. arded, 381 mi. are of waterbound macadam; 176 mi. of waterbound macadam, surface treatment; 317 mi. of bituminous macadam, penetration method; 2.2 mi. of bituminous macadam, mixed method; 113 mi. of cement concrete pavement; 31 mi. of brick; 23 mi. of other types.

The average cost of construction of different classes of road was as follows:

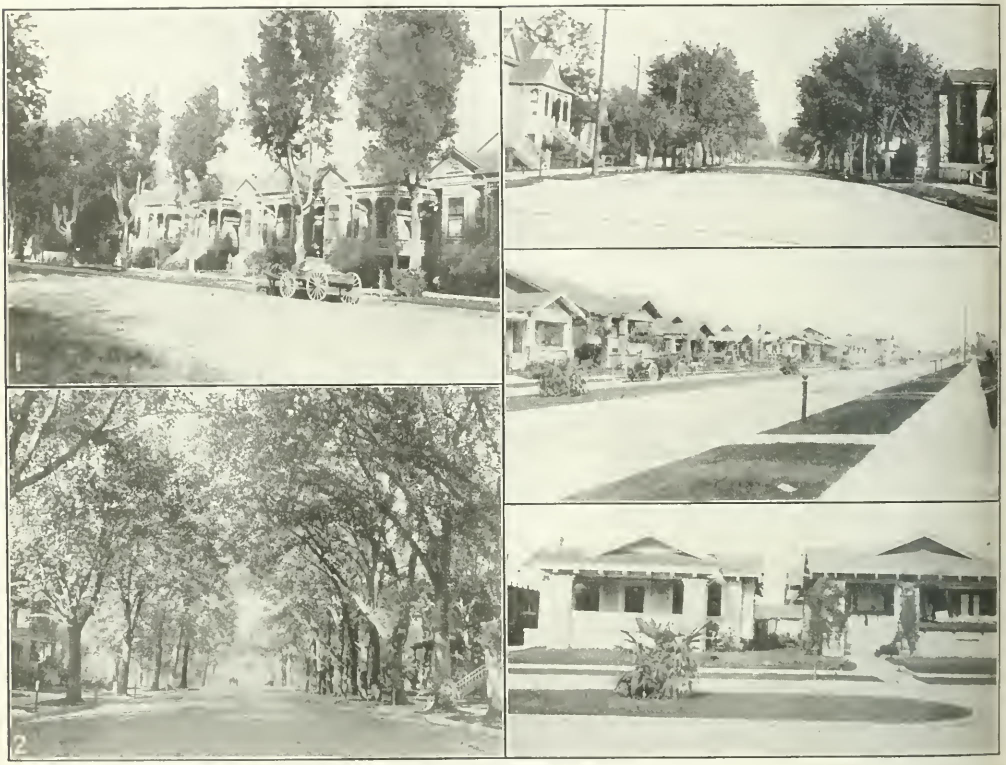
	Cost per Sq. Yd. Pavement Only	Total Cost per Mile of Highway—16 to 26 Ft Wide
Waterbound macadam	$0.648	$10,250
Bituminous macadam	.871	12,970
First-class concrete, 6 in. thick	1.121	15,320
Brick pavement on 5-in. concrete foundation	2.015	25,750

In all construction the state has been widening the pavement proper on curves and banking it in order that the fast moving motor traffic might be better safeguarded against accident. The slopes have been cut back and the clearing carried far enough along the inside of the curve to insure better sight distance for users of the road. Greater radius, wherever possible, has been given to the curve, in many cases to the extent of purchasing additional right of way.

During the past year the depth of pavements has been increased because of the large increase in the use of motor vehicles. There were 208,087 pleasure cars licensed in the state in the past year, and 23,585 commercial cars. The increased use of commercial trucks and the damage done by them to highways is alarming. Many of the old roads which were built only 6 in. in thickness have already begun to break up under this traffic, particularly at seasons of the year when ground water seeps through the soil under the pavement making it wet and unstable. At these times the vibratory action caused by the pounding from impact and by shifting of the heavy moving loads creates a shear in the pavement such as to break its bond. Raveling follows, and unless immediately taken care of the pavement rapidly disintegrates and failure is the result. As a factor against this, the state has been increasing the use of cut-off drain tile and designing roads of greater thickness, i.e., from 9 to 12 in. of stone according to the soil and traffic conditions to be encountered. It has also been the policy to build quite a number of miles of concrete roads, as these seem more adequately to meet this class of traffic.

Replanning and Districting Sacramento, Calif.

Now that it has awakened to the importance of considering its city plan, Sacramento, Calif., finds that it is greatly hampered by overwide streets where narrower ones would serve much better, that it lacks a satisfactory circulatory street system, due in large part to the adoption of the common gridiron plan, and that its industrial, business and residential sections need to be separated and kept distinct in accordance with some well-conceived plan. Sacramento has been helped to a clear vision of all this by a study and report made by John Nolen, landscape architect and city planner, of Cambridge, Mass.



FIGS. 1 TO 5. TYPICAL STREET SCENES IN OLD AND NEW RESIDENTIAL DISTRICTS OF SACRAMENTO, CALIF.

Fig. 1—Narrow lots, residences crowded, in old city. Fig. 2—A cool-looking old street; compare with treeless streets in annexed bungalow territory. Fig. 3—11th St. State Capitol in the distance (which is lost in this view) justifies a wide street, but the width is nevertheless accidental and is found in many Sacramento streets where not needed. Fig. 4—A row of crowded bungalows on an unnecessarily wide street in the annexed district. Fig. 5—Near view of bungalows on narrow lots in annexed district, with land to burn in the unnecessarily wide street

As to the large part of the area of Sacramento given up to streets, Mr. Nolen said in a recent report:

> More than 50% of the area of the old city is taken up in streets and alleys, whereas 30% would be a liberal allowance for a city of the character of Sacramento. This means that at least 20% of the 3,000 acres of the old city, or about 600 acres of the most valuable land in Sacramento, is worse than wasted. These 600 acres would give the city many streets 100 ft. wide for transportation purposes, double the present number of plazas, provide three or four blocks for a liberal civic center and at least two blocks for each public school. Furthermore, it would reduce the cost of street upkeep many thousand dollars a year, save time in transit for both people and goods and increase the income of the city from local taxes, because more property could be used productively.

Taking up first the general character and the width of some of Sacramento's streets, attention may be called to the five photographs presented herewith and the descriptive notes beneath them (Figs. 1 to 5). A study of these views and notes, together with an examination of the plan of the city (Fig. 6), shows in general that the tiresome gridiron layout of streets was followed in the old city. The views emphasize the fact that the excessive width of streets has tended to crowd the houses close together on lots with narrow frontage. This is strikingly evident in the newer sections of the city, where residences of the bungalow type almost touch each other (Figs. 4 and 5) and have their fronts close upon needlessly wide streets.

The general principle of zoning or districting cities, which has for some time been common abroad and is being urged more and more in this country, is too well known to need description. The city commissioners of Sacramento have adopted the three-zone plan, shown by Fig. 6. The industrial zone has railway connections or else they can be readily provided, and it is also near the waterfront. As there are now comparatively few industries in this section, it can readily be laid out with

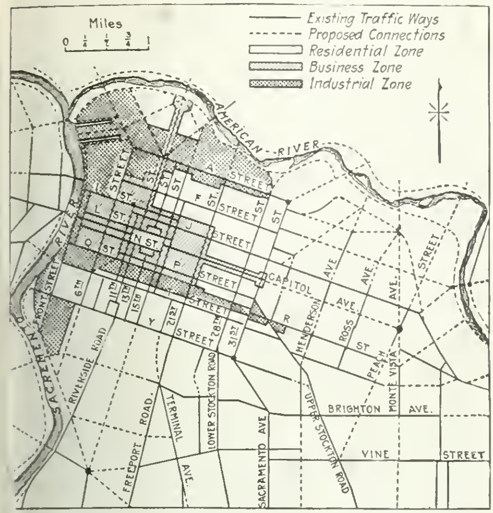
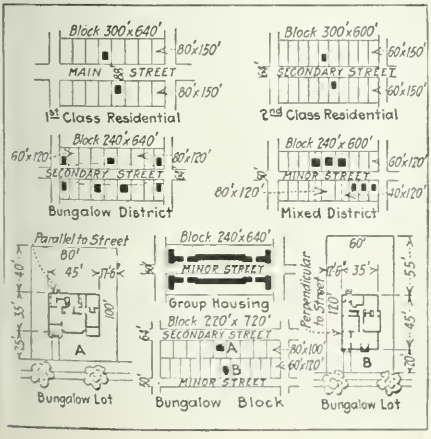


FIG. 6. MAIN THOROUGHFARE AND THREE-ZONE MAP ADOPTED BY CITY OF SACRAMENTO

treets of such a width and such a character of pavement nd with such other improvements as may be required ›meet the needs of an industrial zone.

The proposed business zone is already devoted to that urpose. Fig. 7 shows how frontage for business pur- ses may be provided in a neighborhood center and the same time provision be made for open spaces and iblic and semipublic buildings. It is proposed to have ch neighborhood centers as this at important street tersections, a fourth-mile or so apart, each complete itself.

A portion of the residential district is located close the industrial zone. The land thus set aside for sidences is of low value. Studies designed to improve ›ck and lot arrangements and to vary the width of eets according to sectional needs are shown by Fig. 8. ırious restrictions for the three zones, including pos- ›le regulations of the height of buildings in the business section and possible subdivisions of the residence zone into private-residence, tenement and apartment-house districts, are being given consideration by Mr. Nolen, in order to furnish a guide for future ordinances.



ıG. 8. PROPOSED BLOCKS AND LOTS IN ANNEXED DISTRICT OF SACRAMENTO

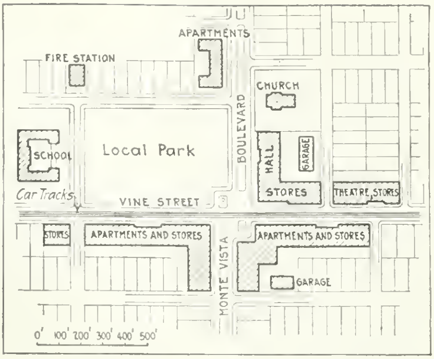


FIG. 7. LOCAL CENTER SCHEME, SACRAMENTO

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Engineers in Politics

By Thomas C. Desmond*

A good deal has been written and said recently in regard to the unfortunate fact that so few engineers ever occupy important administrative and executive positions in life as compared with men of other professions—lawyers, for instance, many of whom secure such positions. The point of this article is to suggest that engineers take more interest in politics and by so doing not only fulfill their plain duty and help the communities in which they live, but also supplement their technical experience with a broad understanding of men and affairs. There would be more engineers rightfully in prominent positions both in public and in private business life if more engineers had taken supplementary courses in the great graduate school of American politics.

By engineers in politics is meant engineers active in city, state or national political-party organizations—that is, engineers who take the time necessary to study the political issues of the day, who familiarize themselves with the machinery of popular government, who belong to local political clubs, who attend political meetings and party conventions and strive continually in a practical way to make their beliefs effective as regards good candidates for office and good party programs of legislation. Engineers active in politics in this way will benefit greatly the communities in which they live and will themselves be benefited. Let us consider this personal side first.

Activity in politics will benefit an engineer greatly because it will bring him into close and friendly relationships with other men of entirely different outlooks on life. It will give him a broader sympathy and understanding with men of other businesses and professions. It will strengthen his place in the community as a citizen and a man and not merely as a technical machine. By greatly enlarging his personal acquaintance it will give him the opportunity of learning to be a quick and accurate judge of men, which is a qualification necessary for the man who would hold many an important position.

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*Consulting Engineer, 110 West 31th St., New York City.

Activity in politics will help to teach the engineer how to express his ideas in terms that will be understood by other men. It will help to develop in him the power of forceful expression, the ability to persuade other men of the truth of what he says.

Activity in politics will also teach the engineer something he seldom, if ever, learns from his technical experience—to judge of shifting data. Most engineers have learned to reason correctly from data which are fixed and determinate, as is usually the case in purely engineering problems; but few engineers ever get so that they can fulfill that qualification which is so often required as vitally important in high administrative positions—the ability to find quickly the approximate truth from a complex problem not capable of exact solution where the data are changing even while a conclusion is being reached. Experience in studying political problems and in making decisions in political matters will help to develop this qualification in the engineer. Such experience would help to qualify for the presidency of a great corporation many a man who is now just a good chief engineer.

Few good engineers ever get beyond the chief engineer stage. They remain in a state of mind where they would be almost lost in dealing with the indefinite problems continually coming before an administrative executive, problems in which only a few moments' time can be given to consideration before a decision must be made; problems which no slide-rule or mathematical tables can solve and affairs is necessary for a correct solution. Engineers would occupy more executive positions of prominence, instead of letting the lawyers have most of them, if like the lawyers they sought more experience in politics of the kind which helps to give the training prerequisite to the proper filling of such positions.

In general, it will be a great benefit to the community in which the engineer lives to have him give part of his time to political work. It could easily be shown that most of the failures of our democracy—and we are far from having in America a very successful democracy—are due to the fact that a great many of our best qualified citizens do not attend properly to their political duties. On this ground alone it would be well to have engineers active in politics. But above this general reason there are several special reasons why the influence of engineers in politics would produce much good.

In the first place, the average engineer would bring with him into politics, regardless of everything else, a straight, clean character. In spite of the many faults and deficiencies of engineers as a class there is little question that association with engineering work does tend to bring out all there is of truth and honesty in a man. Just trying to design and build things strong and straight is what an engineer does all the time, and a little more of that spirit and influence in American politics would answer many of our governmental problems. There has been too much of the worst kind of the second-rate lawyer spirit of equivocation and specious pleading in American politics and too little of the straightforward, constructive, honest, unselfish work done by men to whom that kind of work is a matter of course.

While acknowledging the patriotism, the devotion and the vision of many of the lawyers who have borne the burden of public service and political work in the past when men of other professions and businesses, including engineers, were shirking this burden, one cannot help but think that it would be a very good thing for the country if the places of many lawyers now in public life were taken by engineers. The lawyer has essentially an analytical mind and is primarily a critic, while the engineer is essentially a builder and is accustomed to driving through constructive programs, of planning things definitely and then completing them.

The special familiarity of engineers with many of the functions of a government is another reason why their influence in politics would be for the good of the community. City governments in particular have largely to do with engineering matters, such as the building and care of streets and pavements, sewers, water and lighting systems, etc. State and national governments also are largely concerned with the administration of engineering matters.

Will engineers forever be content to remain technical subordinates and let others manage their government? This is a time of a great world crisis. New problems, many of them resulting from the war in Europe, are constantly coming up for solution by our political leaders and the electorate. After the war is over, America will have to solve many other governmental problems, mostly domestic. During this vital period of national adjustment, when democracy as never before will be on trial, shall engineers keep giving their best thought to their blueprints, with never any visions beyond such things as the strength of materials? Let it rather be said that engineers who live in this great democracy will fulfill their duty as American citizens by taking an active part in politics, by lending their strength in any way they can to assist in making our ideals of democracy successful, by helping to prove that it is not necessary to have a despotic militaristic state in order to have efficient city and national government.

And this is the great reason why engineers should be in politics, because America needs them. Activity in politics will benefit an engineer personally and make him more capable of holding an important administrative or executive position; but, much more than that, it will give him a great opportunity for doing good for others. In the old days of chivalry there was a phrase current—*noblesse oblige*. To the modern American engineer the interpretation of this might be: "If you have good judgment and clear vision enough to know how parties and governments should be run in a democracy and have some ideals of public service, it is your duty and your privilege to do your share in political work and strive to make your work effective for the good of all."

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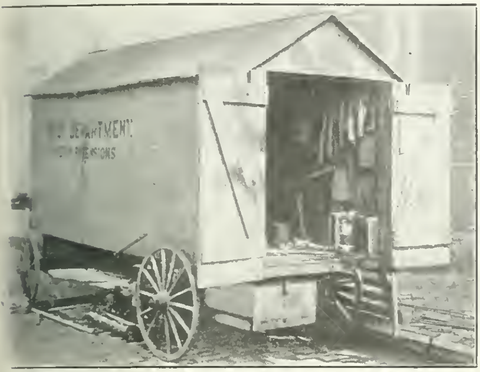
Several Mining-Experiment Stations and three mine-safety stations have been located under the provisions of an act passed last year by Congress and appropriated for at the present session. The first of the experiment stations is to be at Fairbanks, Alaska, the second at Tucson, Ariz. The safety stations will be at Butte, Reno, and at Rapon, N. M. The sum of $25,000 is appropriated for each of the experiment stations and $101,500 for the three safety stations. The purpose of the stations is to make investigations with a view toward improving conditions in the mining, quarrying, metallurgical and other mineral industries, safeguarding life among employees, preventing unnecessary waste of resources and otherwise contributing to the advancement of these industries. Each of the safety stations is to be equipped with an all-steel mine-rescue car of special design. When not employed at the scene of a mine disaster, these cars will be sent to the various mining camps for the purpose of training the miners in rescue work.

Setting 10,000 Water Meters

In May, 1914, the City of Wilmington, Del., began installing water meters on all services. About half of the 20,000 services had been metered up to that time.

The first question confronting the Water Department was to decide between curb and cellar settings. After refully considering the advantages of curb installations d the additional expense necessitated, the problem was ved by adopting the following policy: (1) Water ters to be set at curb on all new properties; (2) meters be set at curb on properties without cellars, except ere the probable life and nature of the building did not warrant the expense of a curb setting; (3) meters to be set at curb when requested by property owner; (4) meters to be set at curb where danger of freezing existed, if installed in cellar or where cellar did not permit convenient location from the meter reader's standpoint; (5) all meters not covered by the foregoing stipulations to be installed in cellars. The practical results of the above policy have been entirely satisfactory to the Water Department and to the property owners.



G 1 SHOP-WAGON FOR INSTALLING WATER METERS, WILMINGTON, DEL.

FIG 2. INSIDE VIEW OF SHOP-WAGON

Organization and Equipment

The first step in establishing a working program was to subdivide the city into five installation districts and to work systematically in one district at a time. The force engaged varied from time to time in the number of laborers, but conformed on an average to the following schedule: 1 plumber; 7 pipe fitters; 8 helpers; 2 pavers; 2 drivers and from 10 to 20 laborers. The equipment included a cart and horse, motor truck and a wagon shop (see Figs. 1 and 2).

The meter installations were made under the direct supervision of S. N. Van Trump, Assistant Engineer and Superintendent of the Water Department. The plumber (37½c. per hr.) acted as foreman of the installation gang. All employees reported each morning at the wagon shop, which was located at the point of starting the day's work. The necessary equipment of tools and supplies was contained in this wagon. Depletions of stock were filled each day from the main storeroom by use of the motor truck.

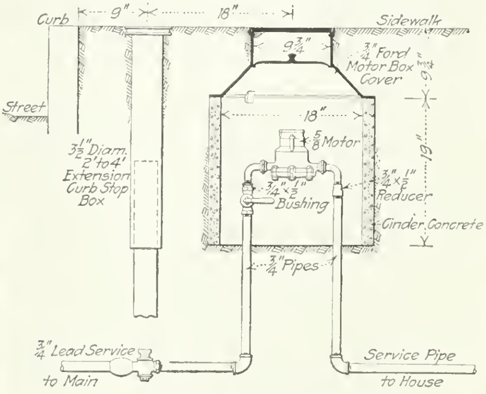


FIG. 3. STANDARD CURB METER SETTING, WILMINGTON, DEL.

Working Methods in Field

Slips were prepared each day at the main office, containing the street number of every house in the district in which the force was working, and a notation as to whether or not the house was already metered. These slips were distributed to the fitters at the start of the day's work and were turned in to the foreman as the meters were installed. They were then approved by him and returned to the main office for the purpose of permanent entry in the Water Department's books. In addition, each fitter was required to enter on a printed form a report of each meter installed, with its location, or notation of any service complications or other reason preventing its installation.

When such complications existed, the fitter's report was returned to the Engineering Department, and the property owner was notified by letter to remedy the condition within 30 days. At the expiration of this time an inspection was made; and if the situation had been corrected, the meter was ordered installed. For this purpose two men were employed who worked independently of the main force, in order that the progress of the latter might not be held up.

In cases where the property owner failed to comply with the requirements, the contract for a supply of water to such property was canceled. Service complications existing between the main and curb line were taken care of by the Water Department, while those existing between the curb and building line were corrected by the property owner. Before any meter was installed and prior to making an inspection for such purpose, the tenant of each house was supplied with literature explaining the nature of the work and the benefits to be derived.

Progress and Cost of Work

From May 8 to June 30, 1914, 1,233 meters were placed, of which 239 were curb and 994 cellar installations. From June 30, 1914, to July 1, 1915, the number of installations was 9,180, of which 4,055 were curb and 5,125 cellar settings. Throughout the winter the work was continued without interruption, the working force being confined to cellar installations during periods of bad weather.

The average cost of installing ⅝-in. meters at the curb, including meter, meter box, top, pipe and fittings as shown in Fig. 3, was $12.81. This price includes the cost of repaving, but not the cost of the curb-stop box or the curb stop. The average cost of installing meters in the cellar or other inside location was $8.55, including all necessary labor and material.

The standard meter box is of cinder concrete. These boxes were manufactured in large quantities by the Water Department, and to their use is due largely the low cost of curb installations. Experiments conducted by the Water Department have demonstrated that there is no danger of freezing in this climate from such comparatively shallow settings.

The work of installing meters disclosed an enormous amount of service complications and bad plumbing. The system of notices by letter, as well as frequent inspections, has resulted in correcting such conditions. The value of this work in reducing the water consumption, aside from the installation of meters, is difficult to estimate.

The foregoing data are taken from the recent annual report of the Board of Water Commissioners of Wilmington, of which Edgar M. Hoopes, Jr., is chief engineer.

⁂

Fish Screens for the head-gates of irrigation ditches are desired by the Federal Forest Service. The Government annually expends large amounts in stocking with trout the streams in the National Forest Reserves. The water from many of these streams is used for irrigation, and unless screens are placed at the head gates, many of the trout go down the irrigation ditches and are washed onto the fields to die. Most of the Western states have laws requiring that screens be placed at the head of irrigation intakes. Because of trouble from the clogging of the screens with floating drift, the irrigators oppose their use and the laws are not enforced. Unless a practicable screen can be devised which will eliminate the trouble from clogging, the Government is likely to restrict its work of stocking the headwaters of streams used for irrigation.

Brookline Iron-Removal Plant

F. F. Forbes, superintendent of water-works of Brookline, Mass., is chief engineer and general superintendent of construction of an interesting iron-removal filtration plant for that town, now nearing completion. Construction work is all being done by day labor, under Mr. Forbes' personal supervision, the original purpose being to furnish employment to the town's unemployed during the then prevailing hard times. Mr. Forbes is the practical designer of the plant, the detail plans of which, made by the town engineering department, commonly follow construction.

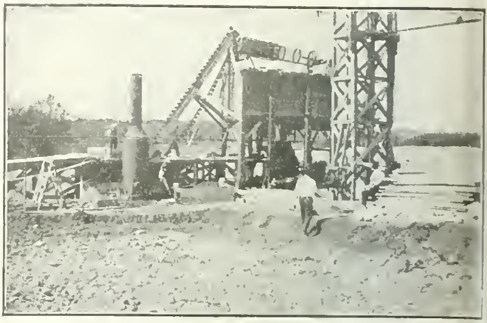


FIG. 1. CONSTRUCTION PLANT: BROOKLINE IRON-REMOVAL PLANT

The general layout of the plant is shown in the accompanying plan, Fig. 3. The water from the pumping station is distributed to the six 31-ft. concrete cylinders, which form the coke tricklers or prefilters. The depth of coke is to be 11½ ft. The water will be sprayed over the coke from perforated pipes laid over the surface of the beds.

From the coke prefilters the water, which has thus been thoroughly aërated, flows to the covered settling or coagulation basin, on the end of the first row of sand-filter beds. This basin is of similar construction and of the same size as one of the sand filters. It is divided into five compartments or channels by 8-in. brick walls, so that the water traverses the length of the basin five times before reaching the outlet. The object is to continue the aëration of the water and give a maximum time for its effect.

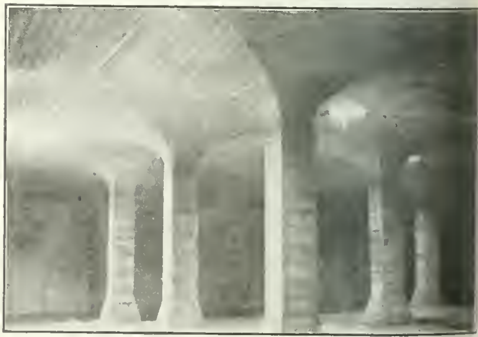


FIG. 2. INTERIOR VIEW OF COVERED FILTERS

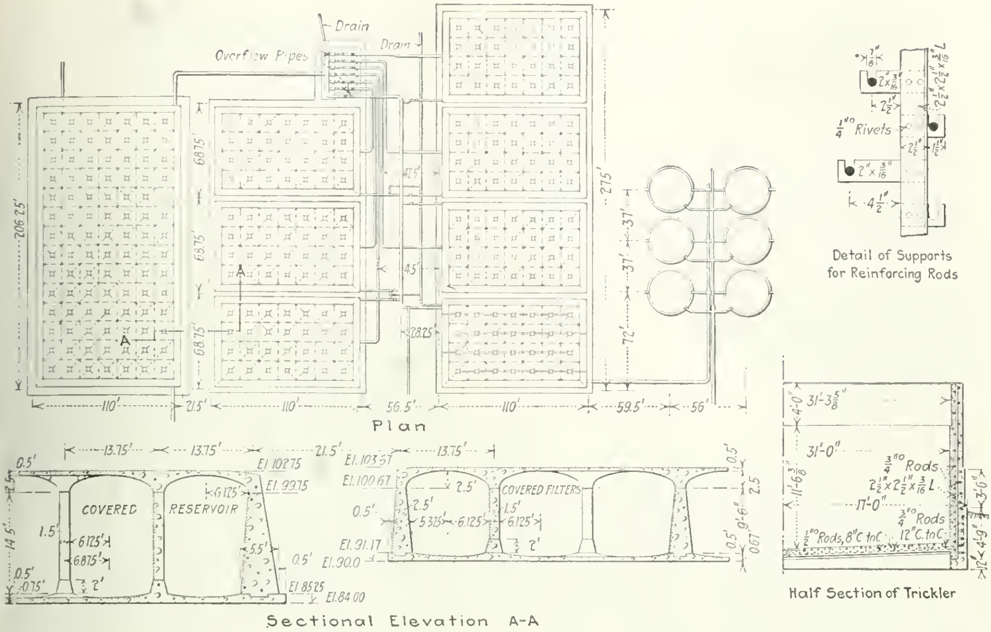


FIG. 3. GENERAL PLAN OF IRON-REMOVAL PLANT; F. F. FORBES, SUPERINTENDENT OF WATER-WORKS, BROOKLINE, MASS., ENGINEER AND SUPERINTENDENT OF CONSTRUCTION

From the coagulation basin the water may be drawn off through the gate house to the clear-water reservoir at the left of the filters, Fig. 3, or it may be passed into any one or all of the six filters, which have a combined area of one acre, and are designed for a daily capacity of 10,000,000 gal. The filter drains are unusual. The filter floor adjacent to the drains is depressed and the drains are built in the form of concrete boxes entirely above the floor, the object being to make all parts of the drains easily accessible.

The clear-water reservoir holds a day's supply. The water flows from it by gravity back to the pumping station, where it is repumped into the mains. The gate house is built alongside the second row of filters. The effluent pipe from each filter bed is equipped with a venturi meter. Two open-end overflow pipes are provided, one on the filter line and one on the reservoir line. These are so placed that they will waste the entire flow, if necessary, and make it impossible to get pressure on the filter or reservoir roofs, which has been the cause of failure in one or more filtration plants.

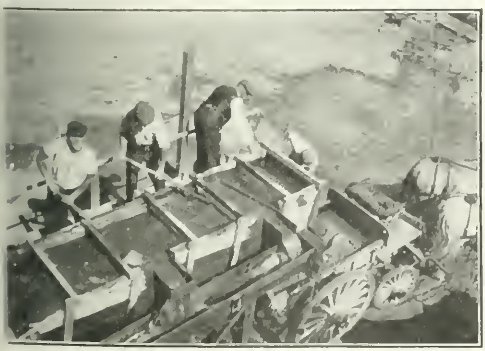


FIG. 4. SAND-WASHING DEVICE FOR FILTER SAND

The construction plant was simply and economically arranged. A gravel bank is adjacent to the plant. The concrete mixer was set up under the screened gravel bins (see Fig. 1) and the aggregates chuted into the mixer hopper. The concrete was distributed to the various parts of the work from a tower by means of chutes. The same screening plant and bins are used for separating the sand for the filter beds, although sand from another bank, some distance away, was used.

The sand-washing device for the filter sand is shown in Fig. 2. This consists of a trough built out from the sand spout of the bins. There is sufficient water in this sand as it comes from the screen to make it flow into this trough. Along the bottom of the trough is a perforated pipe, which also admits water under considerable pressure. Two overflow spouts are provided on the sides of the trough, which carry off the dirty water. A baffle is built just beyond the second waste spout, under which the clean sand is carried into the end compartment, where it is drawn off through an ordinary pipe gate-valve. Water is admitted to the compartment containing the clean sand from the pipe on the bottom, in order to keep the sand in suspension and make it flow readily through the outlet valve. By varying the size of the holes in the bottom water-inlet pipe just the right size sand could be saved and the mud and small-sized material washed away. The sand used is rather coarse.

Long-Time New York Rainfall as Basis for Sewer Design--II

By O. Hufeland*

SYNOPSIS—Tabulations and diagrams of the New York City rainfall for the years 1869 to 1913 inclusive, being a continuation of those in the issue of Aug. 31.

In the issue of Aug. 31, 1916, p. 393, the first part of this article was devoted mainly to the "Average-Rate" method of tabulating the 45-yr. of rainfall available in New York City. In this issue the "Uniform-Intensity" method will be taken up.

Uniform Intensities of Precipitation

In the "uniform-intensity" method the rates of precipitation above the minimum previously described are compiled for periods during which they were uniform. This method consists in giving the intensities and their duration as they actually occurred. For instance, a 2-in. rate for 15 min. means that it rained at that rate for every minute of the 15, while in the other method it generally means that the average of several rates for that period was 2 in. per hr.

Table 4 gives the date, duration, quantity of rainfall and rate of uniform intensities for the years from 1869 to 1913. Table 5 gives the same figures arranged by time from 2 to 70 min., the latter being the longest period during which a uniform intensity of a sufficient rate occurred. Fig. 3 shows the frequency and rate arranged in the order of their occurrence, beginning at 5 min. These tables and this diagram correspond to Tables 1 and 2 and Fig. 1 of the first method. Fig. 4 substantially corresponds to Fig. 2, showing the frequency curves, except that it shows all the recorded intensities for the whole 45 yr.[1]

The two methods give widely different records for the same storm, and it will be interesting to compare them.

Preliminary to such a comparison it will be necessary to get a clear understanding of the word "average" as it is used here. Average is the mean of a number of points of a known value without a limitation as to the distance these points are apart. When all the data and the time to analyze them are available an average should not be misleading; when this is not the case it may be very misleading. An illustration may simplify my meaning. If 24 cars pass a given point in 24 hr. the average is one car per hour, even if all the 24 pass in 5 min. The average is correct, but misleading; again, if the cars passed at regular intervals of an hour and carried a total of 600 passengers daily, the average would be 25 per hr., even if six of the cars carried all the passengers in 6 hr. and not one in the other 18. Such an average, like the preceding one, would be misleading. Now if it was necessary to transfer these passengers it is clear that any transfer system that could carry only 25 passengers an hour would be hopelessly flooded on the arrival of the first car with passengers or idle if the empty cars arrived first. The application is obvious. The only excuse for such a system would be the lack of knowledge as to the time and rate of arrival at the

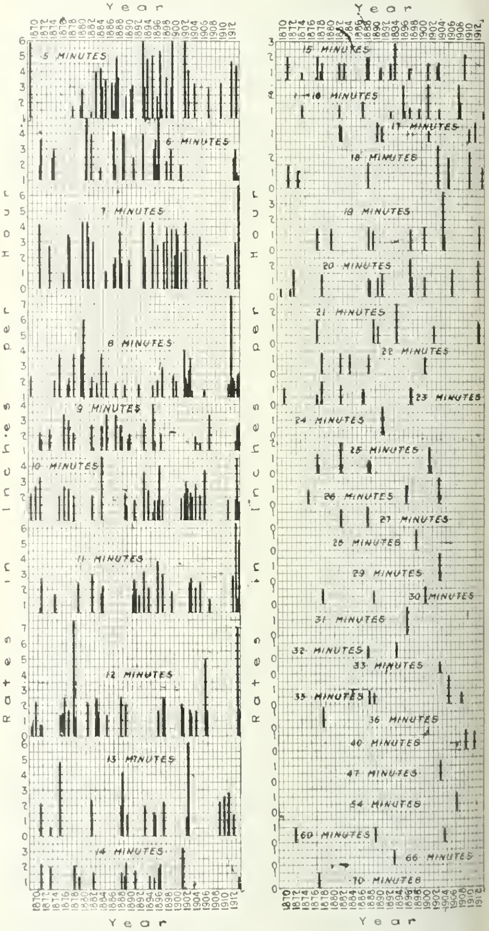


FIG. 3. RATES AND FREQUENCY OF "UNIFORM INTENSITIES" OF RAINFALL AT NEW YORK CITY, 1869-1913

transfer point. A similar lack may have been the reason for the common use of the "average rate" of rainfall in sewer design. But the possession of such knowledge requires an analysis that may throw a new light on the use of rainfall records.

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*Assistant Engineer, Consulting Engineer's Office, Borough of Manhattan, Municipal Building, New York City.

[1] In Fig. 4 I have drawn a dotted line that may be considered a maximum curve with an equation $I = \frac{72}{t+1}$. I have experimented with other curves on this diagram, and if it is thought desirable to lay down curves for use I would suggest that the numeral in the divisor be increased by 1 (t + 1, t + 2, t + 3) until the desired curve is obtained; if this is done to t + 10 the curve obtained will just come within the dated points. Such curves have naturally no relation to any period of frequency like that claimed for those of the other method, but will show what points are enveloped and which are omitted, while the dates will show when they occurred. Such a curve is a simple guide with all the data upon which it is based before the engineer.

The value of any theory for determining the quantity of water to be carried off by storm sewers must depend upon the correct use of the data. Let us see if the "average rate" method provides such a use.

In the year 1913 three heavy storms occurred. The exceedingly large quantity of rain that fell in a short period would favor the application of the "average rate" method to these storms rather than to longer ones with less rain and will therefore furnish a fair illustration. These storms were accurately recorded on July 28, Sept. 1 and Oct. 1 of that year at the Central Park observatory by a Frieze self-recording rain gage, under the supervision of the United States Weather Bureau, and are carefully plotted in a cumulative form in Fig. 5. Lines drawn through the plotted points show each of the assumed "uniform intensities" of rainfall. Directly above these are plotted diagrams showing these rates in the order of their occurrence, their relation to each other and their duration. On the same diagram are tabulations of the "average rates" for the three storms. The July 28 storm lasted 85½ min., during which 2.98 in. of rain fell giving an "average rate" of 2.09 in. per hr. Such a rate occurred at no time during the storm, the nearest being three widely separated periods, together 18½ min., during which the rate was about 2.50 in. Of the other "average rates" not one, even approximately, corresponds to an actual occurrence. Out of the total of 85½ min., for 30 min. the rate was less than 0.7 in.; for 22 min. it was less than 1.5 in.; for 18½ min. it was about 2.5 in.; for 4½ min., 1.4 in.; and for 10½ min. it was 6.3 in. An "average" for 85½ min. of such rates is grossly misleading. The storm of Sept. 1 lasted 80 min., during which 3.62 in. of rain fell; and for this an "average rate" of 2.70 in. per hr. is given. The nearest approach to such a figure is a rate of 3.84 in., which lasted 2½ min., the next being two periods of 10 and 12 min., for which the rate was 1.80 in. Between these there was an interval of 3 min. when it did not rain at all. For 24 min. of the total 80 it rained at the rate of 0.75 in. per hr.; for 5½ min., 1.52 in.; for 22 min., 1.80 in.; for 2½ min., 3.84 in.; for 11 min., 5.18 in.; for 12 min., the rate was 7 in., and for 3 min. no rain fell. In the first 31 min., 2.65 in. of rain fell, which would give an "average rate" of 5.16 in. In the last 19 min. 0.97 in. fell, giving an average rate of 1.20 in. An average of 2.70 in. per hr. for the whole 80 min. approaches the limits of absurdity. Would a sewer designed to carry off 2.70 in. of rainfall in an hour carry off 2.65 in. in 31 min.?

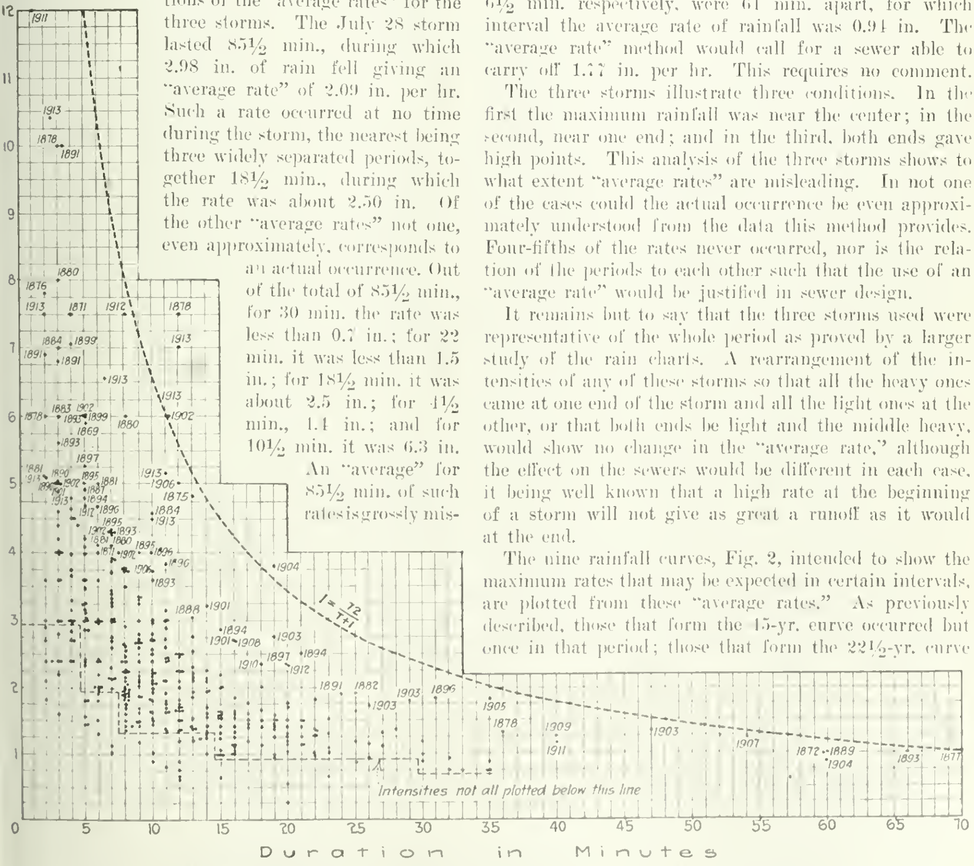


FIG. 4. "UNIFORM INTENSITIES" OF RAINFALL, NEW YORK CITY, 1869 TO 1913, INCLUSIVE

A total of 235 storms and 455 points were plotted

The third storm occurred on Oct. 1 and lasted 109 min., for which the "average rate" is 1.77 in. per hr. Of this total of 109 min., for 8 min. it did not rain at all; for 51½ min., at less than 1.05 in. per hr.; 6 min., 1.30; 10 min., 1.50; 8 min., 1.95; 9 min., 2.80; 10 min., 4.50; and 6½ min, 6.66 in. per hr. The two last periods of high intensity but short duration, 10 and 6½ min. respectively, were 61 min. apart, for which interval the average rate of rainfall was 0.94 in. The "average rate" method would call for a sewer able to carry off 1.77 in. per hr. This requires no comment.

The three storms illustrate three conditions. In the first the maximum rainfall was near the center; in the second, near one end; and in the third, both ends gave high points. This analysis of the three storms shows to what extent "average rates" are misleading. In not one of the cases could the actual occurrence be even approximately understood from the data this method provides. Four-fifths of the rates never occurred, nor is the relation of the periods to each other such that the use of an "average rate" would be justified in sewer design.

It remains but to say that the three storms used were representative of the whole period as proved by a larger study of the rain charts. A rearrangement of the intensities of any of these storms so that all the heavy ones came at one end of the storm and all the light ones at the other, or that both ends be light and the middle heavy, would show no change in the "average rate," although the effect on the sewers would be different in each case, it being well known that a high rate at the beginning of a storm will not give as great a runoff as it would at the end.

The nine rainfall curves, Fig. 2, intended to show the maximum rates that may be expected in certain intervals, are plotted from these "average rates." As previously described, those that form the 15-yr. curve occurred but once in that period; those that form the 22½-yr. curve

TABLE 4. STUDY OF RAINFALL AT NEW YORK CITY, 1869 TO 1913, BY "UNIFORM-INTENSITY" METHOD

Dates, Duration in Minutes, Together with Totals for Each Rainfall and Rates per Hour in Inches

Date	Year	Min.	Rain-fall	Rate
June 21	1869	12	0.13	0.65
		12	0.18	0.90
		8	0.32	2.40
		20	0.18	0.54
		20	0.09	0.27
Aug. 13	1869	5	0.49	5.88
		10	0.07	0.42
Aug 15	1869	10	0.37	2.22
June 27	1870	12	0.45	2.25
		23	0.41	1.08
July 28	1870	10	0.45	2.70
June 7	1871	7	0.48	4.11
		9	0.34	2.22
		29	0.13	0.27
		8	0.05	0.38
July 16	1871	18	0.45	1.50
		10	0.50	3.00
		12	0.15	0.75
		20	0.15	0.45
Aug. 4	1871	9	0.25	1.62
Aug. 16	1871	15	0.50	2.00
Sept. 26	1871	14	0.49	2.10
		3	0.15	3.00
		11	0.15	0.80
		12	0.10	0.60
		27	0.11	0.25
Oct.	1871	13	0.16	2.12
		4	0.50	7.50
		2	0.09	2.70
Oct. 26	1871	3	0.18	3.60
		11	0.50	2.73
		6	0.19	1.90
July 4	1872	20	0.57	1.71
July 25	1872	60	1.00	1.00
July 5	1873	14	0.45	1.92
		3	0.20	4.00
July 27	1873	18	0.34	1.13
		7	0.32	2.72
Aug. 21	1873	13	0.12	0.55
		9	0.40	2.40
July 10	1874	8	0.27	2.02
		6	0.24	2.40
		5	0.15	1.80
		6	0.30	3.00
		16	0.38	1.40
July 12	1874	15	0.24	0.96
		2	0.26	7.80
		11	0.31	1.70
June 22	1875	10	0.35	2.10
July 26	1875	13	1.05	4.81
		4	0.18	2.70
Aug. 18	1875	26	0.41	0.95
		8	0.50	3.75
		12	0.27	1.35
May 22	1876	10	0.45	2.70
July 11	1876	12	0.30	1.50
Aug. 16	1876	7	0.12	1.02
		12	0.50	2.50
		9	0.50	3.33
June 21	1877	70	1.18	1.02
July 3	1877	7	0.40	3.40
July 9	1877	19	0.45	1.42
July 17	1877	8	0.24	1.80
		3	0.08	1.60
		9	0.45	3.00
		7	0.38	3.27
		3	0.11	2.20
Aug. 14	1877	8	0.30	2.25
Aug. 14	1877	12	0.34	1.70
Aug. 25	1877	10	0.43	2.58
Oct. 4	1877	15	0.16	0.64
		25	0.50	1.20
		15	0.50	2.00
		21	0.53	1.50
		23	0.25	0.65
June 21	1878	15	0.27	1.08
		23	0.58	1.51
July 10	1878	9	0.33	2.16
July 21	1878	10	0.35	2.10
July 31	1878	20	0.48	1.44
		22	0.50	1.37
Aug. 1	1878	14	0.17	2.01
		15	0.39	1.56
Aug. 5	1878	8	0.50	3.75
		12	1.50	7.50
		3	0.50	10.00
Sept. 4	1878	12	0.24	1.20
		2	0.20	6.00
		36	0.80	1.33
		3	0.15	3.00
Nov 27	1878	30	0.50	1.00
June 15	1879	14	0.50	1.28
Aug. 25	1879	11	0.45	2.45
July 12	1880	3	0.40	8.00
		2	0.10	3.00
		3	0.12	2.40
		3	0.35	7.00
		8	0.50	3.75
July 27	1879	7	0.50	4.29
Aug. 10	1879	5	0.24	2.88
Aug. 2	1879	8	0.40	6.00
Aug. 25	1879	5	0.15	1.80
		19	0.45	1.41
May 22	1881	6	0.50	5.00
		7	0.50	4.29
		2	0.17	5.10
July 4	1881	12	0.45	2.25
Aug. 7	1881	7	0.38	3.26
June 15	1882	4	0.26	3.90
June 19	1882	17	0.45	1.60
June 26	1882	9	0.40	2.67
Sept. 11	1882	15	0.40	1.60
		10	0.35	2.10
Sept. 20	1882	2	0.13	3.90
		17	0.40	1.41
Sept. 22	1882	7	0.35	3.00
		13	0.50	2.31
		14	0.36	1.56
Sept. 23	1882	3	0.14	2.80
		22	0.50	1.37
		8	0.20	1.50
		9	0.17	1.18
		4	0.20	3.00
		2	0.12	3.60
		2	0.08	2.40
		16	0.35	1.32
		27	0.50	1.11
		4	0.18	2.70
		5	0.12	1.44
		8	0.30	2.25
		11	0.55	3.00
		25	0.80	1.92
		23	0.50	1.30
May 21	1883	15	0.40	1.60
		12	0.50	2.50
		3	0.20	6.00
		12	0.33	1.65
June 6	1883	4	0.31	4.65
July 13	1883	2	0.06	1.80
		5	0.43	3.96
		8	0.25	1.88
June 25	1884	6	0.18	1.80
		4	0.16	2.40
		11	0.31	1.70
July 12	1884	11	0.40	2.20
Aug. 5	1884	5	0.35	4.20
		4	0.16	2.40
Aug. 22	1884	10	0.46	4.60
		8	0.50	3.75
		9	0.39	2.60
Aug. 30	1884	3	0.22	4.40
		5	0.25	3.00
		22	0.47	1.28
June 5	1885	8	0.35	2.63
July 29	1885	5	0.29	3.48
Aug. 3	1885	7	0.13	1.12
		9	0.50	3.33
		12	0.27	1.35
Nov. 18	1886	5	0.28	3.26
May 31	1887	5	0.12	1.44
		7	0.30	2.60
		9	0.50	3.33
		2	0.07	2.10
June 17	1887	5	0.28	3.36
June 20	1887	6	0.41	4.10
June 22	1887	8	0.25	1.88
		3	0.20	4.00
		6	0.20	2.00
Aug. 18	1887	5	0.41	4.92
Aug. 21	1887	5	0.30	3.60
Aug. 22	1887	16	0.41	1.60
		23	0.38	1.00
Aug 24	1887	7	0.35	3.00
May 28	1888	27	0.59	1.31
May 29	1888	14	0.37	1.60
June 26	1888	13	0.40	1.85
		7	0.38	3.70
July 19	1888	9	0.40	2.67
July 31	1888	25	0.36	0.86
Aug. 4	1888	20	0.38	1.14
		9	0.28	1.86
		12	0.50	2.50
Aug. 4	1888	15	0.50	2.00
Aug. 21	1888	35	0.50	0.86
		15	0.50	2.00
		32	0.40	0.75
		20	0.35	1.05
		18	0.50	1.67
Sept. 8	1888	19	0.47	1.50
Sept. 12	1888	7	0.27	1.60
Sept. 17	1888	22	0.47	1.28
Sept 20	1888	13	0.66	3.05
April 12	1889	3	0.20	4.00
June 11	1889	12	0.40	2.00
June 15	1889	8	0.29	1.78
July 4	1889	30	0.45	0.90
July 19	1889	11	0.31	1.33
July 27	1889	35	0.45	0.75
		21	0.53	1.50
July 30	1889	4	0.25	3.75
		13	0.30	1.38
		60	1.00	1.00
July 31	1889	6	0.30	3.00
Aug 2	1889	6	0.30	3.00
Aug. 13	1889	19	0.40	1.26
Sept. 13	1889	5	0.20	2.40
Sept. 17	1889	14	0.53	2.27
May 4	1890	3	0.25	5.00
June 6	1890	7	0.35	1.80
		3	0.25	5.00
June 11	1890	4	0.21	3.15
June 13	1890	4	0.19	2.85
		21	0.38	1.13
July 17	1890	10	0.38	2.28
Aug. 22	1890	17	0.50	1.77
Aug. 29	1890	9	0.25	1.68
Sept. 16	1890	5	0.24	2.88
		9	0.31	2.07
Sept. 17	1890	20	0.40	1.20
Oct. 10	1890	10	0.24	1.44
April 18	1891	11	0.30	1.64
April 23	1891	5	0.26	3.12
June 17	1891	14	0.40	1.72
July 23	1891	11	0.48	2.62
Aug. 23	1891	4	0.20	3.00
		24	0.76	1.90
		15	0.33	1.32
Sept. 5	1891	11	0.36	1.98
June 9	1892	4	0.24	3.66
		11	0.30	1.64
		8	0.24	1.80
July 3	1892	3	0.50	10.00
		4	0.22	3.30
Aug 5	1892	17	0.41	1.51
Aug. 9	1892	6	0.24	2.40
		20	0.50	1.50
Sept. 13	1892	2	0.23	6.90
		10	0.30	1.80
May 3	1893	15	0.39	1.56
June 6	1893	11	0.58	3.16
		9	0.41	2.73
July 26	1893	3	0.28	5.60
Aug. 19	1893	10	0.60	3.60
Aug. 20	1893	6	0.40	4.00
		5	0.50	6.00
		7	0.50	4.30
		7	0.23	1.96
Aug. 23	1893	66	1.09	1.00
Sept. 7	1893	13	0.42	1.94
Oct. 27	1893	5	0.25	3.00
		16	0.27	1.00
July 29	1894	10	0.40	2.40
Aug 3	1894	5	0.40	4.80
Aug. 15	1894	14	0.33	1.40
Sept. 8	1894	15	0.72	2.88
		21	0.87	2.50
Sept 16	1894	11	0.32	2.10
May 27	1895	4	0.20	3.00
June 5	1895	9	0.60	4.00
July 27	1895	8	0.23	1.73
July 30	1895	14	0.30	1.29
Aug. 4	1895	9	0.22	1.47
		13	0.33	1.52
		10	0.17	1.02
Aug. 6	1895	5	0.50	5.00
		10	0.27	1.62
Aug. 31	1895	7	0.50	4.30
		13	0.30	1.38
Feb. 6	1896	26	0.50	1.15
May 28	1896	14	0.45	1.93
June 10	1896	3	0.34	6.80
June 21	1896	10	0.27	1.62
		31	0.95	1.84
		16	0.70	2.62
July 15	1896	6	0.36	3.60
		6	0.30	3.00
		8	0.26	2.10
July 12	1896	5	0.20	2.40
		6	0.20	2.00
		14	0.50	2.14
July 20	1896	16	0.27	1.01
		7	0.32	2.75
July 27	1896	12	0.33	1.65
July 30	1896	10	0.40	4.00
Sept 3	1896	11	0.70	3.82
Sept 15	1896	4	0.30	4.50
Sept 18	1896	6	0.47	4.70
May 24	1896	5	0.46	5.28
		12	0.50	2.50
June 9	1897	9	0.32	2.10
		19	0.43	1.36
July 12	1897	10	0.30	1.80
July 21	1897	8	0.39	2.93
July 23	1897	20	0.78	2.34
July 28	1897	23	0.42	1.10
		20	0.42	1.26
Aug. 4	1897	15	0.31	1.24
Aug. 23	1897	13	0.47	2.17
		12	0.45	2.25
		11	0.55	3.00
		5	0.13	1.56
Sept 1	1897	7	0.35	3.00
		16	0.33	1.24
Apr 24	1898	5	0.30	3.60
July 4	1898	7	0.46	3.93
Aug. 21	1898	6	0.22	2.20
June 15	1899	28	0.80	1.36
June 28	1899	6	0.30	3.00
July 12	1899	16	0.30	1.12
		5	0.25	3.00
Aug. 10	1899	4	0.47	7.05
Sept. 1	1899	5	0.50	6.00
		11	0.35	1.91
Sept 3	1899	7	0.45	3.86
		8	0.32	2.40
May 19	1900	8	0.27	2.02
		19	0.50	1.58
June 8	1900	30	0.60	1.20
June 27	1900	22	0.38	1.04
Aug. 12	1900	4	0.20	3.00
Aug. 15	1900	7	0.25	2.14
Aug. 17	1900	20	0.43	1.29
Aug. 26	1900	7	0.45	3.86
		7	0.40	3.43
July 5	1901	3	0.25	5.00
		12	0.42	2.10
		7	0.27	2.31
		3	0.18	3.60
		15	0.40	1.60
		3	0.21	4.20
		16	0.72	2.70
July 6	1901	14	0.75	3.21
July 17	1901	10	0.32	1.92
Aug. 24	1901	17	0.34	1.20
		25	0.68	1.63
		6	0.20	2.00
		12	0.36	1.80
June 21	1902	4	0.30	4.50
		13	0.26	1.20
July 20	1902	10	0.35	2.10
July 28	1902	13	1.31	6.06
		3	0.25	5.00
		7½	0.66	4.04
		10	0.50	3.00
		21	0.37	1.15
Aug. 5	1902	8	0.30	2.25
		5	0.50	6.00
		7	0.50	4.28
Aug. 19	1902	10	0.50	2.50
		8	0.25	1.88
Feb. 28	1903	5	0.34	4.08
June 14	1903	26	0.74	1.70
June 21	1903	10	0.38	2.28
June 29	1903	33	0.40	0.73
		8	0.35	2.62
		18	0.83	2.77
July 2	1903	11	0.44	2.40
July 22	1903	8	0.47	3.52
July 30	1903	15	0.36	1.44
		12	0.35	1.75
		15	0.40	1.60
Sept. 17	1903	10	0.33	1.98
Oct. 8	1903	3	0.23	4.60
		16	0.30	1.12
		11	0.50	2.73
		12	0.30	1.50
		8	0.25	1.88
		29	0.85	1.78
Oct. 9	1903	47	1.07	1.36
May 30	1904	11	0.40	2.10
		60	0.87	0.87
July 28	1904	5	0.27	3.24
Aug. 19	1904	19	0.30	0.95
		19	1.20	3.80
		9	0.28	1.87
Sept. 14	1904	10	0.47	2.82
		12	0.33	1.65
June 22	1905	11	0.45	2.45
		35	1.07	1.83
July 29	1905	10	0.35	2.10
Aug. 13	1905	7	0.39	3.34
		9	0.22	1.47
Oct. 19	1905	18	0.60	2.00
May 5	1906	12	1.00	5.00
May 27	1906	8	0.19	1.42
		12	0.34	1.70
		7	0.25	2.14
July 10	1906	20	0.58	1.74
July 17	1906	10	0.62	3.72
Aug. 9	1907	5	0.25	3.00
Aug. 24	1907	54	1.10	1.22
Sept. 11	1907	9	0.49	3.27
		11	0.25	1.36
July 24	1908	16	0.72	2.70
		16	0.41	1.54
Sept. 28	1908	3	0.20	4.00
		35	0.45	0.77
June 28	1909	15	0.55	2.20
		40	0.84	1.26
Aug. 13	1907	13	0.48	2.21
Mar. 27	1910	5	0.27	3.24
June 10	1910	13	0.55	2.54
		17	0.40	1.41
June 11	1910	18	0.71	2.36
		32	0.50	0.94
July 30	1911	13	0.60	2.78
Aug. 15	1911	1	0.20	12.00
		7	0.25	2.14
		10	0.30	1.80
Aug. 24	1911	8	0.25	1.88
		40	0.78	1.17
Oct. 19	1911	17	0.52	1.84
Feb. 27	1912	11	0.53	2.90
May 30	1912	8	1.00	7.50
June 17	1912	5	0.39	4.68
July 21	1912	20	0.78	2.34
		38	0.30	2.25
		8	0.25	1.88
Oct. 23	1912	19	0.50	1.58
		21	0.50	1.43
		6	0.24	2.40
		13	0.30	1.38
Oct 24	1912	21	0.44	1.26
Mar. 26	1913	7	0.35	3.00
June 30	1913	2	0.25	7.50
		3	0.12	2.40
		6	0.30	3.00
July 1	1913	18	0.42	1.40
		2	0.17	5.10
July 24	1913	6	0.15	1.50
		2	0.35	10.50
		8	0.18	1.35
		4	0.32	4.80
July 28	1913	10½	1.10	6.30
		2½	0.10	2.40
		8	0.33	2.46
		8½	0.20	1.41
		4½	0.33	4.40
		8	0.34	2.55
		13½	0.28	1.24
Aug. 6	1913	9	0.40	2.67
		11	0.25	1.36
Sept. 4	1913	8	0.30	2.25
		12	1.40	7.00
		11	0.95	5.18
		12	0.35	1.80
		10	0.30	1.80
Oct. 1	1913	16	0.28	1.05
		9	0.42	2.80
		10	0.75	4.50
		8	0.26	1.95
		6	0.13	1.30
		10	0.25	1.50
		6½	0.72	6.66

TABLE 5. RAINFALL STUDIES AT NEW YORK CITY, 1869 TO 1913, BY "UNIFORM-INTENSITY" METHOD

Uniform Intensities from 2 to 70 Min. Duration with Dates of Their Occurrence

Date	Year	Rate
2 Min.		
Oct. 11	1871	2 70
July 12	1874	7.80
Sept. 4	1878	6 00
July 12	1880	3.00
May 22	1881	5 10
Sept. 20	1882	3.90
Sept. 23	1882	3.60
Sept. 23	1882	2 40
uly 13	1883	1 80
May 31	1887	2 10
ept. 13	1891	6 90
une 20	1913	7 50
uly 1	1913	5.10
uly 24	1913	10.50
3 Min.		
ept. 26	1871	3.00
ct. 26	1871	3.60
uly 5	1872	4 00
uly 17	1877	1 60
uly 17	1877	2 20
ug. 5	1878	10.00
pt. 4	1878	3 00
uly 12	1880	8 00
uly 12	1880	7 00
uly 12	1880	2 40
pt. 3	1882	2 80
ay 21	1883	6.00
ug. 30	1884	4 40
une 22	1887	4 00
pr. 2	1889	4 00
ay 4	1890	5 00
ne 6	1890	5.00
ly 3	1891	10 00
ly 26	1893	5.60
ne 10	1896	6 80
ly 5	1901	5 00
ly 5	1901	3 60
ly 5	1901	4 20
ly 28	1902	5 00
t. 8	1903	4 60
pt. 28	1908	4 00
ne 20	1913	2 40
y 28	1913	2.40
4 Min.		
11	1871	7 50
y 26	1875	2 70
ne 15	1882	3 96
t. 23	1882	3 00
t. 23	1882	2 70
e 6	1883	4 65
e 25	1884	2 40
t. 5	1884	2 40
30	1889	3 75
e 11	1890	3 15
e 13	1890	2 85
23	1891	3 00
e 9	1892	3 66
31	1891	3 30
27	1895	3 00
15	1896	4 50
10	1899	7.05
12	1900	3 00
21	1902	4 50
24	1913	4.80
5 Min.		
13	1869	5.88
10	1878	1 80
10	1880	2 88
25	1880	1 80
13	1883	3 96
23	1882	1 44
5	1884	4 20
30	1884	3 00
29	1885	3 48
18	1886	3 26
31	1887	1 44
17	1887	3 36
18	1887	4 92
21	1887	3 60
13	1889	2.40
16	1890	2 88
23	1891	3 12
20	1893	6 00
27	1893	3 00
3	1894	4.80
Aug. 6	1895	5 00
July 12	1896	2 40
May 27	1897	5 28
Aug. 23	1897	1 56
Aug. 24	1898	3 60
July 12	1899	3 00
Sept. 1	1899	6 00
Aug. 5	1902	6 00
Feb. 28	1903	4 08
July 28	1904	3 24
Aug. 9	1907	3 00
Mar. 27	1910	3 24
June 27	1912	4 68
July 28	1913	4 40
6 Min.		
Oct. 26	1871	3 60
Oct. 26	1871	1 90
July 10	1874	2 40
July 10	1874	3 00
May 22	1881	5 00
June 15	1882	3 90
June 25	1884	1 80
June 20	1887	4 10
June 20	1887	2 00
July 21	1889	3 00
Aug. 2	1889	3 00
Aug. 9	1891	2 40
Aug. 20	1893	4 00
July 15	1896	3 00
July 15	1896	3 60
July 22	1896	2 00
Sept. 18	1896	4 70
Aug. 24	1898	2 20
June 28	1899	3 00
Aug. 24	1901	2 00
Oct. 23	1912	2 40
June 20	1913	3 00
July 24	1913	1 50
Oct. 1	1913	1 30
7 Min.		
June 7	1871	4 11
June 27	1873	2 72
Aug. 16	1876	1 02
July 3	1877	3 40
July 17	1877	3 27
July 27	1880	4 29
May 12	1881	4 29
Aug. 7	1881	3.26
Sept. 22	1882	3 00
Aug. 3	1885	1 12
May 31	1887	2 60
Aug. 24	1887	3 00
June 26	1888	3 70
Sept. 12	1888	1 60
June 6	1890	1 80
Aug. 20	1893	4 30
Aug. 20	1893	1 96
Aug. 31	1895	4 30
July 20	1896	2 75
Sept. 1	1897	3 00
July 4	1898	3 93
Sept. 3	1899	3 86
Aug. 25	1900	2 14
Aug. 25	1900	3 86
Aug. 25	1900	3 43
July 5	1901	2 31
Aug. 5	1902	4 28
Aug. 15	1911	2 14
May 27	1906	2 14
Aug. 15	1911	2 14
Mar. 26	1913	3 00
Oct. 1	1913	6.66
8 Min.		
June 21	1869	2 40
July 10	1874	2 02
Aug. 28	1875	3 75
July 12	1877	1 80
Aug. 14	1877	2 25
Aug. 5	1878	3 75
July 12	1880	3 75
Aug. 2	1880	6 00
Sept. 23	1882	1 50
Sept. 23	1882	2 25
July 13	1883	1 88
Aug. 22	1884	3 75
June 5	1885	2 63
June 22	1887	1 88
June 15	1889	1 78
June 9	1892	1 80
June 27	1895	1 73
July 15	1896	2 10
July 21	1897	2 93
Sept. 3	1899	2 40
May 19	1900	2 02
July 28	1902	4 04
Aug. 5	1902	2 25
Aug. 19	1902	1 88
June 19	1903	2 62
June 22	1903	3 52
Oct. 8	1903	1 88
May 27	1906	1 42
Aug. 24	1911	1 88
May 30	1912	7 50
July 21	1912	2 25
July 21	1912	1 88
July 24	1913	1 35
July 28	1913	2 46
July 28	1913	2 55
Sept 4	1913	2 25
Oct. 1	1913	1 95
9 Min.		
June 7	1871	2 22
Aug. 4	1871	1 62
Aug. 21	1873	2 40
Aug. 6	1876	3 33
July 17	1877	3 00
July 10	1878	2 16
June 26	1882	2 67
Sept. 23	1882	1 18
Aug. 2	1884	2 60
Aug. 2	1885	3 33
May 31	1887	3 33
July 19	1888	2 67
Aug. 4	1888	1 86
Aug. 29	1890	1 68
Sept. 16	1890	2 07
June 6	1893	2 73
June 5	1895	4 00
Aug. 4	1895	1 47
June 9	1897	2 10
Aug. 19	1904	1 87
Aug. 13	1905	1 47
Sept. 11	1907	3 27
July 28	1913	1 41
Aug. 6	1913	2 67
Oct. 1	1913	2.80
10 Min.		
Aug. 13	1869	0 42
Aug. 15	1869	2 22
July 25	1870	2 70
July 16	1871	3 00
June 22	1875	2 10
May 22	1876	2 70
Aug. 25	1877	2 58
July 21	1878	2 10
Sept. 11	1882	2 10
Aug. 22	1884	4 60
July 17	1890	2 28
Oct. 10	1890	1 44
Sept. 13	1891	1 80
Aug. 19	1893	3 60
July 29	1894	2 40
Aug. 4	1895	1 02
Aug. 6	1895	1 62
June 21	1896	1 62
July 30	1896	4 00
July 12	1897	1 80
July 17	1901	1 92
July 20	1902	2 10
July 28	1902	3 00
Aug. 19	1902	2 50
June 21	1903	2 28
Sept. 17	1903	1 98
Sept. 14	1904	2 82
July 29	1905	2 10
July 17	1906	3 72
Aug. 15	1911	1 80
Sept. 4	1913	1 80
Oct. 1	1913	4 50
Oct. 1	1913	1.50
11 Min.		
Sept. 26	1871	0 80
Oct. 26	1871	2 73
July 12	1874	1 70
Aug. 25	1879	2 45
Sept. 23	1882	3 00
June 25	1884	1 70
July 12	1884	2 20
Apr. 11	1891	1 64
July 23	1891	2 62
Sept. 5	1891	1 98
June 9	1892	1 64
June 6	1893	3 16
Sept. 16	1894	2 10
Sept. 3	1896	3 82
Aug. 23	1897	3 00
Sept. 1	1899	1 91
July 2	1903	2 40
Oct. 8	1903	2 73
May 30	1904	2 10
June 22	1905	2 45
Sept. 11	1907	1 36
Feb. 27	1912	2 90
July 28	1913	6 30
Aug. 6	1913	1 36
Sept. 4	1913	5.18
12 Min.		
June 21	1869	0 65
July 21	1869	0 90
June 27	1870	2 25
July 16	1871	0 75
Sept. 26	1871	0 60
Aug. 18	1875	1 35
July 11	1876	1 50
Aug. 16	1876	2 50
Aug. 14	1877	1 70
Aug 5	1878	7 50
Sept. 4	1878	1 20
July 4	1881	2 25
May 21	1883	2.50
May 21	1883	1 65
Aug. 3	1885	1 35
Aug. 4	1888	2 50
June 11	1889	2 00
July 27	1896	1 65
May 24	1897	2 50
Aug. 23	1897	2 25
July 5	1901	2 10
Aug. 24	1901	1 80
July 30	1903	1 75
Oct. 8	1903	1 50
Sept. 14	1904	1 65
May 5	1906	5 00
May 26	1906	1 70
Sept. 4	1913	7 00
Sept. 4	1913	1 80
13 Min.		
Oct. 11	1871	2 12
July 26	1875	4 81
Aug. 22	1882	2 31
June 26	1888	1 85
Sept. 20	1888	3 05
July 30	1889	1 38
Sept. 7	1893	1 94
Aug. 4	1895	1 52
Aug. 31	1895	1 38
Aug. 23	1897	2 17
June 21	1902	1 20
July 28	1902	6 06
Aug. 13	1909	2 21
June 10	1910	2 54
July 20	1911	2 78
Oct. 23	1912	1 38
14 Min.		
Sept. 26	1871	2 10
July 5	1873	1 92
Aug. 1	1878	2 01
June 15	1879	1 28
Sept. 22	1882	1 56
May 29	1888	1 60
July 19	1889	1 33
Sept. 17	1889	2 27
June 17	1891	1 72
Aug. 15	1894	1 40
July 30	1895	1 29
May 28	1896	1 93
July 12	1896	2.14
July 6	1901	3 21
July 28	1913	1 24
15 Min.		
Aug. 16	1871	2 00
July 12	1874	0 96
Oct. 4	1877	0.64
Oct. 4	1877	2 00
June 21	1878	1 08
Aug. 1	1878	1 56
Sept. 11	1882	1.60
May 21	1883	1 60
Aug. 4	1888	2 00
Aug. 21	1888	2 00
Aug. 23	1891	1 32
May 3	1893	1 56
Sept. 8	1894	2 88
Aug 4	1897	1 24
July 5	1901	1 60
July 30	1903	1 44
July 30	1903	1 60
June 28	1909	2 20
16 Min.		
July 10	1874	1 40
Sept. 23	1882	1 32
Aug 22	1887	1 60
Oct. 7	1893	1 00
June 21	1896	2 62
July 20	1896	1 01
Sept. 1	1897	1 24
July 12	1899	1 12
July 5	1901	2 70
Oct. 8	1903	1 12
July 14	1908	2 70
July 14	1908	1 54
Oct. 1	1913	1 05
17 Min.		
July 19	1882	1 60
Sept. 10	1882	1 41
Aug. 22	1890	1 77
Aug. 5	1891	1 51
Aug. 24	1901	1.20
June 10	1910	1 41
Oct. 19	1911	1 84
18 Min.		
July 16	1871	1 50
July 27	1873	1 13
Aug. 21	1888	1 67
July 29	1903	2 77
Oct 19	1905	2 00
July 11	1910	2 36
July 1	1913	1.40
19 Min		
July 9	1877	1 42
Aug. 25	1880	1 41
Sept. 8	1888	1 50
Aug. 13	1889	1 26
June 9	1897	1 36
May 19	1900	1 58
Aug. 19	1904	3 80
Aug. 19	1904	0 95
Oct. 23	1912	1 58
20 Min.		
June 21	1869	0 54
June 21	1869	0 27
July 16	1871	0 45
July 4	1872	1 71
July 31	1878	1 44
Aug 4	1888	1 14
Aug 21	1888	1 05
Sept 17	1890	1 20
Aug 9	1891	1 50
July 23	1897	2 34
July 28	1897	1 26
Aug. 17	1900	1 29
July 10	1906	1 74
July 21	1912	2 34
21 Min.		
Oct. 4	1877	1 50
July 27	1889	1 50
June 13	1890	1 13
Sept. 8	1894	2 50
July 28	1902	1 15
Oct. 23	1912	1 43
Oct. 24	1912	1 26
22 Min.		
July 31	1878	1 37
Sept. 23	1882	1 37
Aug. 30	1884	1 28
Sept. 17	1888	1.28
June 27	1900	1.04
23 Min.		
June 27	1870	1 08
Oct. 4	1877	0.65
June 21	1878	1 51
Sept. 23	1882	1 30
Aug. 22	1887	1 00
July 28	1897	1 10
24 Min.		
Aug. 23	1891	1 90
25 Min.		
Oct. 4	1877	1.20
Sept. 23	1882	1.92
July 31	1888	0.86
Aug. 24	1901	1.63
26 Min.		
Aug. 18	1875	0 95
Feb. 6	1896	1 15
June 14	1903	1 70
27 Min.		
Sept. 23	1882	1.11
May 28	1888	1 31
28 Min.		
June 15	1898	1 36
29 Min.		
June 7	1871	0 27
Oct. 8	1903	1 78
30 Min.		
Nov. 27	1878	1 00
July 4	1889	0.90
June 8	1900	1 20
31 Min.		
June 21	1896	1.84
32 Min.		
Aug. 21	1888	0 75
June 11	1910	0.94
33 Min.		
June 29	1903	0.73
35 Min.		
Aug. 21	1888	0 86
July 27	1889	0 75
June 22	1905	1 83
Sept. 28	1908	0 77
36 Min.		
Sept. 4	1878	1.33
40 Min.		
June 28	1909	1 26
Aug. 24	1911	1.17
47 Min.		
Oct. 9	1903	1 36
54 Min.		
Aug. 24	1907	1.22
60 Min.		
July 25	1872	1 00
July 30	1889	1 00
May 30	1904	0.87
66 Min.		
Aug. 23	1893	1 00
70 Min.		
July 21	1877	1 00

urred twice, the 15-yr. curve three times, etc., *even ll of the storms had occurred in the same year.* The s of the storms used to construct these curves are lly omitted, and like the averages of which they are ned must be taken on faith. I have supplied these sing dates, however, and have thereby given an op- unity to study the reasoning upon which the curves r based. Of the 99 points through which the nine ues covering the whole 45 yr. are drawn, *25 occurred in 65 days in the year 1913,* 57 in the last 15 yr. only 42 in the preceding 30 yr.

gain, overlooking these facts, these curves represent imum rainfalls that are supposed to re-occur in a ain interval of years. They are obtained by dividing the total period observed by the number of times certain rates occurred in that period. This gives a definite result that must either be substantially right or totally wrong. If it is correct, it should coincide with a similar curve based on any period of observation.

In doing this work the writer began with only 25 yr. of rainfall observations, and the rainfall curves produced from a 25-yr. period by this method varied widely from those he obtained later from a 45-yr. period; and it is safe to predict that curves based on 60- or 100-yr. observations would vary widely from both.

Again, these curves should be an average of maximum storms for their designated periods. Let us take the 15-yr. period for an example. In the 45 yr. under discussion there are *thirty* 15-yr. periods, the first from 1869 to 1883, the second from 1870 to 1884, etc. What relation does the 15-yr. curve bear to the storms in all of these 15-yr. periods? Obviously, none whatever. The same reasoning will apply to all the other curves.

Rainfall curves constructed in this way of misleading "average rates" are not a safe guide for designing engineering work. Not only does the theory upon which they are based seem illogical, but an examination of the facts does not bear out any of its assumptions.

The "average-rate" method for the 45 yr. examined provides 934 intensities above the adopted minimum for 11 periods beginning at 5 min., very few of which actually occurred, while the "uniform-intensity" method, recorded with equal care from the same storms, finds only 394 for 37 periods of 5 min. and over, every one of which records an actual occurrence. An examination of the diagrams and tables will disclose some other significant variations. The first shows 280 intensities of over 30 min. duration, the second only 18. The first gives 50 of 80 min. duration and over and the second only one as high as 70 min. Fig. 4 (uniform intensities) will also show that 94% of them have a duration of 25 min. or less and that only 4% exceed 30 min. in duration.

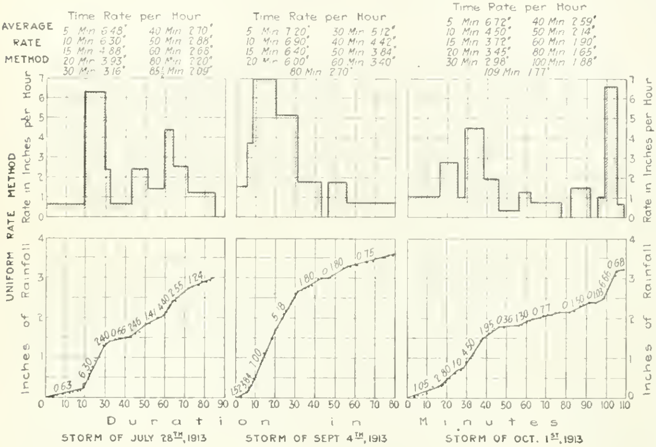


FIG. 5. STORMS OF JULY 28, SEPT. 4 AND OCT. 1, 1913, AT NEW YORK CITY

Another test of the rainfall curves of the "average-rate" method is furnished by an examination of Fig. 4. It will be seen that I have affixed dates to 64 of the highest intensities of a duration of 5 min. and over. Arranging these dates by years, we find that 17, or 26½%, occur in the first 22 yr. between 1869 and 1890 and that 47, or 73%, occur in the following 23 yr. between 1891 and 1913, which demonstrates that dividing the whole period of 45 yr. by the number of occurrences to find average frequencies is unwarranted.

Whatever value the "average-rate" method of compiling rainfall data has, is confined to recording the maximum quantity of rain that accumulates in certain periods, but deductions based on a factitious "average rate" computed from such an accumulation must prove fallacious, even if the averaging in the other stages of the method were justified.

In the compilation of "uniform intensities" given here the writer has confined himself closely to every noticeable variation of the rate. While this is the most consistent way, it is well to remember that very short periods with high precipitation give very high rates per hour and consequent high points in the rate diagram. Now it is well known that very high intensities for short periods are apt to be confined to small areas and may not affect the whole drainage area. Nor is it certain that the high intensities even for the longer periods begin and end over the whole area at the same time. Unfortunately there are no data on which the area covered by the storms can even be estimated.

A further study of the subject of uniform intensities may disclose that certain lower intensities for very short periods preceding and following the higher ones may be added in certain cases, resulting in slightly lower rates and a corresponding slight increase in duration. An interesting study by Professor Weyrauch in the *Gesundheits Ingenieur* for March, 1912, discusses the problem without, however, giving a final determination. Whether future investigations will result in formulating a generally applicable rule, I doubt; but with an intelligent use of the records, "uniform intensities" will furnish safer guides to the engineer than the system of complicated "average rates." This reference to a departure from a hard-and-fast application of the rule must not be assumed, however, to be an approach to the old system, but is an attempt to eliminate unnecessary refinement and a dogmatic precision from a subject as variable as thunder storms and to apply the axiom "that no computation need be more accurate than the data upon which it is based."

While the writer must dissent from the application of the unsound "average-rate" theory, he regrets that at present he can offer no substitute other than the primitive one of examining the rainfall diagrams that show the actual frequency of high intensities and from them selecting the storms that in the engineer's opinion should be carried off by the sewers he intends to design. This will of course require some study of the rainfall and good judgment in applying the knowledge gained, but will have the advantage of being based on simple facts without the interposition of any theory. Nor does such a study involve the expenditure of more time than is warranted in the construction of a drainage system where a consideration of the rainfall is necessary.

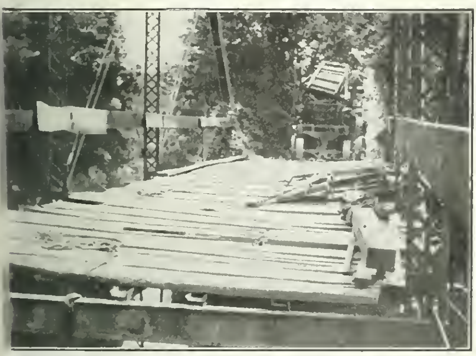
In order that the two methods may be compared and also that adherents of the "average-rate" method may find this compilation useful the data have been carefully presented in both ways. But whichever method is followed, one important question will remain to be answered after the frequency of certain intensities is determined. What frequency shall be provided for? Shall storms that occur once in 20 yr., once in 10 yr. or that occur every year be the measure, or will some other rule than "the relation of original cost to probable damage from flood" be more broadly economical? Here the theorists of the old school have another *pons asinorum* that may have to be rebuilt in the near future.

Overturning Stringers Cause Highway-Bridge Failure

By D. A. Thomas*

The Michigan State Highway Department was recently called upon to inspect an interesting bridge failure caused by the failing of the stringers in one panel, which turned over and buckled under the weight of a traction engine, permitting the engine to drop through into the river. Had the stringers remained upright, the engine would have undoubtedly crossed in safety, although a subsequent computation of the stresses showed that the floor system would be 30% overloaded with a 10-ton traction engine—he size of the engine which caused the failure. Three of the stringers in the panel adjoining the one which the ngine went through were turned down through part of heir length (see accompanying illustration).

The bridge, which is typical of many old highway ridges, is of the through Pratt type and was erected in 880. It has six panels 14 ft. 8 in. long, making a total pan length of 88 ft. The roadway is 14 ft. wide. The or stringers are five lines of I-beams and two lines of unnels, all 5 in. deep, spaced 2 ft. 4 in. apart. The or-beams are of quite heavy section, 10¾ in. deep. The or planks, laid directly upon the stringers, are not tened to them.



STRINGERS OF HIGHWAY BRIDGE TURN OVER

The cause of the turning of the stringers may be traced t some movement of the engine which had a tendency to se a sidewise motion, due in part, perhaps, to the fact t the floor planks were not fastened down. It should have been possible for the stringers to turn over, vever, had they been properly attached to the floor-ms. The stringers were secured to the floor-beams by one bolt through the flange at each end, and both ts were on the same side. Thus comparatively little tance to overturning was offered in one direction.

n the report on the failure the State Highway Department advised that the present stringers be replaced by n lines of 7-in. 15-lb. I-beams and that the following ventive measures be taken to guard against the tition of a similar failure: First, the stringers should bolted to the floor-beams by two bolts at each end, on each side of the web, and connected by fishplates; nd, furring strips should be attached to the stringers, the floor planks nailed to these.

Michigan State Highway Department, Lansing, Mich.

Cost of Testing Road-Building Materials; New York

So few data exist on the cost of testing construction materials that the accompanying table and explanations from the 1915 report of Henry E. Breed, Deputy Commissioner of Highways of New York, are noteworthy.

The New York State Highway Department Bureau of Tests is divided into three divisions—a physical testing laboratory, which makes field examinations and laboratory tests of stone, gravel, slag, cement, sand and concrete; a chemical laboratory for testing asphalts, tars, paints, oils, brick, etc.; and an office of record, which compiles and tabulates records of tests of both laboratories for use in the Highway Department.

During the year 1915 the physical laboratory tested and examined the following number of samples: 947 samples of stone; 973 samples of sand and gravel; 1,444 concrete cubes; 867 samples of cement, which represented 816,317 bbl. of cement. For sand testing, 2-in. mortar cubes are now used, being broken at 7 and 28 days.

Concrete Cubes of Field-Made Concrete

Making 6-in. concrete cubes in the field and testing them in the laboratory have proved valuable in determining more accurately the quality of the concrete in the work. The following tabulation of the 1,444 test cubes is given to show the average results obtained:

Concrete Mix	Average Compression, Lb. per Sq.In.	Number of Cubes
1 : 1½ : 3	3,620	796
1 : 2½ : 5 (crushed stone)	1,935	222
1 : 2½ : 5 (gravel)	1,755	200
1 : 2½ : 5 (all cubes)	1,875	474
1 : 3½ : 4 1 : 3 : 4½ } (mostly slag)	2,140	56

Cubes failing below 3,000 lb. per sq.in. for 1:1½:3 concrete and 1,800 lb. per sq.in. for 1:2½:5 concrete were considered below the desirable grade. There were 10.95% of these in 1915. All cubes showing a breaking strength below 3,000 lb. per sq.in. were carefully inspected to determine to what the low strength was due. Any of them which showed indications of carelessness in mixing were returned to the division office with laboratory comments.

The following is a tabulation of the low-strength cubes during 1915 and reasons which seemed to have caused the low breaking strength, with percentage of the whole number of cubes:

Cause of Low Break	%
Sand dirty, containing loam and also dirt from subgrade	35.4
Stone or gravel coated	35.0
Sand too fine	8.5
Poor quality of stone or gravel	8.2
Poor manipulation in making cubes	4.7
Lack of proper mixing	3.5
Miscellaneous, too wet, etc.	4.7

All concrete cubes previous to 1915 were tested 28 days after casting. This period was chosen because comparative data were available on compression for concrete at this age. During 1915 enough cubes were broken at an age of 7 days to give sufficient data to be able in future to judge the quality of the material when broken at this age.

Tests of Paving Brick

There were 269 lots of paving brick submitted for test, representing 22 different brands, or approximately 27,000,000 brick. Each sample consisted of 30 brick, representing hard, medium and light burned brick. These different grades of brick were tested separately, and the results obtained served as a guide in culling where culling was necessary.

The brick were subjected to the following tests: (1) General inspection to cover burning, kiln marks, size, lugs, grooves, etc.; (2) abrasion tests (each test on 10 brick); (3) modulus of rupture or cross-breaking (10 brick being broken); (4) absorption (5 brick being used). Of the 538 abrasion tests made 73, or 13.6% of the brick tested, failed to meet the standard required by the specifications. There were 269 tests (each on an average of 10 brick) made for cross-breaking strength. Of these 269 tests 14 tests, or 5.3% of the brick, failed to meet the required standard. Of the 269 absorption tests (each on an average of 5 brick) 4 tests, or 1.5%, failed to meet the required standard.

Tests of Bituminous Materials

Under the head of bituminous materials there were 1,368 samples tested during 1915. According to the type of construction under which they were used, these materials and the quantities represented were classified as follows:

	Samples	Gal.
Asphalt:		
Type No. 1	23	334,219
Type No. 2	27	357,948
Penetration	473	8,028,130
Tars:		
High-carbon binder	187	1,278,282
High-carbon hot application	33	181,536
High-carbon cold application	345	2,630,328
Low-carbon binder	4	23,087
Low-carbon hot application	10	25,462
Low-carbon cold application	32	205,405
Paving pitch	11	16,750
Hot application oil	35	342,914
Cold application oil	188	2,571,981
Total		15,996,642

The other materials tested included glutrin, crude tars, rocmac, mixed paint, motor-cylinder oil, premolded joint and miscellaneous oils.

TABLE OF UNIT COSTS OF TESTING SAMPLES OF ROAD-BUILDING MATERIALS, NEW YORK STATE

Distrihution	Analyses, Oils and Asphalts, Asphalt Blocks, Paints, Etc. 1,748 Samples	Brick, 269 Samples	Cement, 867 Samples	Concrete Cubes, 1,444 Tests	Sand and Gravel, 973 Samples	Stone, 947 Samples
Laboratory work	$3.36	$5.13	$3.06	$0.49	$2.80	$1.88
Fieldwork inspection	2.67	....	7.44	....	....	....
Office work	.80	2.57	.97	.30	1.26	.91
Total cost per test of sample	$6.83	$.770	$11.47	$0.79	$4.06	$2.79

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Hydrated Lime Pays at Council Bluffs Settling Basins

By J. B. Thornell[*]

The use of hydrated lime at the settling basins of the Council Bluffs water-works as an aid to aluminum sulphate in the coagulation of suspended matter in the water was commenced in February, 1915.

The snowfall in the Missouri River valley during the winter of 1914-15 was very heavy and it lay on the ground until late in February. Then came a sudden rise in temperature and several days of drizzling rain. A large volume of soft water was suddenly thrown into the river, flushing the ground and carrying with it much vegetable matter and silt and many bacteria. The alkalinity of the river water was reduced 50% and the organic content increased 300%. A marked reduction in the alkalinity and increase in the organic content and turbidity of the river water occurs every spring, but so great and so sudden a change as that of 1915 is very unusual.

The low alkalinity and the presence of the organic matter were immediately shown in the action of the alum solution used as coagulant, or rather in its failure to act as it should. The alum, instead of forming a flocculent precipitate of aluminum hydroxide, was combining with the organic matter in the water and passing on through the settling basins in solution. In other words, little or no coagulation was taking place. The suspended matter in the water was exceedingly fine and very little of it was removed by natural sedimentation. The tap water became very turbid. The fine particles of suspended matter carried bacteria and it became necessary to add an excess of calcium hypochlorite to make sure that no harmful bacteria were being carried into the mains.

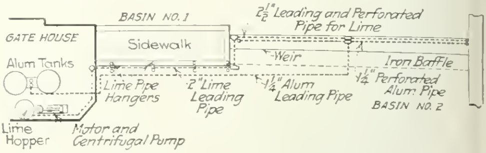

FIG. 1. SKETCH PLAN OF LIME AND IRON PIPES, COUNCIL BLUFFS SETTLING BASINS

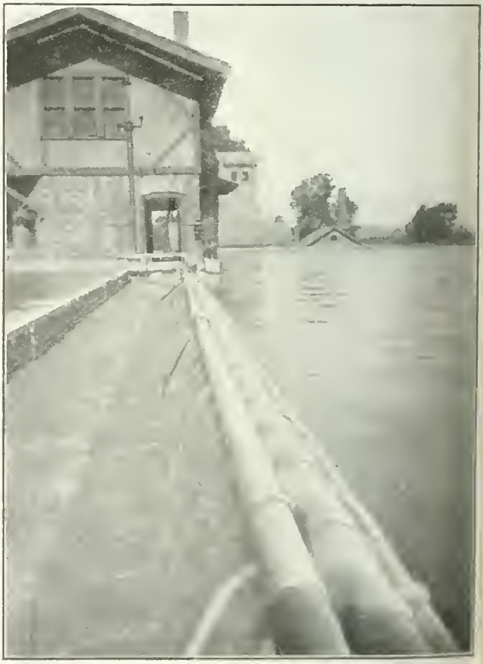

FIG. 2. VIEW OF LIME AND ALUM PIPES, COUNCIL BLUFFS SETTLING BASINS

Lime pipe on right, alum pipe on left, discharging in opposite directions

It was decided to use hydrated lime to assist the alum in removing the turbidity. Temporary apparatus for this purpose was installed as quickly as possible. The apparatus was crude and it was impossible under the

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[*] Chemist in Charge of Water Treatment, Council Bluffs, Iowa.

RESULTS WITH ALUM ALONE AND WITH LIME AND ALUM AS COAGULANTS, COUNCIL BLUFFS WATER SEDIMENTATION BASINS

	Suspended Matter Parts per Million			Total Bacteria*			Presumptive Test for B. Coli† (% Positive)		Coagulants Used (Grains per Gal.)		Cost of Coagulants per 1.000 Gal. Treated‖	
Month	Raw Water	Basin No. 1‡	Tap	Raw	Settled§	% Removed **	Raw	Settled	Alum	Lime	Actual	Based on 1914 Alum Price
1914												
April	2,345	1,271	6.9	27,440	1,017	96.4	80	41	2.3	0	$0.0032	$0.0032
May	3,458	1,175	5.4	54,041	1,291	97.7	100	100	2.9	0	.0040	.0040
Average	2,901	1,223	6.1	40,740	1,154	97.0	90	70.5	2.6	0	.0036	.0036
1916												
April	3,400	2,223	1.7	40,270	329	99.2	100	50	2.4	1.1	.0048	.0038
May	3,200	945	1.0	16,000	490	97.0	100	0	1.3	1.3	.0029	.0024
Average	3,300	1,584	1.4	28,135	409	98.1	100	25	1.9	1.2	.0039	.0031

* Nutrient agar, room temperature, 72 hr.
† Lactose broth, 37° C., 48 hr.
‡ Samples taken at weir at point of application of lime and alum.
§ Clear water samples taken just before treatment with sterilizing reagent.
‖ Cost of alum per 1,000 lb.: 1914, $9.75; 1916, $12.50. Cost of lime, 1916, $3.50.
** By coagulation and sedimentation combined, but not including chlorination.

conditions then existing to make the application of the lime in the place where it would do the most good. The only way in which it could be applied at that time was to inject the lime solution into the intake pipe of the low-service pumps that lift the water from the river into the settling basins. There were two disadvantages in applying it at this point. First, it was too far from the point where the alum solution was applied, and second, the lime was going into the water before any of the heavier suspended matter (sand and mud) had settled out.[1]

The application of lime in the suction of the low-service pumps brought the turbidity of the tap water down to the zero mark within two weeks and did very effective work during the high-river stage; but, under the conditions described, it was necessary to use about twice as much lime as would have been required with better means of applying it. The use of lime, therefore, was discontinued about July 15, and our attention was turned to contriving better apparatus for carrying the lime solution to a more advantageous point of application. This was effected after several months of experimenting.

The lime solution is now added to the water through a perforated pipe extending over the entire length of the weir between the first and second settling basins. (See sketch plan, Fig. 1, and view, Fig. 2.) The water flows over this weir, which is 45 ft. long, in a sheet about 3 in. deep. The alum solution is added in the same manner immediately after the lime solution, the two lines of application being only about 18 in. apart. The water then passes through an iron baffle and into the second basin.

The lime-feeding apparatus is located in the gate-house near the weir. The lime is placed in a large iron hopper in the bottom of which is a worm that feeds the dry lime into another smaller hopper below, where it meets a stream of water and is carried out through a 2-in. pipe to the weir. The feeding device is driven by a small electric motor and is so constructed that it can be run at six different speeds, according to the amount of lime required. The same motor that drives the feeding device also drives a small centrifugal pump that draws from one of the settling basins the water needed to dissolve the lime and carry it to the weir. A large volume of water is used with the lime so that it is carried to the weir completely dissolved and not as a sludge. The use of plenty of water with the lime is important as it not only prevents clogging of the feed-pipes, but it also brings about more uniform and thorough mixing with the water before it comes in contact with the alum solution.

The amount of lime used is varied with the condition of the raw water. During April and May, 1916, it ranged from 0.5 to 1.5 grain per gallon of water treated. The amount of alum required varied between 1 and 3 grains per gallon. During this period the average turbidity of the raw water was 3,300 p.p.m. and the turbidity of the water at the point of application of the lime and alum was 1,584 p.p.m.

The accompanying table shows the comparative results in the removal of suspended matter and bacteria by the coagulants in April and May, 1914, and in April and May, 1916. The year 1914 is taken for comparison because no hydrated lime was used at that time and the condition of the river water was very nearly the same then as two years later.

The number of bacteria and the percentage of positive tests for *B. coli* in the settled water have been considerably lowered since hydrated lime was put into use. With the use of alum alone as the coagulant it seemed almost impossible to remove all the suspended matter. A barely visible smokiness remained in the tap water most of the time—even when the alum was working at its best. That this suspended matter carried bacteria is seen in the column showing total bacteria in the settled water. The water, after clarification, is further treated with liquid chlorine for the removal of bacteria. It is obvious, however, that the increased removal of bacteria, especially those of the colon type, which has been brought about by the use of lime in clarification has greatly lessened the chance for harmful bacteria to enter the mains.

The last column shows that the use of lime with alum is more economical than the use of alum alone.

We regard our experience with the use of hydrated lime as highly satisfactory. We have obtained treated water, the sanitary and esthetic qualities of which were much better and the cost of which was less than could have been procured by the use of alum alone. The main factors in the success of the treatment are:

1. Natural sedimentation before the addition of coagulants.
2. Points of application of lime and alum solutions near together—but far enough apart to allow thorough mixing of the lime solution with the water before receiving the alum.
3. Uniform feed of the lime and alum solutions.
4. Thorough baffling of the water immediately after application of the coagulants but not too violent agitation.
5. Large volume of water to carry the lime.
6. Constant care in determining the amounts of lime and alum required.

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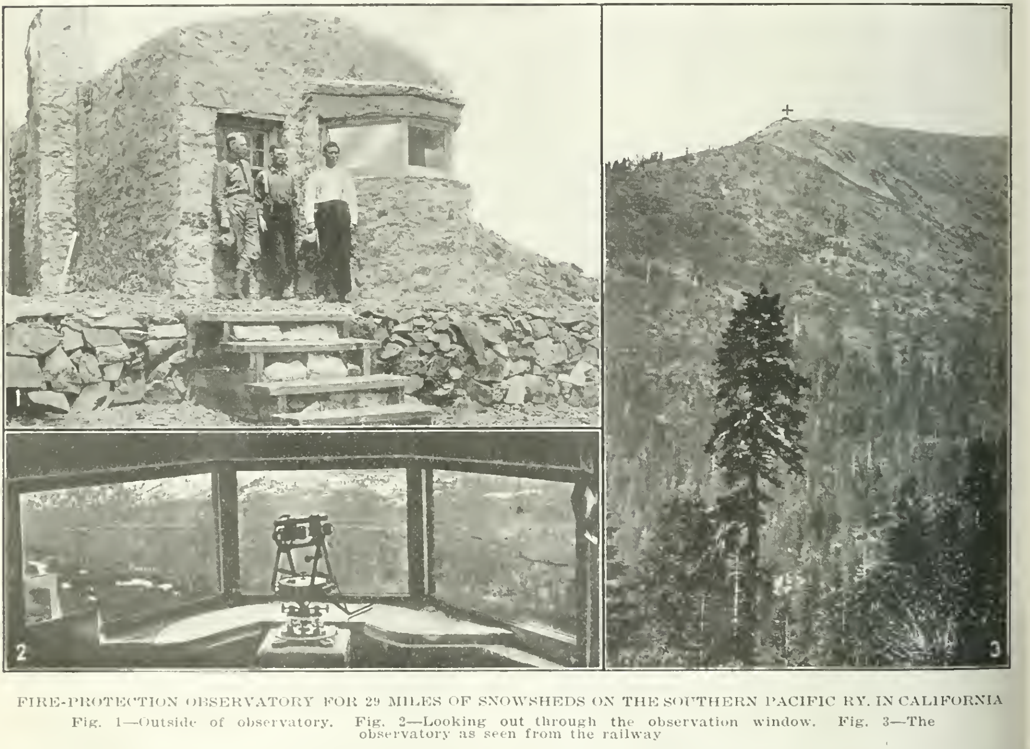
[1] In regard to this second point, we have found by experiment and actual experience that the effectiveness of lime and alum in removing suspended matter from the Missouri River water is more than doubled by allowing the heavier matter (which usually amounts to about 70% of the total suspended matter) to be removed by natural sedimentation—that is, before the addition of coagulants.

Field and Office

Spotting Fires in 29 Miles of Wood Snowsheds

The Southern Pacific Ry. has nearly 28 mi. of continuous snowshed on its line over the summit of the Sierra Nevada Mountains, between Blue Cañon and Truckee, Calif., just west of the Nevada state line. The elevation of Blue Cañon is 4,700 ft. and that of the eastern end of the sheds near Truckee is 6,000 ft. The average annual snowfall in this zone exceeds 200 in.

There are 29 mi. of snowsheds in all, one mile being in detached sections 130 to 1,500 ft. in length. The present distribution of the sheds is 77% west and 23% east of the summit. These are all wooden sheds and represent an investment of 97 million feet, board measure, of rough pine lumber, valued at $2,326,000.



FIRE-PROTECTION OBSERVATORY FOR 29 MILES OF SNOWSHEDS ON THE SOUTHERN PACIFIC RY. IN CALIFORNIA
Fig. 1—Outside of observatory. Fig. 2—Looking out through the observation window. Fig. 3—The observatory as seen from the railway

During the summer season there is a period of nearly five months with no rainfall, hence the fire hazard is great and the railway has sustained large losses. Fire-fighting trains have been in service since 1870. At present the sheds are protected by four fire trains, located one at each end and two at points of vantage in the shed. Each of these trains consists of a standard 10-wheel locomotive and two water cars. Each engine carries a duplex fire pump of 300 gal. per min. capacity, and an inspirator of 100 gal. per min. capacity. The total water-supply of each train is 20,000 gal. Each train has 1,000 ft. of 2½-in. fire hose.

Unique Fire-Alarm System

A mountain top—the summit of Red Mountain—7,860 ft. high, was selected for an observatory. The mountain is on the north side of the main cañon, while the railway winds about on the south side about 1,800 ft. below, so that with the exception of two points in near parts of the shed, which are cut off from view by intervening mountain tops, the whole of the line of the shed is visible from the observatory. The two hidden parts are watched from another observatory.

To readily locate the position of any fire or suspicious smoke a surveyor's transit is mounted on a fixed pier in the center of the bay window of the observatory. On a shelf in front of the instrument is a silver-coated copper plate on which the line of the shed is shown in black. The station points, tunnels, mileposts, signal boxes, etc., are shown on this plate.

Attached to the transit's lower plate is a bracket carrying a knife-edge pointer, which, when the transit is pointed to some station on the shed, intersects the corresponding station on the copper-plate map. The map was constructed in place, the transit and pointer being used to fix the desired points. The sheds are not shown on the map as the arc of a circle, which would answer were the track on a tangent, but are shown as they appear in perspective from the window, for the line doubles back on itself in a number of places.

The copper plate was first covered with wax and knife-marks were scratched on, as were the station numbers and lettering. The marks were then etched with dilute nitric acid. When the wax had been removed the etchings were trued with an engraver's tool and the entire plate was silver-plated, but not polished, so that it has a clear, white mat surface. The plate was then painted with transparent lacquer, the marks having been illed with colored enamels. The whole is protected from scratches by a plate-glass cover.

Where the line of collimation in following the line of the shed cuts the plate-glass window of the observatory n front of the instrument, a line was etched on the window glass, so that the observer may readily follow he line of the shed in the darkness or twilight. At ight a small battery-operated electric light is turned on, hich illuminates the map, and the reflection on the late-glass window makes visible the etched line and the ross-hairs of the instrument, so that it is easily possible o set the instrument on a fire, or other light.

The milepost and location of any fire are telephoned o the points where the fire trains are stationed. The heme has worked to such perfection that a tramp's amp-fire 18 mi. from the observatory has been spotted, also was a forge fire which a foreman was using to harpen drills. This fire being apparently in the shed, he fire train was called, ran 2 mi., and stopped exactly pposite the forge, which of course was outside the shed. n the case of an actual fire in the shed, or an exposure re of magnitude, when fire trains are called, the ones earest the fire go to the reported scene, and the others ose in as in regular fire-department service.

The photographs and data for this article were furshed by Niles Searls, general fire inspector of the outhern Pacific Railway Co., San Francisco, Calif.

Stopping Underground Leakage from a Power Dam

In the construction of a power dam crossing Black River at Black River Village, N. Y., it was found that a considerable quantity of water was lost by underground diversion, the water flowing out of the pond through a gully located a few hundred feet upstream from the dam. There is a second dam across the Black River at a point about one mile downstream. Between these two, the river is of crescent shape, bowing outward to the north, as shown in the accompanying sketch (Fig. 1). Extending in an irregular curved line from the gully described to a point just above the lower dam, is a series of sink holes averaging about 20 ft. in depth. Trenton limestone, the underlying rock formation, is in nearly horizontal beds and lies near the surface.

About 100 ft. upstream from the lower dam is the mouth of an underground channel, through which a considerable volume of water entered the pond above the lower dam, this quantity being estimated roughly at 15 to 25 cu.ft. per sec. in high water. A small stream coming off the hills from the southeast drains into one of the sink holes. Apparently the water lost from the pond above the upper dam traverses an underground channel, following approximately the route indicated by the dotted line on the sketch. The water can be seen flowing across the bottoms of the sink holes in various places.

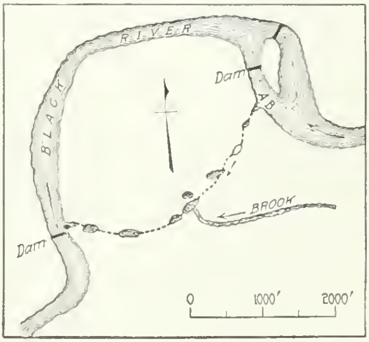


FIG. 1. COURSE OF NATURAL UNDERGROUND CHANNEL ON BLACK RIVER

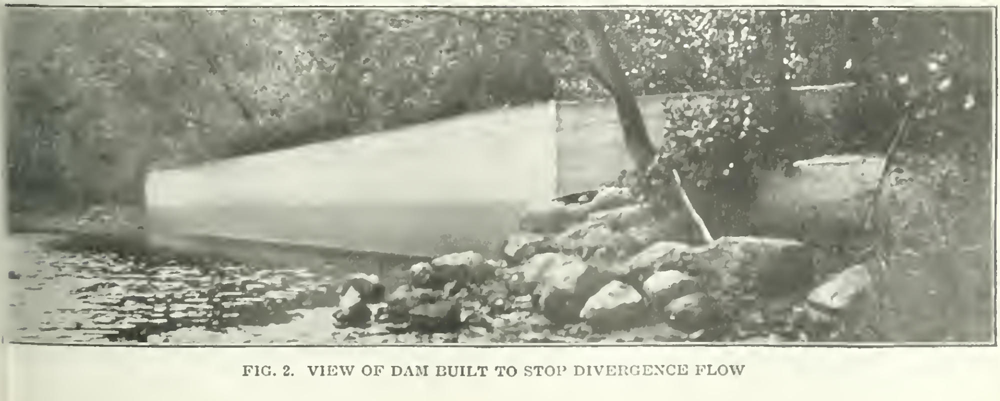


FIG. 2. VIEW OF DAM BUILT TO STOP DIVERGENCE FLOW

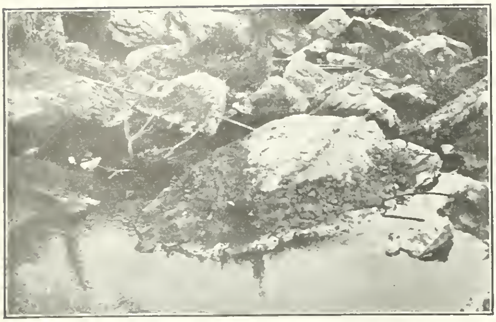


FIG. 3. BOTTOM OF ONE OF THE SINK HOLES

Under the conditions described the lower dam caught all of the water of the river but the upper dam lost an appreciable volume. To prevent this loss of water and power, a concrete wall was constructed across the head of the gully at *AB* (see sketch). The length of the wall is about 180 ft.; top thickness 1 ft.; average height, 8 to 10 ft. Considerable difficulty was experienced in stopping the underground flow. However, the work was finally successful and subsequently the outflow of the underground channel above the lower dam has diminished, being now an amount about equal to the inflow from the stream tributary to one of the sink holes.

The work was done under the direction of S. A. Staege, consulting engineer, Watertown, N. Y.

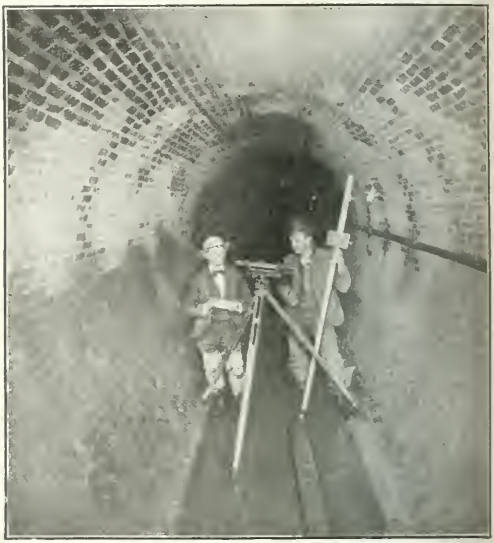
⁂

Old Brick Intake Tunnel Shows Low Kutter Factor

By Dabney H. Maury* and Robert E. Horton†

Owing to rapid growth in population and increase in water consumption of Detroit, it recently became desirable to determine the quantity of water which the present main intake tunnel could deliver from Detroit River to the receiving basin and other shore works at the pumping station, under different conditions.

The tunnel is a brick ring with walls 18 in. thick. It was constructed in 1895; its character can be seen from the accompanying view. It extends for a length of 3,160 ft. into Detroit River, the depth of the center being 63 ft. below mean river level. Water enters the tunnel through an intake crib having numerous inlet ports; the interior diameter of the crib is 37 ft. There is a right-angled bend in the tunnel underneath the crib, a vertical pipe rising 40 ft. from the center of the tunnel and about 9 ft. above the bottom of the crib. The water enters a similar vertical shaft near the shore, and in testing the capacity of the tunnel, water level readings were taken in the center of the crib and in the shore shaft, respectively. The total head losses involved between these two points were those for 3,160 ft. of horizontal tunnel, and for the two vertical shafts (making the total length of 10-ft. tunnel 3,245 ft.)



DETROIT WATER-WORKS INTAKE TUNNEL DURING CONSTRUCTION, 1895

RESULTS OF CAPACITY TESTS OF DETROIT WATER-WORKS INTAKE TUNNEL (MAURY AND HORTON)

Time, Apr. 3, 1916 (1)	Mean Water Elevation In Crib (2)	Mean Water Elevation In Shore Shaft (3)	Gross Head, Ft. (Means in Brackets) (4)	Recorded Pumpage Rate, Cu.Ft. per Sec. (5)	Net Pumpage Rate, Cu.Ft. per Sec. (6)	Storage Change, Cu.Ft. per Sec. (7)	Net Flow in Conduit, Cu.Ft. per Sec. (8)	Mean Velocity, V, Ft. per Sec. (9)	$3.5\frac{V^2}{2g}$ (10)	Net Friction Head, Ft. (11)	Slope, S (12)	$\sqrt{S}$ (13)	$\sqrt{RS}$ (14)	C (15)	Value of "n" for Averaged Heads (16)	Value of "n" for Averaged Pumpage (17)
A.M. 8:30																
				280.3	271.9	—26.25										
9:00	94.27	92.84	1.43													
			[1.465]	285.3	276.7	—30.90	245.8	3.13	0.532	0.933	0.000288	0.0170	0.0270	116	0.0152	0.0156
9:30	94.28	92.78	1.50													
			[1.50]	286.4	277.8	—16.96	260.8	3.32	0.598	1.002	0.000310	0.0176	0.0280	119	0.0148	0.0145
10:00	94.25	92.75	1.50													
			[1.515]	285.8	277.2	—1.54	275.7	3.51	0.672	0.843	0.000260	0.0161	0.0256	137	0.0130	0.0132
10:30	94.21	92.68	1.53													
			[1.58]	281.4	273.0	—1.54	271.5	3.46	0.651	0.929	0.000287	0.0169	0.0269	129	0.0137	0.0129
11:00	94.25	92.62	1.63													
			[1.63]	269.7	261.6	0	261.6	3.33	0.602	1.028	0.000317	0.0178	0.0283	118	0.0150	0.0142
11:30	94.26	92.63	1.63													
			[1.615]	259.7	251.9	+ 9.25	261.2	3.33	0.602	1.013	0.000312	0.0177	0.0281	118	0.0150	0.0147
12:00	94.27	92.67	1.60													
			[1.555]	262.0	254.1	13.88	268.0	3.42	0.637	0.918	0.000284	0.0168	0.0267	128	0.0138	0.0141
P.M. 12:30	94.28	92.77	1.51													
			[1.48]	263.1	255.2	+ 3.08	258.3	3.29	0.588	0.892	0.000273	0.0166	0.0264	125	0.0141	0.0142
1:00	94.27	92.82	1.45													
			[1.445]	264.2	256.3	—3.08	259.4	3.31	0.595	0.850	0.000262	0.0162	0.0258	129	0.0136	0.0136
1.30	94.26	92.82	1.44													
														Mean	0.0142	0.0141

---

*Consulting Engineer, Chicago, Ill.

†Consulting Hydraulic Engineer, Albany, N. Y.

ogether with the losses due to velocity and entry head nd to two right-angled turns at the junctions of the ertical shafts with the horizontal conduit. In reducing he results, an allowance equal to the velocity head was nade for each of the right-angled bends, and one-half he velocity head for the loss at entry, making the total sses, other than friction in the conduit itself, 3.5 times he velocity head. The quantity of water flowing through he tunnel during the tests was determined from the ump-displacement records, with allowance for gain or ss of storage in the receiving basins. The outflow from e pumps passes through venturi meters and the slip the pumps had been determined and found to be 3%, hich allowance was accordingly made in utilizing the ump-displacement record.

The conditions were, it is believed, unusually favorable r the accurate determination of the coefficient of roughss in a submerged water-works tunnel such as are in ite common use for the purpose of deriving water pplies from the Great Lakes, and their connecting annels. The tests were divided into nine periods of hr. each, and the coefficient of roughness was deterned for each period. The resulting values of the fficient *n* in the Kutter formula are contained in the ompanying table. Two individual computations of the ults were made, in one of which the gage readings ken at the beginning and end of a chosen half-hour iod were averaged and used in conjunction with the asured pumpage rate for the half-hour period, the ulting values of *n* being shown in column 16 of the le. In the other method of computation, the pumpage e for two consecutive half-hour periods was averaged l used in conjunction with the gage readings taken the even hour or half hour. The values of *n* deterned in this way are shown in column 17 of the table. two sets of values substantially agree and the coeffit of roughness as determined from the tests ranges n 0.0130 to 0.0152, the mean value being 0.0142.

he tests were carried out, under the direction of the hors as consulting engineers, by T. A. Leisen, General erintendent, and H. B. Keeney, Engineer of the Water rd.

⁂

upply Main Sustains Capacity for 28 Years

ests recently made to determine the capacity of the ply main of the village of Malone, N. Y., leading n the intake to the distribution reservoir showed the city after 28 years' use to be fully equal to that of w well-laid conduit of the same size.

he original conduit is of 10-in. cast-iron pipe, laid hill and down, with numerous deflections, a total th of 35,500 ft. from the intake on Horse Brook to distribution reservoir at Pinnacle Hill. The upstream 00 ft. of the conduit was subsequently paralleled 12-in. pipe. A booster pumping station was placed e low point of the 10-in. line, about 1/4 mi. from the ge basin, in 1914, as noted in *Engineering News,* 31, 1911.

ests were made of the inflow to the conduit by weirs d on the supply main above the intake and on the e below the intake. Simultaneous tests of the disge were made by pitometer at a point 230 ft. ream from the booster pumping station, which in turn is located 1,500 ft. from the distribution reservoir. Tests were made of the flow through the conduit under two conditions—with the booster pump operating and with the pump stopped (and bypassed), respectively. Each test was duplicated on the day following the original test, and in addition the results were checked closely by simultaneous pitometer records of the inflow to and outflow from the distribution reservoir in conjunction with the record of the gain or loss of storage in the reservoir. In order to permit coefficients to be determined for various friction-head formulas, the net results have been tabulated as shown in the following statement:

Pump in Operation:

Net friction head in the conduits, 134 ft

Conduit in test, 13,000 ft. of parallel 12-in. and 10-in. pipe, plus 21,000 ft. of 10-in. pipe.

Mean discharge in gallons per 24 hr

By weir	1,410,000
By pitometer*	1,416,000

Pump Shut Down:

Net friction head in conduits, 110 ft.

Pipe involved, 13,000 ft. of parallel 12- and 10-in. pipe, plus 22,500 ft. of 10-in. pipe.

Measured discharge, 1,220,000 gal. per 24 hr.

*In determining the discharge by pitometer a traverse coefficient 0.83 was used.

For the same heads the Hazen-Williams formula, using $C = 130$, which is applicable to good new mains, fairly straight and well laid, gives for the same conditions, under 134 ft. head, a discharge of 1,410,000 gal.; and under 110 ft. head, a discharge of 1,218,000 gal.

There was a small but unknown draft from the supply conduit during the tests through services supplying kitchen sinks in dwellings along the line of the conduit. The rate of draft probably did not exceed 5,000 gal. per 24 hr. Blowoffs and air valves were opened preceding the test, and very little sediment was discharged.

A section of the pipe cut out at the booster pumping station showed its interior condition to be perfect. The coating was smooth and unbroken, without any sign of rust or tuberculation. The water is very cold, exceptionally pure and soft, coming from springs in sand hills.

The tests were made under the direction of Robert E. Horton, Consulting Hydraulic Engineer, of Albany, N. Y., and the pitometer measurements were made by A. W. Hogeland, of the Pitometer Co., New York City.

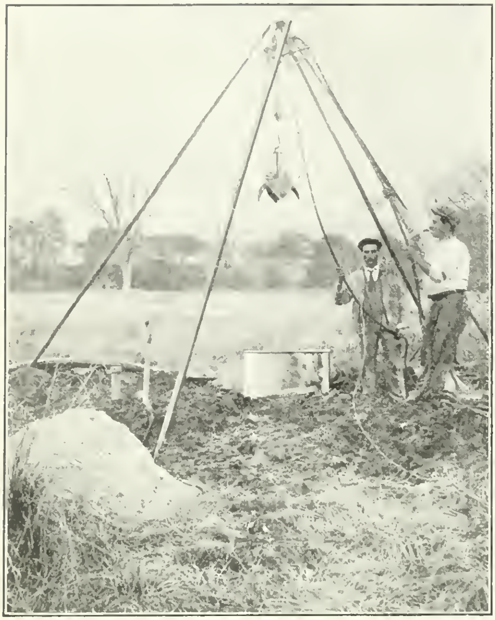
⁂

Vitrified Pipe as Well Casing

A kind of well that is giving satisfaction in the towns of Medway and Barnstable, Mass., is one having a casing of 24-in. vitrified sewer pipe. Wells of this type have been used in fine sand where small-sized iron-pipe wells with strainers proved unsatisfactory, because of clogging up.

The method of sinking the vitrified-pipe wells varied somewhat with the material encountered. A water jet was used in some instances, but a small orange-peel bucket excavator proved best in the majority of cases. The bucket was operated from a four-leg pipe derrick. The material in the bottom of the well was first loosened with a long bar. The wells described were about 30 ft. deep.

The bells of the pipe were cut off, as they would, of course, have interfered with the sinking. The sections of pipe were spliced together by three bars equally spaced around the outside circumference and parallel to the axis of the pipe. Holes were bored in the pipe, and the splice bars were fastened on by small carriage bolts. This was found necessary in order to keep the pipe in alignment, even with pipe having chamber-and-tenon joints.



WELL CLOGGING CURED BY USE OF VITRIFIED PIPE FOR WELL LINING

When it was necessary to make the upper joints watertight they were calked from the inside with oakum and cement mortar. The wells receive practically all the inflow through the open bottom. Should they fill up with sand or silt, they can readily be reëxcavated.

The completed wells have reinforced-concrete covers, which are locked on by running a rod through the pipe and through a staple on the under side of the cover. The rod is fastened on the outside with a padlock.

The wells were devised by H. A. Symonds and L. L. Wadsworth, engineers of the Hanscom Construction Co., Boston, Mass., for the water-works of Medway and Barnstable. The maximum depth to which such wells have been sunk is 35 ft., and the cost is about $200 each.

⁂

Grade Checks at Railroad Street Crossings

In an effort to reduce the number of accidents at grade crossings, the Board of Public Utilities, Los Angeles, Calif., is experimenting with grade checks or "bumps," especially constructed in the pavements to necessitate the reduction of speed of automobiles and other vehicles before crossing the tracks.

The experiment is being made at probably the most dangerous grade crossing in the city—the intersection at an oblique angle of the 4-track system of the Pacific Electric Ry. and Mission Road, a main route of travel between Los Angeles and Pasadena. Substantial grade checks are being constructed for a distance of about 50 ft. on each side of the tracks, so arranged as to demand careful driving and to eliminate any possibility of the dashing ahead of oncoming cars.

Prior to making this installation, speed data were taken at this point, and further investigations will be made after the completion of the grade check to determine accurately the value of this plan of crossing protection. Other plans suggested to the Board for inexpensive experiments include the construction of a large dip in the road, as well as the installation of sand beds for a suitable distance to compel a reduction of speed.

The principal parkway of the park system at Memphis, Tenn., has a length of about 12 mi. and has five railway grade crossings, some of the lines crossing diagonally. The Park Commissioners have installed ridges or "bumpers" across the roadway. These are placed also at a dangerous point where a county road enters the parkway on a steep grade, and at a point where a street-car line is crossed at the foot of 5% grades.

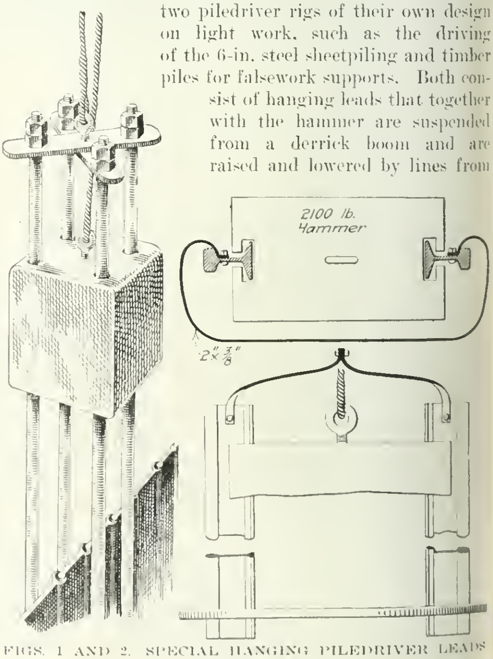
The bumpers are rounded ridges 9 to 12 in. high above the surface of the roadway, and are approximately 4 to 6 ft. wide at the base and 2 ft. at the crown. Where there is a double roadway only the right-hand roadway is thus marked. They are placed 50 to 75 ft. from the crossing or danger point, with "Go Slow" signs on the right side of the roadway about 100 ft. in advance of the bumper.

It is stated that crossing accidents have been noticeably absent since the installation of the bumpers, but that the "Go Slow" signs should be properly illuminated at night to secure the best results. J. E. Weatherford is city engineer of Memphis.

⁂

Two Light Piledriving Rigs

In the construction of the new concrete bridge across Lake Quinsigamond at Worcester, Mass., the contractors, C. W. Blakeslee & Son, of New Haven, Conn., are using two piledriver rigs of their own design on light work, such as the driving of the 6-in. steel sheetpiling and timber piles for falsework supports. Both consist of hanging leads that together with the hammer are suspended from a derrick boom and are raised and lowered by lines from



FIGS. 1 AND 2. SPECIAL HANGING PILEDRIVER LEADS

Fig. 1—(Left) Rig in which leads pass through hammer Fig. 2—(Right) Light rails form hanging leads

the derrick hoist, the hammer directly from the drum and the leads from the snubbing spools.

Fig. 1 shows the lighter hammer of the two, which has a weight of about 1,400 lb. It is a special casting, provided with four longitudinal holes about 2½ in. in diameter. These holes serve as guides for four 2-in. rods that are the piledriver leads. The rods, joined together at their tops by the crossed plates shown, are hung from the derrick lines so as to fork over the pile being driven. They are quite rigid and effectively hold the hammer in line during the driving. In driving a single pile the bottom of the rods can be bound round with a line to position the leads, but in driving a line of sheetpiles this is not necessary.

The heavier rig, shown in Fig. 2, has a 2,100-lb. hammer of regulation design, but instead of the usual clumsy wooden leads, two 30-lb. rails are used. These are bound together at the bottom by a strap bent to clear the hammer and are held at the top by another strap, which also serves for the hanger.

⁂

Special Piledriver with Adjustable Leads

Demands for more space at the Gold St. generating station of the Edison Electric Illuminating Co. of Brooklyn, N. Y., made it necessary to increase the height of a one-story building there to four stories. In view of the greatly increased loading—total of 600 lb. per sq.ft.—it was decided that the foundations would have to be carried to hardpan. This was accomplished by driving a number of hollow steel piles, closed at the lower end by a projectile point, and placing foundation piers on top of the piles. The piles were driven into the soil—which consisted of fill, boulders and cribwork—a distance of 22 to 27 ft.

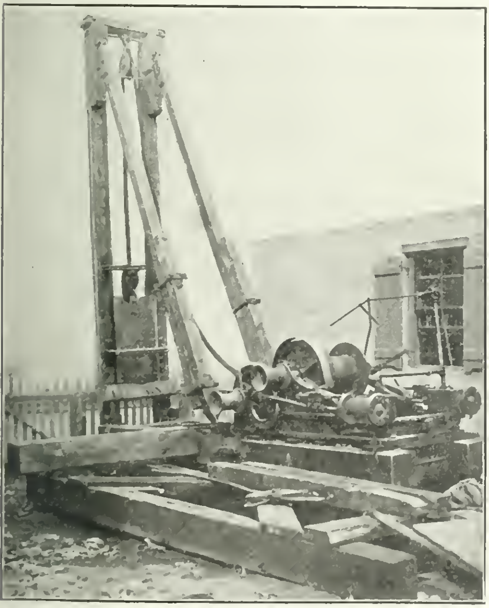


FIG. 1. SPECIAL PILEDRIVERS SET UP FOR STRAIGHT WORK; BROOKLYN, N. Y

The piledriver used was especially designed for the job, the leads and braces being arranged so that the leads could be used as with the ordinary type of driver, as shown in Fig. 1, or could be dropped in the hole. The braces were hinged top and bottom and so adjustable that when the leads were in the hole the long upper member of the spliced braces could be removed and a shorter one substituted, as indicated in Fig. 2. With this arrangement it was not necessary to use a follower. These leads could be placed in many awkward positions which otherwise would have rendered necessary the use of sliding leads and special rigging. The work was done by John H. Duncan, contractor, under the supervision of G. L. Knight, Designing Engineer of the Edison Co. and Bernt Berger, Consulting Engineer. A year ago another foundation at this station was constructed by driving hollow steel piles not fitted with a point, and then excavating inside them by 10-in. orangepeel.

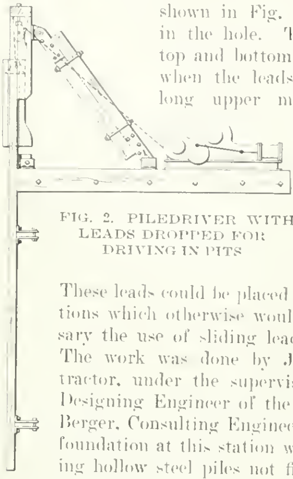


FIG. 2. PILEDRIVER WITH LEADS DROPPED FOR DRIVING IN PITS

⁂

Computing Paving Outside Curved Curbing

By Richard A. Lewis*

In the computation of the area of street surfaces where the corners of intersecting streets are rounded by a curb of some definite radius, the work can be made easier by the use of tables giving the area between the intersecting curb lines. Fig. 1 shows such an intersection and the area to be computed.

Areas of streets *A* and *B* are found directly from the product of their length by their width. Ordinarily the areas of *C* and *D* are found by taking one-fourth of the difference between the area of a circle of the given radius and the area of a square with sides equal to twice the radius of the circle. If the streets do not intersect at right angles, the computation is more complicated.

Table 1 gives the areas of *C* and *D* in square feet, where the intersection is at right angles, for any radius from 1 to 20 ft. for each inch change in length of radius.

Where the streets intersect at an angle of less than 90°, the areas of *C′* and *D′* are not equal, and each has a certain relation to *C* and *D*, depending on the angle of intersection. The ratio of *D′* in Fig. 2 to *D* in Fig. 1, for

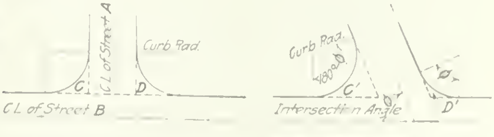


FIG. 1 FIG. 2
AREAS OF CURVED STREET CORNERS COMPUTED BY R. A. LEWIS TABLES

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*Assistant Engineer, New York Department of Highways, Binghamton, N. Y.

the same radius, is a constant and is equal to the same ratio for any other radius. C″ being subtended by the angle 180° — o, has a different ratio.

Table 2 contains these ratios for every degree from 30 to 150°. Therefore, to obtain C″, find the product of C′ in Table 1 and the factor for the angle which subtends C″, in Table 2.

Example 1—Two streets intersect at right angles, with curbs rounded by a radius of 10 ft. The gutter of concrete is 20 in. wide. Here the brick or other pavement will not be estimated with the concrete gutter; hence the radius to use will be 11 ft. 8 in. From Table 1 the area for one corner is 29 sq.ft.

Example 2—Take the same conditions as in the foregoing, except that the streets intersect at 37°. As in Example 1, find 29 sq.ft. from Table 1. From Table 2, for 37°, find a factor 0.055 for D′. The factor for 143° (180° — 37° = 143°) will be found to be 8.112 for C″. Then 29 × 0.055 = 1.6 sq.ft. for D′; 29 × 8.112 = 235.2 sq.ft. for C″; 1.6 + 235.2 = 236.8 sq.ft. for the two corners.

TABLE 1. AREA OF PAVING OUTSIDE CURB WHEN STREETS INTERSECT AT 90°

	Inches —											
Feet	0	1	2	3	4	5	6	7	8	9	10	11
4	3	4	4	4	4	4	4	5	5	5	5	5
5	5	6	6	6	6	6	6	7	7	7	7	8
6	8	8	8	8	9	9	9	9	10	10	10	10
7	11	11	11	11	12	12	12	12	13	13	13	13
8	14	14	14	15	15	15	16	16	16	16	17	17
9	17	18	18	18	19	19	19	20	20	20	21	21
10	21	22	22	23	23	23	23	24	24	25	25	26
11	26	26	27	27	28	28	28	29	29	30	30	30
12	31	31	32	32	33	33	34	34	34	35	35	36
13	36	37	37	38	38	39	39	40	40	41	41	42
14	42	43	43	44	44	45	45	46	46	47	47	48
15	48	49	49	50	50	51	52	52	53	53	54	54
16	55	56	56	57	57	58	58	59	60	60	61	61
17	62	63	63	64	64	65	66	66	67	68	68	69
18	70	70	71	71	72	73	73	74	75	75	76	77
19	77	78	79	80	80	81	82	82	83	84	84	85
20	86	87	87	88	89	89	90	91	92	92	93	94

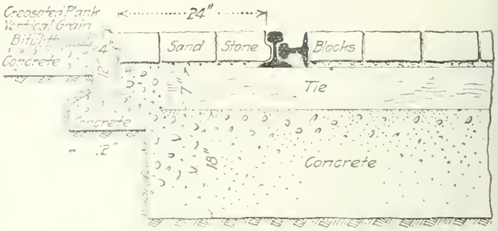
TABLE 2. RATIO OF CONDITIONS WHEN STREETS INTERSECT AT LESS THAN 90° TO THE CONDITIONS AT A 90° CORNER

Deg.	0	1	2	3	4	5	6	7	8	9
30	0.029	0.032	0.035	0.038	0.042	0.046	0.050	0.055	0.059	0.064
40	0.069	0.075	0.081	0.087	0.093	0.100	0.107	0.115	0.123	0.131
50	0.140	0.149	0.158	0.168	0.178	0.189	0.201	0.212	0.224	0.237
60	0.250	0.264	0.279	0.294	0.309	0.325	0.342	0.360	0.378	0.397
70	0.416	0.437	0.458	0.480	0.502	0.526	0.550	0.575	0.602	0.629
80	0.657	0.686	0.716	0.748	0.780	0.813	0.848	0.884	0.922	0.960
90	1.000	1.041	1.084	1.129	1.175	1.223	1.272	1.323	1.375	1.430
100	1.487	1.546	1.607	1.670	1.735	1.803	1.873	1.946	2.022	2.100
110	2.182	2.266	2.354	2.445	2.540	2.638	2.740	2.846	2.957	3.072
120	3.191	3.316	3.446	3.581	3.722	3.869	4.022	4.182	4.349	4.524
130	4.707	4.898	5.099	5.309	5.529	5.760	6.003	6.259	6.527	6.811
140	7.110	7.426	7.759	8.112	8.486	8.883	9.305	9.754	10.233	10.744
150	11.291	11.879	12.509	13.188	13.922	14.717	15.579	16.520	17.518	18.677

NOTES

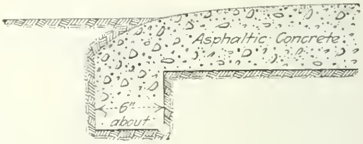
Paraffin-Wax Coating for Filter Tanks and Pipes—The wetted interior of the steel filter tanks and the inside of the pump and filter piping of the new drifting-sand water-filtration plant now being built for the City of Toronto by the John ver Mehr Engineering Co. are coated with solid paraffin wax, dissolved in gasoline at a minimum temperature of 110° F. Before coating, the surface is cleaned with wire brushes. This cleaning must be thorough, and the surface must be dry before the paraffin is applied. The coating is put on with whitewash brushes. Paraffin wax was chosen because it was feared that the common tar or asphalt coatings would break away in sufficient quantities to clog the sand-collecting and removing system that takes drifting sand from the filters.

A Railway Street Crossing that has proved very satisfactory at Pueblo, Colo., is shown in the accompanying illustration. This method was first tried on the Atchison, Topeka & Santa Fe Ry. crossing on the recommendation of the railway's engineers. The header blocks are 12-in. lengths of 4x12-in. creosoted plank on end. The great advantage claimed for this type of crossing is that it entirely separates the pavement from the railway-track area, so that reconstruction of the track will not require any disturbance of the pavement. D. P. Gaymon is city engineer.



RAILWAY CROSSING FOR PAVED STREETS IN PUEBLO, COLO.

An Edging for Asphaltic Pavements which has given good service in some Southwestern cities is shown in the accompanying illustration. It is used in place of a header where the pavement joins an unpaved street as well as at the ends of a section of paving. So far as known it has never been tried as an edging for asphaltic road pavements, but it would seem to be a feasible solution of that vexing problem. The beveled end with a thin cushion of soil saves the edge of the pavement from abrasion and the small amount of additional material under the edge avoids the feather-edge ends or sides of a pavement, which are constantly breaking off.



AN EDGING FOR ASPHALTIC PAVEMENTS

Cleaning Outfall Sewer of Quicksand—About 10,000 ft. of 21-in. vitrified pipe outfall sewer at Great Bend, Kan., was recently cleared of quicksand, which had entered through a broken pipe. In some places the quicksand had reached a depth of 15 to 18 in. The cleaning out was accomplished with 15-in. wooden balls weighted so that they would just float. The balls were inserted in the sewer at manholes and were forced through the pipe by the head of water backed up behind them. The quicksand and other suspended materials were cut out underneath the balls, which revolved in a direction opposite to the current. At times 6 to 10 cu.yd. of material was being moved ahead of the balls. The contractor who was in charge of the work stated that the more material in front of the balls, the more satisfactorily the scheme worked. Cleaning was begun at the manhole nearest the outfall; the balls were then placed in the second manhole and taken out at the first, and so on. About every fifth manhole a ball was allowed to go through to the end of the sewer.

Distribution of the Load and Moment to the beams supporting an oblong rectangular concrete slab reinforced in two directions is not standardized. M. G. Findley, 59 W. 57th St., New York City, inquires as to prevailing practice. He notes that there is authority for three methods of distribution, as follows: One, triangular, that is assuming a triangular load on each beam, the maximum ordinate being at the middle of the beam and the proportion of the total load borne by each beam varying as the ratio of the fourth power of the length of that side of the rectangle to the sum of the fourth powers of the two sides; two, parabolic, in which the load varies as the ordinates of a parabola; three, equiangular, that is where the distribution to the short beam is that part of the load included in the triangle made by bisecting the corner angles. He also inquires whether there is any authority for a uniform distribution of the load to the beam, that is the use of WL ÷ 8 instead of the WL ÷ 6 imposed by the triangular method, particularly in the design of steel beams supporting concrete slabs reinforced in two directions.

An Aëroplane as an Engineering Tool was recently used by a California engineer. The problem had to do with city planning and beautification and photographs taken from the flying machine at a great height served to visualize the city layout so that the effect of the new design could be realized.

Editorials

Raising Railway Trainmen's Wages by Act of Congress

The nation-wide railway strike ordered by the trainmen's brotherhoods for Sept. 4 was called off because 36 hours before the time fixed, Congress, under the whip and spur of President Wilson, passed a law compelling the railways to grant to the trainmen their principal demand. This demand, while it is called the eight-hour day and so masquerades in the law passed by Congress, is, when stripped of technicalities, merely an increase of 25% in the hourly wage rate to all railway train service employees engaged in interstate commerce.

Congress dropped all its other work and postponed its day of adjournment in order to enact this law under the same compelling motives that influenced President Wilson when he attempted to make the railway executives grant the demands of the brotherhoods. He believed that a nation-wide railway strike must be averted at any cost and hence that the demands of the brotherhoods must be granted, without stopping to inquire whether or not they were justified.

This remarkable piece of Congressional legislation which was rushed through the Senate while the Brotherhood leaders sat in one of the committee rooms and issued orders as to the form the legislation should take and the limit of time in which it must be passed, had the desired effect of postponing the strike. The issues that are raised by the legislature, and which must be passed upon at an early day, Congress has turned its back upon for the present.

It was long ago said that nothing is ever settled until it is settled right. If the President and the Congressmen at Washington imagine that they have made a permanent settlement of the railway-wage question by this legislation, they are sure to find their error and find it very quickly. Let us suppose that in accordance with the President's desires the railway companies accept and carry into effect the provisions of the law. Some very important questions are nevertheless bound to be raised.

Has Congress the power, under the interstate-commerce clause of the Constitution, to order a wage increase to a certain class of railway employees? It has power to enact minimum-wage laws and hours of service laws, unquestionably; but to pass a law that railway corporations shall raise the wages of their employees is a very different matter.

Suppose, however, it is decided by the courts that Congress has this power. In that case, next winter, we shall see Congress legislating on the wages and hours of labor of the railway shopmen, switchmen, station agents, signalmen, sectionmen, bridge gangs and each and every other class of labor employed by railway companies. The humble officials may even come in for a favorable bill or two, for some of them are drawing fewer dollars from the monthly pay car than the engine runners for whose benefit the Congressmen put off adjournment and worked overtime—and without extra compensation either!

Why should there be objection to such legislation? Each and every class of railway employees is probably better entitled to a raise than the trainmen. Shall these others be denied it merely because they have not threatened to tie up the entire commerce of the nation?

But the avalanche will not stop there. If Congress may enact such legislation, then state legislatures may pass laws raising wages of employees of all public-utility corporations within their jurisdiction. Next winter, then, will see bills passed at Albany and Harrisburg and Sacramento and every other state capitol to raise wages of street-railway motormen, conductors, linemen and a hundred other classes of workmen in the employ of public-utility companies. That is a far easier way to get a raise of wages than striking. Will the street-car men and all other employees of public-utility companies be deep in state politics from this time on? Nothing is more certain.

Perhaps it is well to turn back to the question: Has Congress the power under the Constitution to pass such a law as it rushed upon the statute book? It has not that power if and where the effect of such a law will be to reduce the net earnings of a railway below a fair return on the legitimate investment, for that would be "taking private property without just compensation." Only that brief clause of the Constitution stands in the way of confiscation of the railways and all other public utilities of the country; but that still stands.

A nation-wide railroad strike would be a vast calamity; but there might be a worse calamity. To forsake the principles of right and justice; to yield to the threat of a vast labor monopoly, for fear of immediate consequences, without foresight of other consequences to follow—that may be far worse in the long run for the nation.

A century ago an American statesman won undying fame by declaring that the United States had millions for defense, but not one cent for tribute. One longs to see a little of that spirit among those in authority at Washington today.

What Water Meters Will Do

When an American city has a water consumption of only 35 gal. per capita, it is safe to assume that practically all the water passes through meters. Woonsocket, R. I., shows a consumption of 34.5 gal. per inhabitant and 34.7 per consumer. Of the 3,928 services, 3,837 or 97.9% were metered at the end of the year 1915, and of the total consumption, 83.2% passed meters. Of the water pumped, 84.2% could be accounted for without allowing for meter slip.

Such a record is one for the Water Department and Superintendent Carleton Scott to be proud of, and for meter advocates, including the manufacturers, to make the most of.

It should be noted, however, that some factors for which the Woonsocket Water Department can claim no credit nor be given any blame favor low consumption.

The mileage of mains is low compared with many cities of equal population, the service connections are short and notwithstanding the low per capita consumption each service or tap passed 456 gal. per day. All these things indicate a compact distribution system, with fewer main and service joints than are common to cities of 45,000 population.

The Water Department did not depend on meters alone. During the year, Mr. Scott says, "The customary assistance has been rendered consumers in our efforts to prevent the waste of water, and 707 postal card notices have been mailed."

After all is said by way of explanation, it is the universal meter system at Woonsocket that accounts for the low water consumption and waste in that city—that is, meters and generally efficient management. Other cities with a like combination can get equally good results.

*

Educate the Water Boards

Every superintendent of a municipal water-works, we venture to assert, is or has been at some time handicapped by his inability to get the local water board to back up his recommendations for work which he knew was necessary for the service. If the average standard of members of water boards could be improved in the same degree that the standard of water-works managers and superintendents has been in the last two decades, the quality of water-works service would be materially raised the country over and the cost appreciably reduced. The trouble is evident, and it lies in ignorance and inefficiency rather than in dishonesty. Some means should be sought to educate the water-board members or to select better men.

A few illustrations come conveniently to hand as to the urgent need of a better understanding of their responsibilities by village trustees, members of water boards and other public bodies to whose tender mercies are committed the control of the water-works systems of our smaller cities and towns.

The first case involves the very important matter of water waste. Much has been written on waste prevention; waste detection has become almost an exact science. Yet, withal, extravagant use of water is rampant and restriction is a difficult and delicate task, even when the facts as to the existence and sources of waste are well known. Water-works engineers understand the difference between waste detection and waste prevention, but water boards and village trustees generally do not. Once a leakage survey has been made the board seems to expect the wastes to stop forthwith of their own volition.

In a certain town in the East, the distribution reservoir supplying a population of several thousand has been full but once in the past year—and several times it has been empty. Waste by consumers of all classes has grown until the consumption now exceeds the capacity of the supply line—although this is adequate with a reasonable consumption for 50% increase in population. The water-works superintendent has been subjected to suspicion and vilification because his plant could not deliver to the people all the water they wanted. Some members of the water board were inclined to credit these aspersions. The governing body fortunately employed expert service, and this dispelled the delusions and traced the shortage to the prodigal consumers. Those who most loudly denounced the superintendent were the largest wasters.

Even now the board experiences great difficulty in comprehending that its troubles have not ended and that the burden of remedying conditions rests on it. One of the trustees has just suggested that the board "lay a new main and let the people have all the water they want"—failing to realize that increased supply and unrestricted waste will only add temptation to further extravagance.

Another case: In an Eastern city the water consumption, although it was extravagant and the points of excessive draft were known, had been allowed to grow unrebuked until it had reached the capacity of the filtration works. Filtration was costly and æsthetically not entirely satisfactory. Something had to be done. A public meeting was called and the restriction of waste suggested. What happened? An old and influential member of the water board rose before the assembly and, with streaming tears and trembling voice testifying to his emotion, shouted, "I will not stand for a restriction; while I have been on this board the people have always had all the water they wanted." He spoke truly. Water they had, to use and to waste. Householders going away for Christmas week were known to leave all faucets wide open and closet trip levers tied down to prevent freezing. Filtered water and no meters!

The trouble with these two governing boards, so far as water waste goes, can be briefly stated: (1) Permitting a rampage of extravagant use until restriction was imperative; (2) shifting the burden of enforcing restriction upon the next generation in office.

We said that many water boards needed education, and the matter of water waste afforded a convenient illustration. But it is not the only one, for wisdom is sadly needed in other respects.

A good-sized city in the Middle West recently spent the price of a college education in teaching one of its board members a single simple fact. He was honest, conscientious and in many ways a most capable man, a plumber by trade. But he had great difficulty in understanding how it was that head could be lost by friction in a water conduit. His idea seemed to be that the capacity of a water-works conduit was some fixed and definite amount which it would deliver to the outlet at the same level as the intake, arguing apparently that water seeks its own level and the more it seeks the faster it runs. This man overrode the superintendent and imposed a construction in accordance with this novel principle.

In small towns the superintendent is often the village plumber, the whole responsibility for policy and administration resting on the trustees. What is to be said about one such town which, needing at least an 8-in. main from its intake to its distribution reservoir, replaced a defective 6-in. main several miles long by a 4-in. pipe, the trustees intending as they said to put in another 4-in. pipe later on "when they needed it" and arguing that "two fours would be better than a six anyway."

The circumstances noted are all well authenticated and all less than five years old. They are typical and not exceptional. They indicate that no matter how capable, experienced and qualified the superintendent or engineer may be, his utility to the public is limited by the mental equipment of the board under whose control he must act. How can better boards be secured? How can the old boards be educated? Close the doors of the next water-works convention and discuss this momentous question.

Try State Ownership of Railways on the Boston & Maine

There is without question a very large amount of public sentiment in the United States which favors government ownership of railways, and there has been a steady growth in this sentiment during the past twenty years. There is no doubt either that the events of the past decade have been forcing the United States toward government railway ownership at a rapid rate. All the details of railway operation, including the rates that may be charged, are now subject to regulation and control by state and Federal authorities. Not only this, but the events of the current week have rendered practically certain that the rate of wages will likewise be subject to public regulation.

Under these conditions, unquestionably, a large part of the arguments in favor of continuing the system of private railway management no longer holds good. If railway superintendents and managers have to be mere clerks to carry out the policies that public bodies dictate, the public might as well take over the title to the railways, so that it and not the private owners of railway securities will suffer or will profit from the policies its representatives may put in force.

There is a very large body of intelligent public opinion, however, including those who are most familiar with the science of transportation, who believe that the United States is in no condition as yet to assume government ownership of its railways. One may point to the contrast between the efficiency of American railway operation and the inefficiency and wastefulness with which government work, both state and Federal, is carried on in the United States.

These arguments have been many times set forth and are familiar to most intelligent men. We do not propose to rehearse them now. Instead, *Engineering News* makes the suggestion that before the United States finds itself forced to adopt the policy of government ownership, it should experiment with that policy, not on all the railways of the country, but on one railway system of fair size, located where the operating results may be publicly known.

If that experiment demonstrates the weaknesses of government ownership, it will have more influence with that portion of the public which is now ardently advocating government ownership than all the other arguments that could be presented.

It is true, of course, that government ownership of railways has actually been tried and abandoned in the United States. A number of the states of the Union and some cities tried the experiment of building and owning railways in the early days of the railway era and found the results unprofitable. But while these matters of history are well known to the railway expert, they are unknown and would be unconvincing to the general public. The public will not be convinced, either, by arguments as to the inefficiency with which railroads are operated when they are in the hands of the United States courts. The disastrous results of government ownership in Canada likewise fall on deaf ears.

If, however, an important railway system in the United States were to be transferred to government ownership and operated for a number of years, convincing proof would be available as to whether the railway earned more profits, gave better service, kept its employees satisfied without strikes and in general attained the success that the advocates of Government ownership claim as compared with the results obtained under previous private ownership.

There is an excellent opportunity now to try government ownership on the Boston & Maine system in New England. That system has just been placed in a receiver's hands. There has been for years general public dissatisfaction with the Boston & Maine management, both on the part of the public that the road serves and the owners of the road's securities. The railways composing the system are among the earliest built in the United States, and they transverse an old settled portion of the country where traffic conditions are stable and the scale of public intelligence is high. In no section of the United States, probably, could public ownership be tried under more favorable auspices or with greater certainty that the results will be carefully watched so that either failure or success will become widely known.

Of course, if the experiment of public ownership were tried on the Boston & Maine, it would have to be tried by the several states through which the system runs and not by the Federal Government. These states, however, are as well able to undertake it as any states in the Union. New England has never done its fair share anyway in the line of experimental work in popular government and the states of the Pacific Coast have done more than their share. It is time that New England contributed to our general experimental knowledge of the science of government by trying the state ownership of railways.

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Ingenious Water-Supply

The old proverb, "Where there's a will there's a way," applies admirably to a great deal of the engineer's practice. But to develop a water-supply for a section of the country where there is not any water to be had requires something more than will power. Such conditions are met with in parts of the arid West.

Ever since the Santa Fé Ry. was built across Arizona, on the high plateau above the Grand Cañon of the Colorado the water-supply of the railway (and the towns it has given birth to) has been a source of trouble and expense. There are several points along the line, notably Seligman, Williams, Flagstaff and the Santa Fé hotel El Tovar and the surrounding settlement on the rim of the Grand Cañon, where water has to be brought long distances by rail in tank-cars and then dispensed by the gallon with about as much circumspection as gasoline.

Water at the El Tovar is so precious that very little of it is wasted. The sewage is treated at a disposal works, and the effluent is used to sprinkle lawns and in the boilers of the pumping and power plant. Two qualities of water are supplied there, the potable water being hauled all the way from Del Rio about 70 mi. away.

Under such conditions the development of a pure water-supply of about 2,000,000,000 gal. annually, at a cost of about a quarter of a million dollars, is an engineering feat of considerable ingenuity, especially so when it is accomplished under the very noses of the railway water-supply engineers who have been working on the same problem for many years. This and some of the out-of-the-ordinary details describing the work on San Francisco Mountain lend interest to the brief article elsewhere in this issue.

Letters to the Editor

Jamaica Uses "Sausages" for River Protection

Sir—With reference to the article on p. 79 of your issue for July 13th on "Rock-Filled Wire-Mesh Bags for River Protection" it may be of interest to you to know that this type of river protection has been in use in India for many years and that a full description of it is given in the *Proceedings* of the Institution of Civil Engineers Vol. CLXXIII, p. 244.

During the last six years such "sausages" have been extensively used by this Department for river training and bank protection and have in most instances proved effective and cheap.

J. N. PARK,
Director of Public Works, Jamaica.
Kingston, Jamaica, Aug. 10, 1916.

Quebec Bridge Erection

Sir—In the article "Quebec Bridge in Picture" in your issue of August 24, you were good enough to make complimentary reference to the names of those connected with the work. The ease with which the work has gone together in the field and the rapidity of erection has been in large measure due to the practically perfect shop work, for which our Works Manager, W. P. Ladd, deserves the principal credit. I think his name should be added to your list.

G. H. DUGGAN,
Chief Engineer, St. Lawrence Bridge Co.
Montreal, Aug. 26, 1916.

"Reforming Railway Curves"

Sir—To those of us who have been reading the *Engineering News* for lo these many years the persistence and ever recurring efforts of each successive wave of engineers to reform the railroad curve are either amusing as we realize the futility of it, or serious if we think of it as another sign of the lack of that coördination of commonsense with instruction in basic principles, which Professor Swain claims our methods of technical education fail to impart.

Those of us who are not so far away from the small end of a transit that we have forgotten the sweat dropping on our notebook on a hot summer day in Texas, or the cold breezes playing over our fingers when the thermometer was near the freezing point, while we figured P. T.'s and P. I.'s, will never thank anybody for suggesting anything but even degrees of curvature. And if Mr. Kitts or Mr. Palmer thinks that talking about a curve of 2,864.93-ft. radius conveys any clearer idea to anybody than does the reference to a 2° curve, or that any transitman wants to figure the deflection angle, etc., for a 3,000-ft. radius curve, I would suggest that they go out on the turf some hot summer's day when the heat waves make the back flag look like the reflection of a periscope on a gently rippling stream, and listen to the stream that flows from that transitman, as he tries to work out the odd seconds.

If this is not satisfactory, or does not convey the necessary atmosphere, more interest will be created by asking him to figure the exact length of chord to be measured to correspond to a 100-ft. arc or arcs of odd lengths, when the even station comes on a rock or in the middle of a 24-in. pin oak, and then listen to what the head chainman has to say when he measures 94.896 ft. and gets the tack in "right there."

A knowledge of polar and rectangular coördinates may be a fine equipment for the mathematician, but for running in or calculating railroad curves it is a particularly good part of the equipment on which to accumulate a delightfully warm colored coat of rust.

I am afraid that there are too many mossbacks in the railroad end of the game to hold out much hope of conversion, even where, as in this case, the theory is fine, but the practice better.

F. LAVIS.
New York City, Aug. 18, 1916.

Why Put a Gravel Cover on the Concrete Floor of a Bridge?

Sir—In *Engineering News* of Aug. 17, I notice an extract from the *Minnesota Highway Journal* cautioning road supervisors to be careful and not place too thick a gravel cover on the concrete slab floors of steel truss bridges. The article says:

> It is very important that this covering be thick enough to protect the slab from the horses' calks and from the mud hooks on traction engine wheels, but it is also important to prevent making it so thick that the bridge will be overloaded.

The article then goes on to give details of placing the gravel covering and states that on truss bridges the gravel should be only 2 in. thick at the sides and 4 in. thick at the center, but that it is not uncommon to find truss bridges with gravel of an average thickness of 9 in. on top of the concrete floor.

Any one familiar with the lack of attention from which the average country highway bridge suffers can readily understand how any such bridge may be at any time dangerously overloaded with gravel notwithstanding all the circulars that a state highway commission may put forth.

The question arises, however, what is the sense of placing gravel on the bridge at all? Why not make the concrete floor slab thick enough in the first place to stand the wear and let the traffic run directly on it? Experience has now demonstrated that the rate of wear of concrete roads, even when subjected to heavy traffic, is exceedingly small. With the traffic of the ordinary country highway, the concrete floor slab, assuming of course that it were made of proper concrete, would last for a generation before its strength became impaired. If any surfacing whatever is to be put on the concrete floor of a country highway bridge it should be a coating of asphalt composition, either a thin carpet coat such as is used on the California concrete state highways, about ¾ in. thick, or, if the traffic is sufficient to demand it, a regular asphaltum wearing surface 1½ in. thick. Facilities for doing a good job in applying such an asphalt top coating, however, are so seldom available in country highway bridge construction that the best plan, almost invariably, will be to make the concrete thick enough for the traffic to run directly on it. This will make a much more satisfactory floor surface than any gravel covering, for gravel on a concrete floor dries out so quickly that it is bound to ravel under traffic. C. E. V.

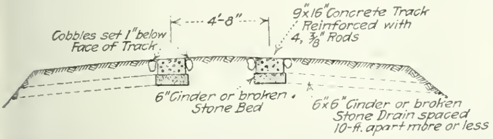
Syracuse, N. Y., Aug. 25, 1916.

Concrete Tracks Proposed for an Earth Road

Sir—Have any of your readers ever seen tried the improvement of an earth country road with two concrete tracks, as shown in the accompanying sketch?

It would seem that on a road of light traffic, where vehicles pass not oftener than once per mile, such a type of road would meet the special requirements. Waterbound macadam roads wear in ruts, and a new road is generally required every three or four years because 50% of the surface has worn out. The more expensive biuminous pavements are too costly, and what actually happens is that a waterbound macadam is laid and is made to answer its purpose long after it has worn out. When, after a bad winter, the road becomes impassable, another waterbound macadam road is built and another cycle is begun. FREDERICK T. WARNER.

39 Pangborn Place, Hackensack, N. J., Aug. 3, 1916.


4'-8"
9"x16" Concrete Track Reinforced with 4, ⅜" Rods
Cobbles set 1" below Face of Track.
6" Cinder or broken Stone Bed
6"x6" Cinder or broken Stone Drain spaced 10-ft. apart more or less

PROPOSED CONCRETE TRACKS ON EARTH ROAD

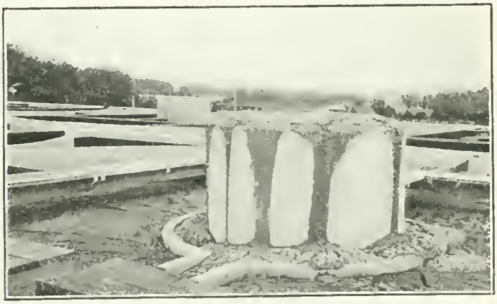
[The scheme described above is not new, but has been everal times proposed. A few weeks ago the newspapers eported a Texas inventor as endeavoring to raise capital build a large mileage of toll roads on the general heme presented above. We are unaware whether the heme has been actually tried in practice anywhere. The te Gen. Roy Stone, the first chief of the Federal Bureau f Road Inquiry, extensively exploited the idea of paved heelways for vehicles. He finally succeeded in having experimental line of rails with broad surfaces for heels laid down on Murray St., New York City. These ils were found to be more of an injury than a benefit d were taken up after a few months.

It does not seem probable that such narrow concrete acks as are shown in the sketch, laid in an ordinary dirt ad, would give satisfaction. In certain seasons of the ar, Jersey mud is very deep and very slippery, and an tomobile which turned off the concrete strips to pass other car would be apt to have a good deal of difficulty getting back onto them. To make the scheme pracable, the space between the concrete tracks and a certain dth on each side of them would have to be paved th gravel or macadam. It would be very difficult to ke a good job of placing and compacting the gravel or macadam after the concrete tracks were built. Further than this, when the whole job was done it probably would be less satisfactory to traffic and less durable in service than a narrow, single-track, concrete road. In the section shown in the sketch there is enough concrete to make a concrete road 6 in. thick and 4 ft. wide. With the added cost of foundations, shoulders, surface treatment, additional forms, etc., it is probable that a concrete strip 7 ft. in width could be laid at no greater cost than the two-rail concrete road shown in the sketch. While a 7-ft. concrete road is narrower than is advisable for single-track service, it is practicable to move traffic over it; and there can hardly be a question that it would be a much more durable and satisfactory road than the one proposed.—Editor.]

Baltimore Imhoff Tank Foams

Sir—The inclosed photograph of the gas vent of one of the Imhoff tanks at the Baltimore sewage disposal works shows one of the difficulties which are encountered in the operation of Imhoff tanks, namely, "foaming." On two recent occasions, when I visited the Baltimore plant, the vents were "foaming," both of the visits being in the summer time. The accompanying picture was taken on July 19.

The remarkable thing about this "foaming" lies in the fact that the vent is nearly 5 ft. high and the gas decomposition in the digestion chamber was sufficient to raise this foam the full 5 ft. and to cause it to spread over the surface of the settling tank as shown.



FOAMING AT GAS VENT OF IMHOFF TANK, BALTIMORE, MD.

When one of these tanks "foams" the attendant immediately turns a fire stream on it for the purpose of breaking it up and cooling it off. The theory is probably the same as in the case of a tea kettle which boils over—if a little cold water is added it will stop the action.

CLYDE POTTS.

30 Church St., New York City, Aug. 18, 1916.

NOTES AND QUERIES

The Dragline Wagon Loader described on p. 78 of "Engineering News," July 13, 1916, stated that it was "devised" by the contractor owners, Barbeau & Werring, Minneapolis, Minn The statement would have been more correct if "revised" had been used in place of "devised," for subsequent information proves that the wagon loader is one of the Albrecht excavators and leaders manufactured by the T. L. Smith Co., of Milwaukee, Wis., which the contractors changed to meet some local requirements.

Modern Sand and Gravel Plant Formally Opened

A large sand-and-gravel plant has been built at Marlborough, N. Y., a few miles above Newburgh, and its completion was signalized by a clambake given at the plant by the John B. Rose Co. on Aug. 30, more than 200 engineers, contractors and building-supply men being present.

The general arrangement of the plant is well shown in Fig. 1, where a 3½-yd. long-boom 175-B Bucyrus shovel digs from a bank 90 ft. high and piles the material convenient to a belt conveyor leading to a 7½-in. and 4½-in. gyratory crusher. Here the material falls on the main conveying belt and is lifted to a pair of scrubbers, falling thence into a series of sand separators, from which the gravel is conveyed by belt to a storage pile and the sand is either elevated to a sand-storage pile or if a barge be available is carried by belt on board, receiving on the way a final washing for gravel.

Shovels of the type shown are familiar enough in coal-stripping work but unusual in gravel pits. The 75-ft. boom and the height of the cab above ground permit the shovel to stand off a considerable distance from the bank, thus making it safer from possible cave-ins. Its capacity is given as 500 yd. per hr.

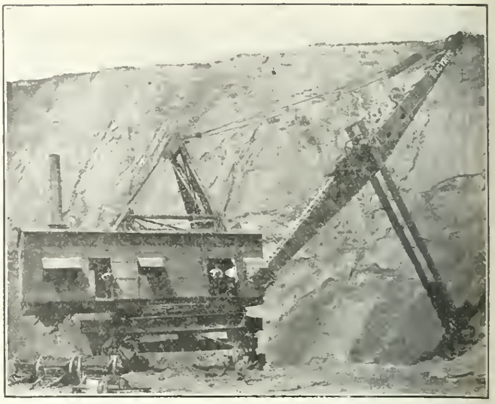


FIG. 2. BIG LONG-BOOM BUCYRUS IN 90-FT. BANK

The output at present is from 2,000 to 2,500 yd. of sand and gravel per day. The demand is so heavy at the present time that it is purposed shortly to put on a night shift when the total daily output will probably reach 4,000 yd. John B. Rose is president of the company and George C. Hudson is superintendent.

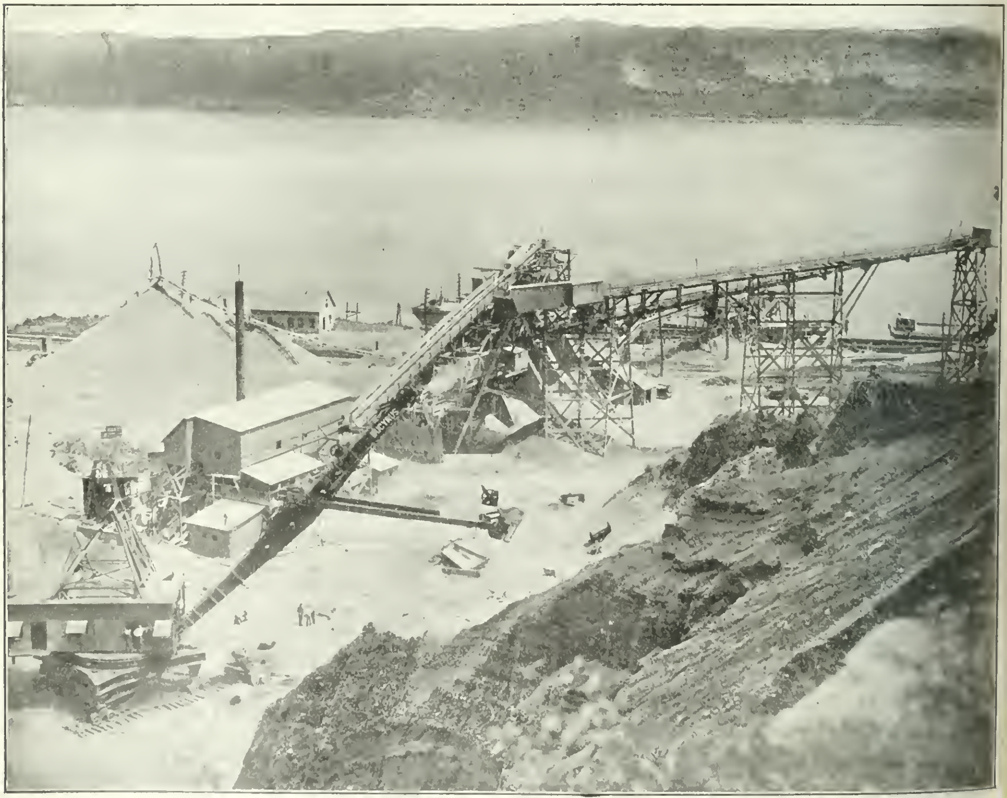


FIG. 1. VIEW OF NEW SAND AND GRAVEL PLANT OF THE JOHN B. ROSE CO., NEAR NEWBURGH, N. Y.

Standard Plans for I-Beam and Concrete Bridges

The use of standard highway bridge designs so that ertain stock drawings can easily and readily be prepared to fit any crossing is a result of the growing importance of governmental highway departments. Several of such standard designs prepared by state highway officials have een noted in these pages. Herewith is shown a standard leveloped by R. L. Longshore, Assistant County Surveyor of Adams County, Indiana, and used on he county road system. The bridge onsists of I-beam stringers incased in oncrete, spanning between concrete ing-wall abutments and carrying a oncrete-slab floor integral with the oncrete casing. Standard drawings, uch as the one shown in Fig. 1, re prepared; and every dimension line s marked on the tracing with a small lack block that, showing white on he blueprint, leaves space in which to nsert the proper dimension to fit the articular bridge. The design covers pans from 6 to 36 ft., using 6-in. 2¼-lb. beams for the former and 20- . 85-lb. beams for the latter. Beams re spaced 3 ft. c. to c., requiring eight or a 20-ft. roadway and seven for a 16- . roadway. The beams rest on all plates made up of steel channels mbeded in the concrete at each abutent. The beam bearing is 12 in. for l spans below 18 ft. and 18 in. for l spans greater. The floor is a 6-in. ab with the bottom of the floor 2 in. low the tops of the beams. The beams e incased in concrete to prevent rust, it the concrete also takes the place of the transverse gles usually found in bridges of this type.

Parapet walls are 30 in. in height as a rule, this height ving been found most satisfactory. For short spans and linary-height abutments plain concrete is used for the ostructure. However, for the longer spans, high abutents or difficult foundations special reinforced substrucres are specified.

2. TYPICAL STANDARD INCASED I-BEAM BRIDGE IN ADAMS COUNTY, INDIANA

The bridge shown in Fig. 2 was built during the season 1916 by the Herman Tapp Construction Co., of Fort Wayne, Ind. The clear span is 36 ft. 6 in., with 18-ft. abutments and 20-ft. clear roadway. The floor is covered with 4 in. of limestone macadam as a wearing surface. Drainage is provided over the wings. Concrete is one part cement, two parts washed sand and three parts 1½-in. crushed stone throughout. The contract price for this structure was $3,100.

This type of bridge is particularly fitted for locations providing scant headroom. It may be built by semi-skilled labor under ordinary inspection. The use of I-beams allows a minimum of staging and forms; and by the use of standard reinforcing in the slab, misplaced reinforcing is almost impossible.

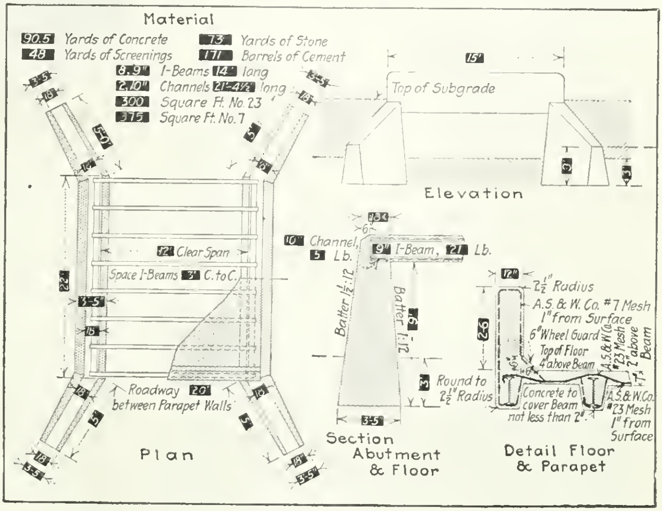


FIG. 1. STANDARD DRAWING FOR HIGHWAY BRIDGE USED BY ADAMS COUNTY, INDIANA

The various dimensions in the blocks on the dimension lines are filled in to suit each bridge

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Computing the Cost of Good Roads—The first thing to be considered in buying good roads is the amount of money which it is wise for a community to spend for them. Find out roughly how much money can be devoted to road work, divide the assessed valuation of the district by the miles of Wayne County, Mich., on the other hand, has a valuation of only $5,420 per mile, showing that not even the entire wealth of the county is sufficient to improve all its roads. Wayne County, Mich., on the other hand, has a valuation of $514,931 per mile, indicating its financial ability to carry out any kind of road improvements in reason. There is a measure of the need for roads, just as there is a measure of the financial resources for roadbuilding. This measure is the travel the road is carrying now and the probable increase in the travel during the next five to ten years. The present travel can be actually counted, however, and this should be done. The State Highway Department or the United States Office of Public Roads and Rural Engineering at Washington will furnish instructions for the work In determining the annual cost of a road, the first element is the first cost of construction per mile of road, including all engineering expenses. Knowing the travel over the road, an expert can estimate the number of years such a road will serve its purpose, if properly maintained, before reconstruction is necessary This cost divided by the number of years of service gives the annual first cost To this must be added the annual interest on the first cost per mile and the annual payment into a fund which will be enough to reconstruct a mile of the road when it is worn out, or to retire the bonds that are sometimes issued to pay for the first cost The annual cost per mile of maintaining the road in serviceable condition is the last item. The sum is the total annual cost per mile

Profit in Water-Works Forestry at Nashua, N. H.

Some very interesting experience in water-works forestry is that of the Pennichuck Water Co., Nashua, N. H., of which William F. Sullivan, President of the New England Water-Works Association, is Chief Engineer and General Manager. While forestry has become an important side line with many municipal water-works departments, in very few instances has it been possible to start experiments with watersheds already well forested, or in few instances have experiments progressed long enough to prove forestry on a 1,000-acre tract a profitable or even a self-supporting feature in water-works operation. Hence, water-works forestry that is actually yielding considerable profit and will continue to do so indefinitely is noteworthy.

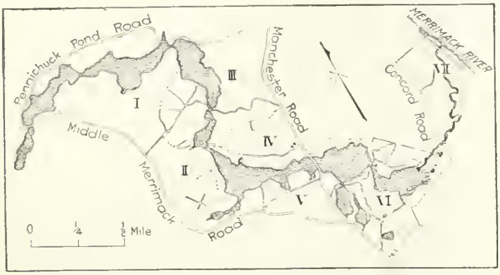

FIG. 1. MAP OF FOREST RESERVE OF PENNICHUCK WATER CO.

As the forestry work referred to is done by a private water company operated for profit, there is no hesitancy in stating that its purpose is so to utilize the lands in the reservoir watersheds as to obtain the greatest possible financial return, although of course the protection and betterment of the watershed by means of a forest cover are considered of quite equal importance. The Pennichuck Water Co. adopted scientific forestry methods as long ago as 1907, when it employed Benton Mackaye, Forest Assistant, United States Forest Service, to make a survey of the tract and to recommend a policy of operation. But before then the company had adopted methods of conserving the timber supply.

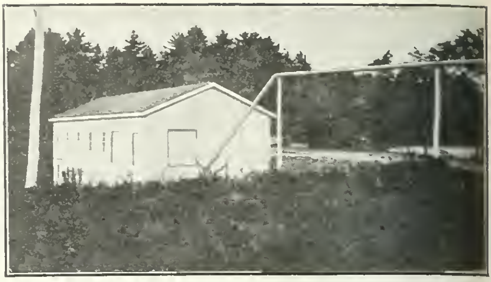

FIG. 2. SAWMILL OF PENNICHUCK WATER CO.

The watershed tract, containing about 1,000 acres, is partly in Nashua and partly in Merrimack in the County of Hillsboro, N. H. (Fig. 1). About 250 acres of this is covered with a chain of ponds made by damming the Pennichuck Brook, which forms the boundary between Nashua and Merrimack. The topography is rolling, and the slopes are generally long and moderate, with many small ridges and steep depressions made from glacial drift. The greatest elevation is 220 ft. above sea level, which is about 120 ft. above the Merrimac River, which bounds the property on the east. Most of the tract is 70 to 100 ft. above the river.

The soil is sandy, chiefly of glacial origin, and covers an underlying schist rock. All this part of the country was originally well forested, and both topographic and climatic

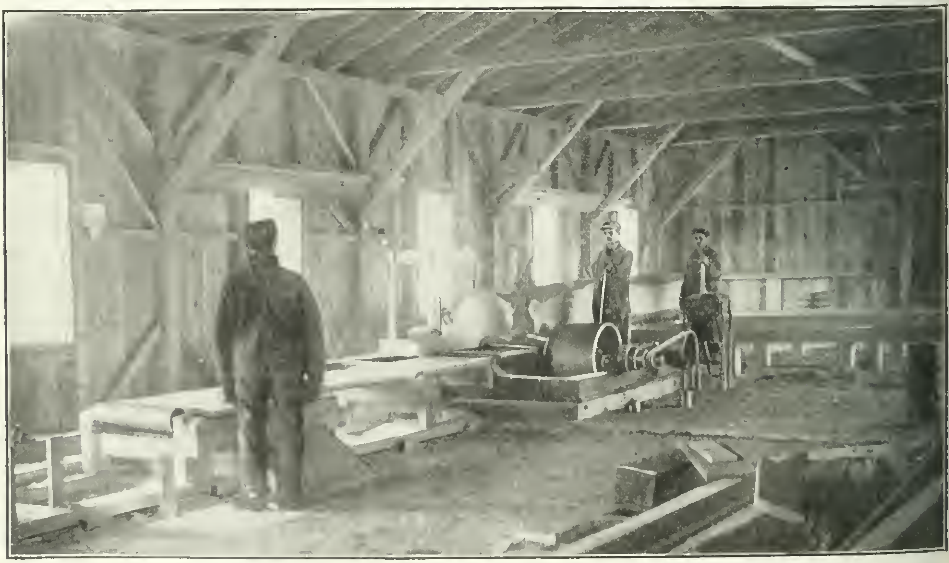

FIG. 3. INTERIOR VIEW OF SAWMILL, PENNICHUCK WATER CO., NASHUA, N. H.

IG. 4 FIRST SEASON'S CUT UNDER SCIENTIFIC FOREST MANAGEMENT; 1913

onditions are favorable to forest culture. The existing rests include both pine and hardwood. Much of the ea was originally well stocked with large white pine, hich was cut off before the land was purchased by the ater company. No seed trees were left, and without oper forestry these areas grew up to small gray birch, ub oak and other hardwoods. These and other lands ich had served for pastures are being devoted to scien- c raising of white pine, for which there is ever a good mand.

Acting on the advice of the forester, the company began the practice of scientific forestry by improvement cuttings, thinnings, final cuttings, planting and by ample measures for fire protection. The work is done chiefly by the company's regular employees at times when they are engaged in other work. This permanent force is composed of 18 or 20 men with two foremen. The regular force is of course increased when new construction work in progress. One of the two foremen has been with the company for over 30 years and is thoroughly posted on practical forestry.

During the construction season this gang lays mains and service pipes, reads and repairs meters and does the other routine of a water-works department. During the winter months the greater part of this gang, from 12 to 14, with a foreman, is sent into the woods to cut, thin and burn n. The company's horses are also sent into the woods for hauling logs. When ready for sawing, there are taken from the permanent force in the city the sawyer, who at other times is fireman at the pumping station and general utility man, and three other men to operate the mill. By h furnishing all-the-year-around employment to the whole gang it is possible to hold a thoroughly experienced water-works maintenance and construction crew—and any water-works superintendent appreciates what this means in general efficiency and ease of operation.

G. 5. ONE OF THE FOREST FIRE PATROL MOTOR TRUCKS

The mill (Fig. 2) is placed about midway on the forest reservation, where a drop between two ponds separated by an earth embankment gives a head of 10 ft. The building is 28x70 ft., one story high with a basement. A 5-ft. penstock is laid through the embankment. A 30-in. S. Morgan-Smith wicket-gate waterwheel is installed in the basement of the building. The wheel has a capacity of 73 hp., with a speed of 165 r.p.m. using 4,300 cu.ft. of water per min., and 57 hp. using 3,100 cu.ft. The waterwheel is used to drive, by means of belts, a 1,200-r.p.m. 60-cycle 3-phase 40-kw. General Electric generator and a 3-kw. 2,100-r.p.m. 125-volt direct-current exciter. To regulate the speed of the waterwheel a Type D Woodward compensating governor is used.

The main saw, blower, etc., are driven by a 50-hp. 2,200-volt motor running at 1,200 r.p.m. A group drive system is used in which the motor is connected to a line of shafting by a flexible coupling, and this shafting drives the main saw and blower. The cutoff saw is driven by a belt-connected 5-hp. 220-volt motor. The current for the small motor is stepped down by two 2½-kw. Type H transformers. The foundations of waterwheel, governor, electrical machinery, shafting piers, etc., are all of concrete masonry.

FIG. 6. TYPICAL FOREST SCENE, PENNICHUCK WATER-SUPPLY

The sawmill is a No. 1 Lane single mill with an iron saw frame, 25-ft. log carriage having 30 ft. of feed rack and 30 chairs and rolls. The mill is equipped with a Guernsy saw guide, Fairbanks gage roll, improved spreader with steel plate, and many other uptodate devices. The main saw is a 48-in. Atkins, and the cutoff saw is a heavy "swing trimmer" 30-in. saw. The sawdust is all drawn off through a blower and discharged through a pipe, shown in the foreground of Fig. 2, to a sawdust pile some distance from the mill. The mill and all equipment are thoroughly up to date and designed as a permanent institution.

When not sawing timber, the electric power may be transmitted to one of the company's water-works pumping stations, where it is used to operate a De Laval 6-in. horizontal single-stage double-suction centrifugal pump having a capacity of 1,000,000 gal. daily. The pump is driven by a direct-connected 35-hp. 2,200-volt motor running at 3,500 r.p.m. The power line was so laid out as to be as direct as possible and yet avoid cutting any unripe timber.

Ample provision is made for forest-fire fighting. The whole water-works crew may be assembled and used for this purpose. The men are quickly summoned by telephone, and three motor cars are kept in constant readiness to transport them to any part of the forest lands. Well-graded and smooth-surfaced gravel roads wind through the forests, serving both for cutoffs in case of fire and to provide access to the various forest compartments (see map. Fig. 1). The equipment of the motor cars used for fire fighting includes 16 portable fire-extinguishers, shovels, picks, etc. A team of horses and a plow are also held in readiness. There have been no serious fires on the company's lands, and most of the fire fighting has been done on neighboring property.

As may be gained from the foregoing description, the forestry end of the Pennichuck Water Co.'s business is by no means insignificant as an income producer. The approximate value of the company's standing timber at the present time is probably close to $100,000. Scientific cutting and care of the forests have been going on for years, and the average annual yield is about 250,000 ft. b.m. ($5,000 at $20 per M.). Besides this cut from the company's own lands the sawmill cuts at a profit, on an average, about an equal amount of timber for neighbors who haul their logs to the mill. Here, then, is a water-works forest that is not experimental, but is a valuable and paying asset.

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Steel Car-Repair Shed with Cement-Tile Roof

A large car-repair shed built recently at Nonconnah, Tenn., by the Illinois Central R.R. is of steel-frame construction with saw-tooth roof and open sides. The building is 1,140 ft. long and 176 ft. wide. Its width is divided into four 44-ft. bays, each having two tracks spaced 22 ft. c. to c., as shown in Fig. 1.

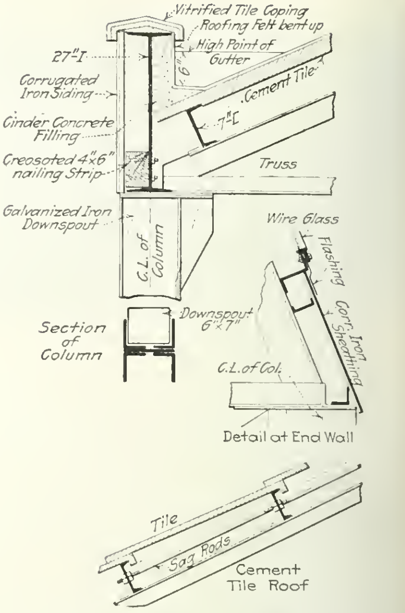

FIG. 2. DETAILS OF ROOF OF CAR-REPAIR SHED AT NONCONNAH, TENN.

The columns are spaced longitudinally 30 ft. c. to c. and stand on concrete pedestals. They have knee-brace connections to the trusses, except in every fifth panel, where diagonal bracing is fitted. The columns are of H-section, built up of four angles and a web plate. Those for the braced bays, with a column load of 150,000 lb., have a plate 3/8x10 in. and angles 5x3½x3/8 in. The interior columns between these bays, with 62,500-lb. load, have angles 4x3x5/16 in., and a plate 8x5/16 in. The exterior columns between the braced bays, with 37,500-lb. load, have angles 3½x2½x¼ in. and a plate 8x¼ in. The knee braces are pairs of angles, and the diagonals in braced panels are pairs of angles 5x3x3/8 in., with lacing.

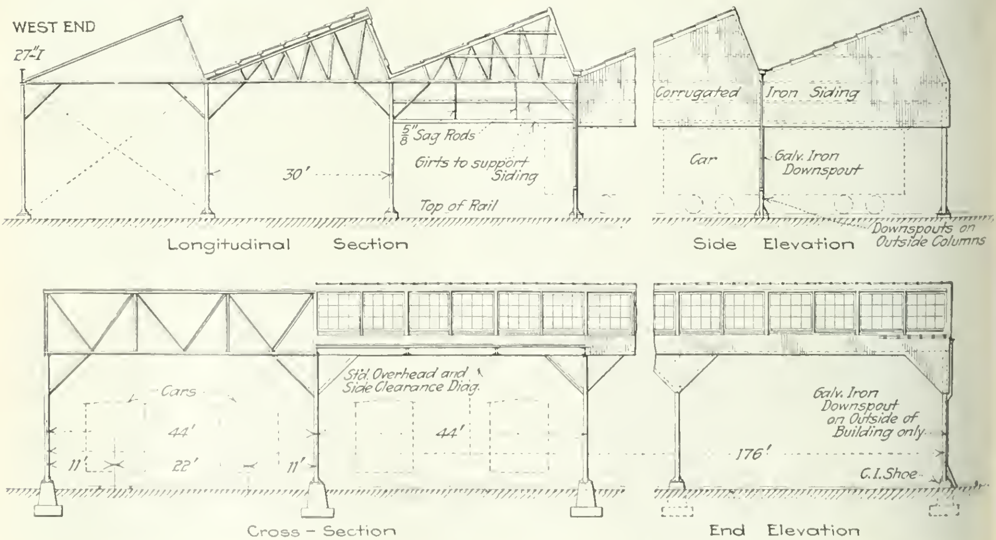

FIG. 1. STEEL-FRAME CAR-REPAIR SHED FOR ILLINOIS CENTRAL R.R. AT NONCONNAH, TENN.

The saw-tooth trusses are built up of angles (single or double) with gusset plates. In each row these are connected by two lines of transverse trusses—one along the upright faces of the trusses and the other in the plane of the inclined top chords. In the braced panels also there is horizontal crossbracing in the plane of the lower chords. There are 13 lines of these trusses, 14 ft. 8 in. c. to c., five of them being supported on the columns and the intermediate lines being carried by the transverse trusses.

On account of the climate and in order to give plenty of light and air the sides are open to a height of about 15 ft. from the ground. Above this there is corrugated-iron sheeting attached to horizontal girts or shelf angles across the outer columns and trusses. The upright fronts of the saw teeth are fitted with wire glass, while the inclined portions of the roof are covered with cement tile.

Across the top chords are laid purlins of 7-in. channels connected by tie-rods. Upon the purlins are laid the ement tiles, which are 4x2 ft., each with a lug at the ipper end to hook over the purlin, while the lower end aps over the next tile. The joints are covered with iles of inverted-trough section. The rows of tile break oints, and the middle of each tile has at its lower end hollow rib or roll to fit over the joint tile of the course elow. The gutters across the roof drain to both sides, nd the outer columns have galvanized-iron downspouts, about 6x7 in., fitted between the flanges, as shown in ig. 2.

The roof construction is of particular interest. The uilding was originally designed to have a composition oofing applied on 2-in. tongued-and-grooved wood sheathng. This heavy sheathing was made necessary by the vide spacing of the purlins—4½ to 5 ft. Later, the ement-tile covering was adopted, and the purlins were paced to fit the length of the tile. Fig. 3 shows a part of the completed roof.

The cost for both designs of roof was 14c. per sq.ft., hat for the original design being divided as follows: umber, 7c.; connections and anchoring lumber to steel purlins, 2c.; composition roof in place, 5c. The weight was 13 lb. per sq.ft. for the wood and composition roof and 15 lb. for the tile. But while the former was estimated to have a life of 10 yr., the latter was considered practically permanent.

As the permanent roof would cost no more than the other, it was adopted; but it is pointed out that the contract was placed at a time when the prices for material were very low, while the unusual extent of the work enabled a low price to be secured for the tile. For a structure of average size it is not thought probable that a tile roof could be built for the same cost as a composition roof.

The car shed was designed and built under the direction of A. S. Baldwin, Chief Engineer of the Illinois Central R.R. The contractors for the foundations and sewers were E. H. Walsh & Son, Memphis, Tenn. The steelwork was fabricated by the American Bridge Co. and erected by the Kelly-Atkinson Construction Co., of Chicago. The cement tile was supplied and placed by the Federal Cement Tile Co., of Chicago, the tiles being manufactured at Hammond, Ind. The steel sash was furnished and placed by the Trussed Concrete Steel Co., of Youngstown, Ohio, and the sheet-metal work and painting were done by Nolsey & Schwab, of Memphis, Tenn.

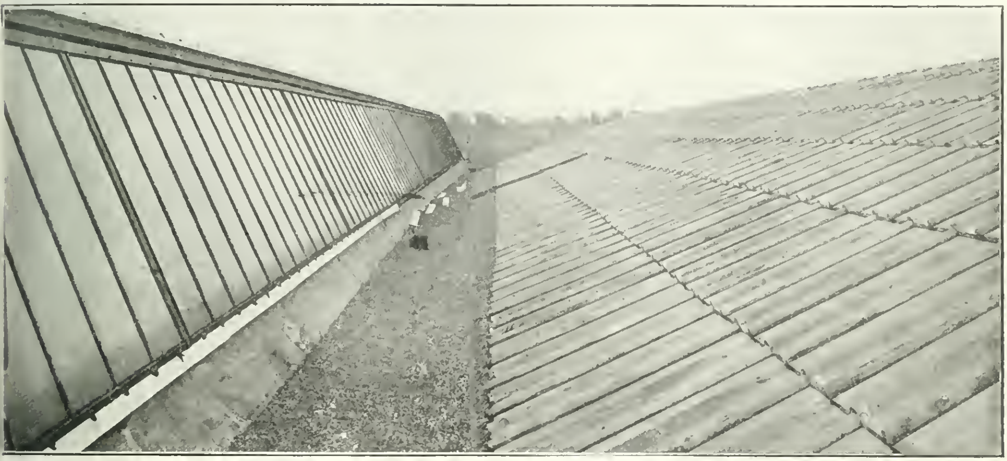

FIG. 3. SAWTOOTH ROOF WITH WIRE-GLASS FACE AND CEMENT-TILE COVERING

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The Only Electric-Car Ferry in this country is reported to be that operated by the Oakland, Antioch and Eastern Ry. across Suisun Bay. Cars with passengers are regularly carried on the gasoline-engine driven barge "Ramon." This boat is of steel, 185 ft. long and weighs 590 tons. It ordinarily carries six passenger or eight freight cars. A noticeable feature is the absence of curved plates and the adoption of a box-like design with ends that are extremely flat in order to present a large area of displacement to overcome tipping while loading or unloading cars. There are two longitudinal bulkheads and four transverse bulkheads. The pilot house is supported by steel towers at the base of which are the deckhouses. A pneumatic steering gear controls a balanced rudder on either end. There are three tracks on the main deck, each 220 ft. long, having a total capacity of nine cars. There is a catenary overhead line so that the trains are able to run off the ferry under their own power. A 600 hp. eight-cylinder 210-r.p.m. gasoline engine is set amidships and coupled through friction clutches to a propeller at either end.

News of the Engineering World

Reinforced-Concrete Wall Tips When Backing is Removed

Removal of the earth front embankment which held up a weak reservoir wall at Madison, Wis., allowed the water in the reservoir to destroy the wall by overturning it on Aug. 26. Though the wall and indeed the whole reservoir were reinforced-concrete structures, there was evident lack of tying between the parts. The wall was reinforced as a beam spanning between floor and roof, but it was not attached to the roof and therefore slipped out from under it.

On the afternoon before the accident the contractor for the extension of the reservoir removed about 12 ft. of embankment at the northwest corner of the existing reservoir. For half the length of the north wall, more or less of the embankment was dug away. The general view, Fig. 1, shows that the wall was quite free to overturn in this condition. The water flowing from the reservoir went into the pit, so that little damage was done to adjoining property.

The reservoir, built nine or ten years ago, is a roofed basin sunk half-depth below grade, in filled ground. It is about 90 ft. square and 16 ft. deep. The earth slopes down from a point about 6 ft. below the roof to street level, 4 or 5 ft. lower, on a 2:1 slope or flatter. Excavation for the extension of the reservoir, along the northerly side, was carried approximately down to the floor level.

The roof consists of a double slab—a 3-in. slab laid on top of a 4-in. slab (see Fig. 1)—carried by 8x10-in. beams, 10 to 12 ft. apart, running at right angles to the wall that failed. Concrete columns under the beams are spaced 10 or 12 ft. The wall, reinforced in its outer plane only, is about 12 in. thick at the top, 18 or 20 in. at the bottom, and contains vertical main reinforcement of $\frac{7}{8}$-in. round rods 4 in. apart, set 2 in. in from the outside. There is horizontal secondary reinforcement of $\frac{3}{4}$-in. rounds spaced 12 in. apart, whose effect shows in the way the wall hangs together and in the nature of the cracking.

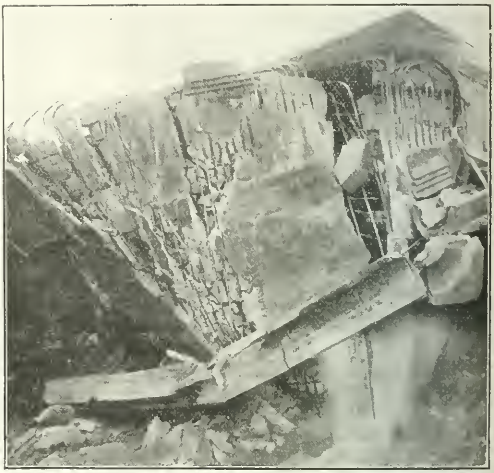

FIG. 2. HOW THE WALL TORE AWAY AT THE CORNER

Tie steel between wall and roof seems to be absent. The bent-over rod-ends in the views evidently were merely bent out of the way because too long. There is a con-

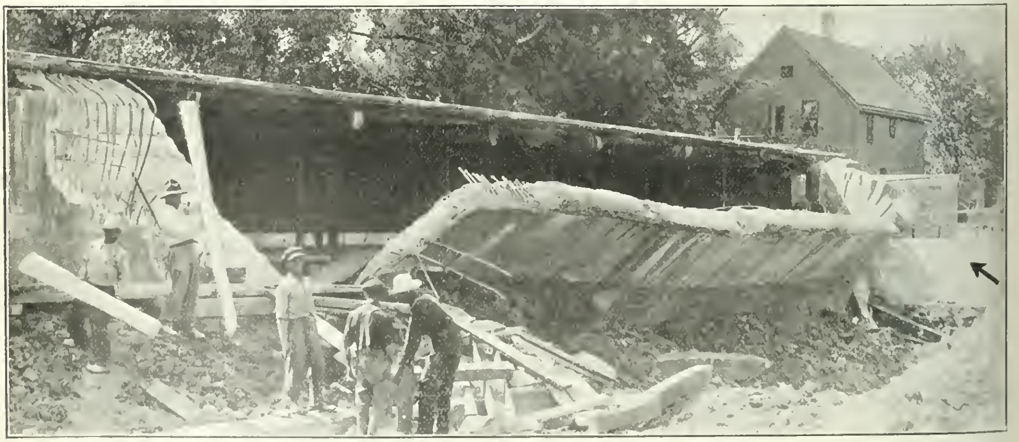

FIG. 1. OVERTURNED RESERVOIR WALL AT MADISON

The horizontal steel was mostly cut after the collapse, to permit entrance. Arrow at right shows point from which Fig. 2 was taken

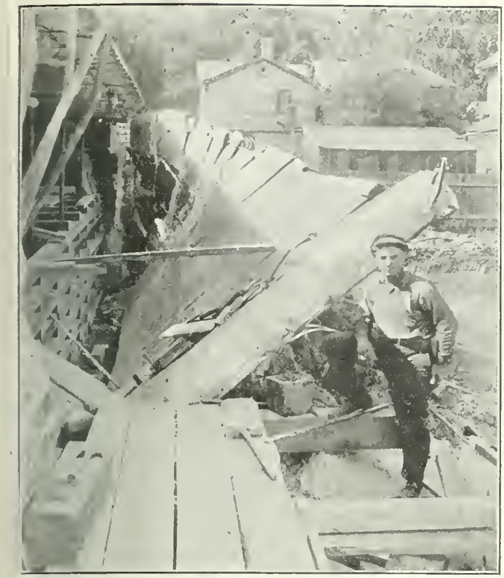

FIG. 3. VIEW ALONG FAILED WALL

ruction joint about 18 in. below top of wall, with sandier oking concrete above than below.

The city officials have not made a statement concerning ie accident. The water-supply is critically affected cause the city's storage is eliminated and water is ing pumped directly into the mains.

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Vater Company Makes Its Own Alum and Chlorine

Plants for making filter alum from bauxite and lorine gas from brine are being built by the Montreal ater and Power Co., under the direction of J. O. eadows, engineer and superintendent of the company's iter-filtration plant. Both plants will be in use about ov. 1.

The filter alum or sulphate of alumina plant will have capacity of five tons a day, and will make use of the ocess worked out by Charles P. Hoover, chemist and perintendent of the filtration works of Columbus, Ohio. uxite, ground and bagged, will be bought from the uminum Company of America, one of the many comnies supplying that material. Under normal conditions proposed plant would save $8 per ton on the sulphate alumina used, but at the present prices of chemicals saving will be five times that. In other words, sulate of alumina now costs $70 per ton and can be made the Montreal filter plant for $30 a ton. The material s already been produced in a crude way by the company, l used with satisfaction.

Chlorine gas will be made in four Moore-Allen cells ving a capacity of 120 lb. of gas per day. From the ks, which are being cast at the plant from crushed and wdered stone and cement, the gas will pass through ser injectors, then be mixed with water and applied t the water to be heated through distributors. The plant will be able to treat 30,000,000 gal. (Imp.) a day. Besides effecting a considerable saving over the present market price of chloride of lime, and a slight saving under normal conditions, the new plant will have the advantage of greater simplicity, will avoid the nuisance due to handling hypochlorite and will save general depreciation around the adjacent parts of the works due to the use of hypochlorite.

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State To Vote for Bridge or Tunnel at New Orleans

The Louisiana Legislature at its recent sessions passed a joint resolution authorizing a constitutional amendment to provide for the construction of a bridge or tunnel across the Mississippi River at or near New Orleans. This amendment is to be voted on by the electorate of Louisiana on Nov. 7, and it is expected that it will be passed with little opposition. The responsibility for planning and constructing the new bridge or tunnel has been placed upon the Public Belt Railroad Commission of New Orleans, which body has created a special committee on "Bridge or Tunnels" to study the situation. This committee has already held hearings at which prominent engineers have given their opinions, and the committee informs us that it is desirous of hearing from other engineering firms who may wish to apply for contracts in connection with the work.

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City Provides Elevated Street To Retain Industrial Plant

The City of St. Paul, Minn., has just vacated about 300 lin.ft. of a city street and elevated the grade so that traffic can be carried on a viaduct in order to retain an industrial plant which otherwise threatened to move away.

The H. Koppers Co. had purchased 38 acres of land from the Northern Pacific Railway Co. for a coke plant. As the plant required a long, unbroken site, the company asked the city to vacate what claim the city might have in an old, unopened county road known as the continuation of Hamline Ave. While desirous of retaining the Koppers Co., the city felt that its rights to Hamline Ave. should not be given up, as it was developing into an arterial street in other parts of the city. The company asked for the vacation of the street in order that it might have full possession and offered to build and extend the present footbridge over the Great Northern Ry. tracks across its property some 300 ft., or would permit the city to reserve the right in the vacation proceedings to build piers to support a viaduct. The corporation counsel ruled that if the city vacated the street it would have no right to order the construction of a viaduct across what would then be private property, so that the reservation of rights to build piers would be valueless.

The problem was solved by establishing an air-line street or a new grade line 22.1 ft. above the present grade and vacating the street to this height. By so doing the city gives up its right to order this portion of the viaduct built at the expense of the property owners underneath, excepting that they might be assessed for benefits.

The city could have compelled the Northern Pacific Ry., former owner of the land, to pay the cost of a viaduct when such a structure became a necessity. It can now compel the railway companies on either side of this vacated portion to pay the cost of a viaduct over their lands, but this viaduct, 303 ft. in length, will have to be paid for out of the general fund of the city or assessed against the district benefited, and the railways could not be assessed any part of this on account of paying a gross-earnings tax.

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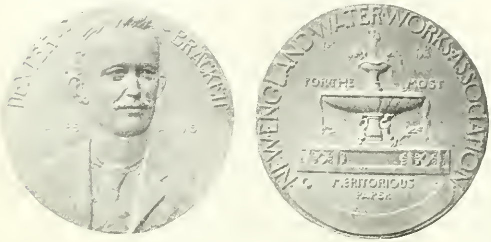
Dexter Brackett Medal

The bronze medal of the New England Water-Works Association, struck in commemoration of the life and work of Dexter Brackett, for many years chief engineer of the Metropolitan Water and Sewerage Board of Boston, Mass., is illustrated herewith. The resolution to honor the memory of Dexter Brackett, past-president of the association, was adopted by the committee in a meeting at Boston, Nov. 10, 1915. Enough members immediately guaranteed a sufficient fund to assure the success of the plan, and later the entire membership was given an opportunity to contribute. The total sum raised was $1,286.



The designer of the Dexter Brackett medal is T. Spicer-Simson, of New York City. The committee of the association in charge consisted of Frederick P. Stearns, chairman; Allen Hazen; Alfred D. Flinn; George A. Stacy; Charles W. Sherman, secretary and treasurer. The committee suggests that the first award be made for the calendar year 1916, so that all papers published in the *Journal* of the association for the present year will be considered. The first presentation of the medal will then take place at the 1917 annual convention.

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Philadelphia Has Record Water Consumption

The greatest water consumption in one week in the history of Philadelphia occurred in the week of Aug. 20. Approximately 2,338,000,000 gal. were used, an average of 334,000,000 gal. daily. The highest previous week's averages were as follows: 1915, average daily consumption, 320,000,000 gal.; 1911, 310,000,000 gal., and 1913, 316,000,000 gal. The daily per capita consumption in Philadelphia is about 180 gal.

The city is threatened with a water famine. The filtration plant, which cost the city $35,000,000 is inadequate and Carleton E. Davis, Chief of the Bureau of Water, is preaching economy in the use of water. In many buildings and houses, especially in South Philadelphia, there is no water for hours daily. Water Bureau officials say the pressure should reach between 30 and 40 lb., while fire underwriters insist that it shall be 60 lb. Two plans to relieve the condition are being considered by city officials. One is securing money for the construction of an additional pumping station and a filter bed with a capacity of 100,000,000 gal. daily, and for the building of a large express main from Torresdale (the head of the supply) to South Philadelphia. The other method is the long-agitated proposition to place water meters over the entire city.

⁂

[Ontario Hydro-Electric Power System To Be Enlarged

Owing to the rapid increase in the consumption of electric power the Ontario Hydro-Electric Commission has decided to proceed immediately with plans for the extension of the provincial power-transmission system which it was intended to postpone until after the war. Sir Adam Beck, Chairman of the Commission, announces that the plants in Toronto and Dundas will be doubled and the transmission line between these points duplicated involving an expenditure of over $1,250,000. Preliminary work on the stations is already under way and plans and specifications for the new transmission line have been completed. At Niagara Falls new switches and other equipment to handle the additional 50,000 hp. being secured from the Canadian Niagara Power Co. are being installed. The maximum load of Niagara power now ranges between 115,000 and 120,000 hp. These extensions will insure an ample supply for the needs of Toronto and bring the equipment at Niagara Falls and Dundas up to the condition necessary to handle the larger load which will be available at the end of the year.

The Commission has also decided to proceed immediately with the work of linking up the four power plants at Eugenia Falls, Big Chute, Wasdell Falls and Swift Current, in the Owen Sound-Collingwood district. This will require the construction of 41 miles of transmission lines. It will give a total supply from these four developments of 15,000 hp. With the increased production possible at the Big Chute and developments yet to be made on the Saugeen and Severn Rivers the ultimate development of this district will be 25,000 hp. As the Northern line will be only six miles distant from the Niagara power transmission line at Mount Forest, the two systems can easily be linked together if thought requisite in the future. Sir Adam Beck states that new municipalities are being connected with the system and that the steady increase in consumption is largely due to the manufacture of war munitions.

⁂

Birmingham, Ala., Water-Works Purchase—Negotiations have been begun by the Board of Commissioners of Birmingham, Ala., and A. M. Lynn, president of the Birmingham Water Co., relative to the purchase of the water-works. Under the franchise of the company, the city may purchase the plant by giving adequate notice, which has already been done. Efforts are being made to arrive at a suitable price, and if this fails arbitrators will be chosen.

Water Company Not Compelled To Test Wells—The chancery court at Little Rock, Ark., decided that it was unnecessary for the Arkansas Water Co. to have its new auxiliary well system tested by other than its own engineers to show whether it had complied with the city's orders. The city of Little Rock sued for an order compelling the company to have the test made by disinterested engineers. The company objected on the ground of expense. The wells have an alleged pumping capacity of more than 6,000,000 gal. per day.

State Highway Commission for Georgia—The Georgia Legislature has passed a bill providing for the creation of a State Highway Commission. This is to consist of the members of the State Prison Commission, the state geologist, and the professors of highway engineering at the Georgia School of Technology and the State University. There is no provision for a state highway engineer other than the engineers that may be employed by the prison commission. One section of the law states that this commission shall be empowered to receive funds from the Federal Government for road purposes.

Tidal Flow Affects Artesian Wells near the ocean, according to a report of the United States Geological Survey. In studying wells in the coastal plain of Virginia it was found that there was a decided variation in the well flow with the rise and fall of the tide, the flow being notably greater at the flood than at the ebb tide. It is the general opinion among well drillers that practically all flowing wells near tidal rivers or inlets from open bays do feel the distant sea, but some of them so slightly that the variation in flow is not noticeable. The geologist in charge of the groundwater investigations in Virginia states that changes in water level in wells, due to fluctuations in the height of the surface of some neighboring body of water, have been observed all over the world. It is customary to explain these changes by supposing a direct connection between the river, lake, or bay; but in many places, as in eastern Virginia, such connection is clearly impossible, owing to the depth of the wells and the nature of the intervening beds, some of them dense, tough marls and clays. These beds, however, though they do not transmit water, nevertheless contain it, and as water is practically incompressible, any variation of level on the river or bay is transmitted to the well through the water-filled gravels, sands, clays and marls. When a porous bed is tapped by a well the water rises to the point of equilibrium and fluctuates as the hand of the ocean varies its pressure on the beds that confine the artesian flow.

PERSONALS

Ross Miller has been appointed Engineer of the South Dakota Railroad Commission to succeed Joseph E. Love, resigned.

A. M. Frink, architect and engineer, 723 Illuminating Bldg., Cleveland, Ohio, announces that he has taken over the business formerly conducted by Izant & Frink.

James W. Moore, recently Engineer of the New Orleans United Gas and Electrical Engineering Corporation, has been appointed Chief Engineer of the Van Kuren Engineering Co., Birmingham, Ala.

H. S. Riddle, M. Am. Soc. M. E., Consulting Engineer of the Ohio Board of Administration, Columbus, Ohio, will resign Oct. 1 to accept a position with the Jeffrey Manufacturing Co., also of Columbus.

Alfred F. Townsend, for the past seven years manager of Woonsocket (R. I.) Electric Machine and Power Co., has been appointed Local Manager of the Stone & Webster properties n Beaumont and Port Arthur, Tex.

Frank H. Olmstead, M. Am. Soc. C. E., of Olmstead & Hillelen, Consulting Engineers, Los Angeles, Calif., has been appointed Engineer in Charge of flood-protection plans for he Gila River, by Secretary Lane, of the United States Department of the Interior.

Francis M. Veatch, Jun. Am. Soc. C. E., recently appointed Assistant Engineer of the Kansas State Board of Health, has resigned, effective Oct. 1, to become Superintendent of he East St. Louis, Ill., water-purification plant of the American Water-Works and Electric Co.

J. T. Bullen, M. Am. Soc. C. E., has resigned as Parish Engineer, Caddo Parish, Louisiana, to become Highway Engineer of several road districts in Raleigh County, West Virginia, the aggregate funds of which are $850,000. He was formerly Senior Engineer, United States Office of Public Roads and Rural Engineering.

E. L. Brown, Vice-President and General Manager of the Denver & Rio Grande R.R., Denver, Colo., has been elected President of the Minneapolis & St. Louis R.R., succeeding Newman Erb, resigned. Mr. Brown is 52 years old and entered he railway service as a telegraph operator. For several ears previous to 1912 he was an operating official of the Northern Pacific and Great Northern railways

J. H. Nuelle, Assistant General Superintendent and Chief ngineer of the New York, Ontario & Western Ry., has been promoted to be General Superintendent, with headquarters at Middletown, N. Y., succeeding the late Edward Canfield. Mr. Nuelle is a graduate of Princeton University, class of 1906, and until June, 1907, was a transitman with the Pennsylvania and New York Central lines. He entered the service of the New York, Ontario & Western Ry. as an assistant engineer. In 1911 he was made Principal Assistant Engineer and in 1912, Engineer of Maintenance-of-Way.

The Universal Portland Cement Co., Chicago, Ill., announces the following promotions and changes in its engineering staff: **Adolph G. Carlson** is appointed Chief Engineer. He was formerly Assistant Superintendent of the Syracuse, Ind., plant of the Sandusky Portland Cement Co. He has had to do with the designing of Nos. 3, 4 and 6 mills of the Universal Portland Cement Co., at Buffington, Ind., and No. 5 mill at Pittsburgh and No. 7 mill at Duluth. He was appointed Mechanical Engineer in 1907. **M. S. Humphreys,** formerly Superintendent, Mill No. 6, Buffington, Ind., plant of the Universal Portland Cement Co., is appointed Assistant Mechanical Engineer at the general offices in Chicago. **Nels Nelson,** formerly Superintendent of Mill No. 2, at South Chicago, which plant has been dismantled, is appointed Superintendent Mill No. 6, Buffington, Ind., plant. **J. H. Lendi** is appointed Electrical Engineer at the general offices in Chicago. Mr. Lendi has been connected with the company for several years in the engineering department.

ENGINEERING SOCIETIES

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW YORK STATE ASSOCIATION OF COUNTY SUPERINTENDENTS OF HIGHWAYS.
Sept. 13-14. Meeting at Syracuse. George S. Tibbits, Chairman of Executive Committee, Oneida, N. Y.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

AMERICAN PEAT SOCIETY
Sept. 21-23 Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N Y.

AMERICAN CHEMICAL SOCIETY.
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N W. Ry, Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct 24-27 Convention in Cincinnati, Ohio. Secy., Prof. Selskar M Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

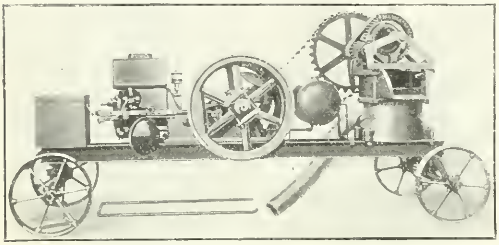
NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS
Nov 14 Convention in Washington, D. C. Secy., W H Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5 7. Annual meeting in New Orleans. Secy., Charle E. Lowe, Sewickly, Penn.

Appliances and Materials

Chain-Driven Trench Pump

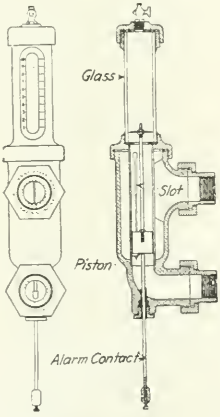
The power-operated trench pump shown herewith has a sprocket-chain drive from the engine to the pump, and the pump rod is driven fron an eccentric instead of from a rocker arm. The eccentric shaft is connected to the sprocket wheel shaft by a single set of gears, and a compensating link attached to the connection of the eccentric with the pump rod maintains the rod in a vertical position during its travel. The pump has a 3-in. suction at the side, and a side discharge spout to which a trough or chute can be attached. All the valves have openings sufficient to pass anything that goes through the suction hose. The outfit as shown has a pump and 2-hp. gasoline engine mounted on a steel-frame truck, the total weight being about 680 lb. If mounted on skids the weight is about 525 lb. When run at 45 strokes per min. the capacity is 3,500 to 4,000 gal. per min., but this may be doubled by an outfit having two pumps and a 3½-hp. engine, with a weight of 1,250 lb. complete. These trench pumping outfits (as well as the gasoline engines used) are built by the Waterloo Cement Machinery Corporation, of Waterloo, Iowa.


TRENCH PUMP WITH CHAIN DRIVE

* * *

Variable-Slot Flow Meter

A new meter for indicating flow of liquids in pipes, but embodying a principle which has been similarly employed before, is shown in the accompanying sketch. It was designed by J. F. Vaughan and is being made by the Spray Engineering Co., of Boston. The liquid flows into a slotted cylinder surrounded by an annular chamber connected to the meter discharge. In the cylinder is a floating piston uncovering more and more of the measuring slot as the pressure difference increases between inlet and outlet. Piston movement is communicated to a pointer in a closed glass chamber, the walls of which are graduated. Calibration is claimed to give a uniform flow scale for all positions of the piston and pointer, within the range of the meter. The head loss is stated to be 0.004 lb. per sq. in. for 15 gal. per min. flow. An insulated brass rod rises through a packing gland in the inlet chamber and makes contact for sounding an alarm on return of the piston to any desired minimum-flow point.

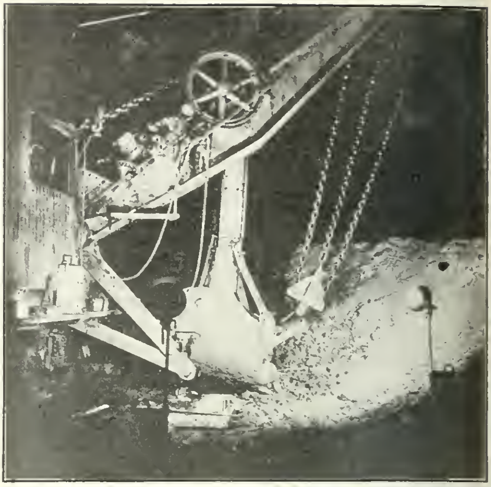


VAUGHAN METER

* * *

A 3,000-Cp. Light for Night Construction Work

The standard "No. 2" acetylene projecting lamp (nominal rating 5,000 cp.) of the Alexander Milburn Co., of 14 Baltimore St., Baltimore, Md., has been redesigned (fitted with new burner and 12-in. reflector) to make a 3,000-cp. light which will run for 12 hr., at a total charging cost of 34c. The charge consists of 9 lb. of ordinary commercial carbide. The body of the lamp is 10 in. square. The total height is 5 ft. It weighs 130 lb. charged and 58 lb. empty, and costs $42.50.

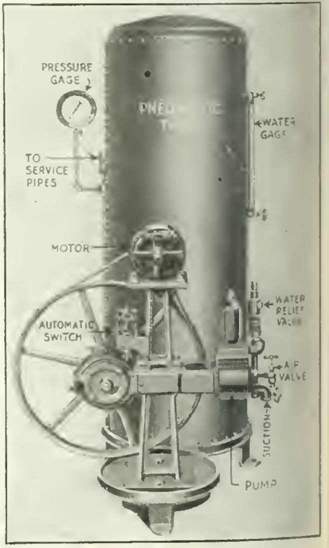

MILBURN NO. 2 AT DALLAS

The accompanying view shows a night grading operation for the new railroad terminal at Dallas, Tex., for which J. W. Thompson was contractor for the excavation which aggregated 760,000 cu.yd. It is claimed that with two steam shovels Mr. Thompson moved 1,800 yd. per night.

* * *

Electro-Pneumatic Water-Supply Outfit

A water service system for isolated residences and small plants or institutions with no water-works connections consists of a pump and pneumatic pressure tank. The pump has a horizontal double-acting cylinder, with air chamber. It is operated by a crank shaft geared to the shaft of a flywheel belted to an electric motor placed above it on top of a standard. The crank case is inclosed and forms an oil bath. The pump delivers both water and air to a cylindrical tank, about one-third of the tank space being filled with air. This tank is designed for 125 lb. pressure. When the air pressure reaches 40 lb. the motor is stopped by an automatic switch, and this again starts the motor when the pressure falls to 25 lb. The equipment includes an air inlet valve and water relief valve. When the supply is taken from a well or spring, a special attachment can be added by which drinking water may be delivered directly from the pump to a tap indoors. The outfit is built with pumping capacity of 180 and 300 gal. per hr. The larger size has a ¼-hp. motor, running at 1,150 r.p.m., 1-in. supply and discharge pipes and a 140-gal. tank. It is 6½ ft. high over all and occupies a floor space 37x44 in. (exclusive of tank). These outfits are built by the Hill Pump Co., of Anderson, Ind.



PUMP AND TANK UNIT

Engineering News

VOLUME 76 SEPTEMBER 14, 1916 NUMBER 11

Construction and Maintenance of Roads in the Arid West

SYNOPSIS—A traveler's notes on road-building materials and road construction under adverse climatic conditions. The problem of gravel-road maintenance under arid conditions and various attempts to solve it.

A great section of country lying in the western part f Texas, Arizona, New Mexico and Nevada was for many years known as the Great American Desert, and the reater part of it still is an arid and desert country. Notwithstanding the fact that counties in these arid regions are as large as states in the East and that the opulation of the counties, concentrated in the irrigated alleys, is about that of townships in the Central West

ere is great activity in road building, and the people e keenly appreciative of improved roads.

It is a country where practically every property owner s one or more motor cars, and where freighting heavy ds for long distances on the roads by team or motor a necessary practice. The traffic in vehicles per day most of the roads would seem insignificant compared th traffic records on roads in the more thickly settled rts of the country; but owing to the dry atmosphere d scanty rainfall the destructive effects of any traffic dirt or gravel roads are magnified many times over at they would be in a country where the roads could be intained by established methods. Anything but an proved dirt or gravel road, costing from $500 to $2,500 r mi., is obviously out of the question except in very e instances.

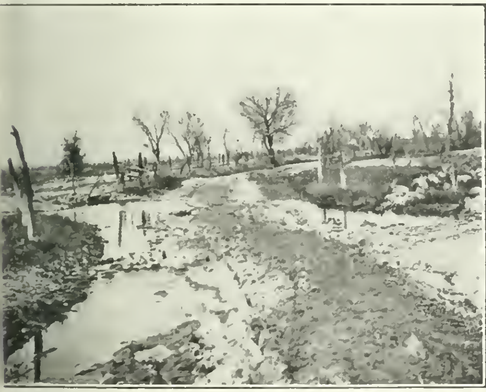


FIG. 1. AN UNIMPROVED ROAD IN IRRIGATED VALLEY, NEW MEXICO

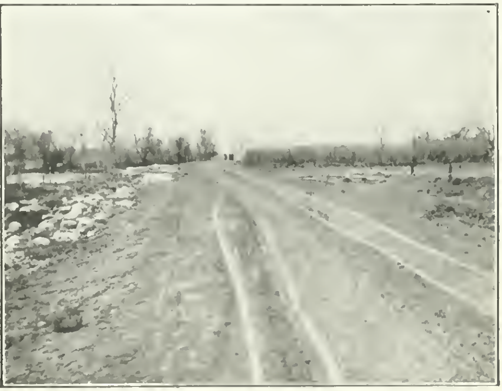


FIG. 2. RELOCATION OF SAME ROAD IMPROVED WITH SAND-CLAY SURFACING

Texas has no state highway department, but much road improvement work has been done by the counties. At Dallas, J. F. Witt, County Engineer, has about 500 mi. of gravel or hard surface road under his jurisdiction. Climatic conditions here are of course not so aggravating as in the western part of the state, yet the long, hot, dry summers give an introduction to the conditions farther west. During this dry season the dust nuisance becomes so acute that not only are gravel-road surfaces rapidly disintegrated, but there is no pleasure or comfort in riding over them.

The use of calcium chloride has not proved of any benefit. It is evident that to be effective this material must be used in a more humid climate where an appreciable amount of water vapor is present in the atmosphere. Mr. Witt has also had poor success with the light semi-asphaltic or nonasphaltic oils. In a dry climate these are not sufficient to hold the dust by capillary attraction, and clouds of dust particles coated with grease are obviously more objectionable than dry dust. On gravel roads in good condition oil containing 50% asphalt has given satisfaction in Dallas County.

Asphaltic oil coating, costing $500 to $1,500 per mi., is obviously too expensive for the ordinary country roads in this section of the country. For $150 per mi. per yr. well-built gravel roads have been maintained in fair condition by periodically regrading and planing them with a road grader to remove ruts and using new material for patching where necessary. This answers for the first six or seven years after construction, then it becomes necessary to entirely resurface the road with new gravel which, owing to the already graded and compacted subgrade, may be done ordinarily for about half the first cost of the road.

For the more heavily traveled roads oiled gravel surfacing on a crushed-limestone base has given fair satisfaction and is about the cheapest form of bituminous-road construction for this section. Farther south, in Harris County, oyster shells have been used experimentally for the foundation course of gravel roads with apparently excellent results. These shells are not hard enough to withstand any considerable amount of wear, yet they mat and bind together to form an excellent base for any type of hard surfacing.

The experience with shell-surfaced roads in Texas has been unsatisfactory. A small amount of steel-tired traffic wears the surface very rapidly and motor traffic raises great clouds of suffocating dust. Oil has been tried, but owing to the presence of the dust and to the fact that the shells mat together so compactly, practically no penetration of the oil is possible. Shell roads have, however, been resurfaced with gravel by first harrowing the old surface and adding about 2 in. or less of new shells and 2 in. of fine, washed gravel. The whole is then reharrowed and compacted, giving a much more satisfactory surface than the shell alone. A 16-ft. road of this type costs from $2,800 to $3,500 per mi.

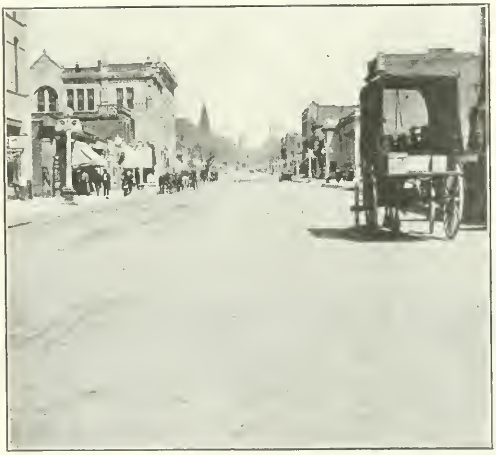


FIG. 3. MAIN STREET OF CHEYENNE, WYO., "PAVED"

In Bexar County (Fred Bennett, County Engineer), of which San Antonio is the county seat, nearly three-quarters of a million dollars has been expended on graveling and improving roads during the last two or three years. Particular attention is paid to maintenance, which is complicated by the arid conditions typical of the country from here west. On these roads tar oils have proved particularly satisfactory. The hardening and cracking of tarred surfaces two or three years old, common in the North, is apparently prevented or delayed by the near-tropical climatic conditions.

Two kinds of gravel are used in Bexar County; in the northern part a good flint gravel, in the southern part adobe gravel. The former makes the most durable road, but the latter is the kind most used throughout the Southwest. Adobe gravel forms a hard, compact road surface, but dusts and ruts badly in the dry atmosphere. No oil penetrates a compacted surface of this material more than ½ in.

The Bexar County roads probably have been constructed with as much care and engineering supervision as those in any of the far western states. Particular attention has been paid to gravel inspection. Men employed for this purpose are paid $80 per month. The roads are rolled with 12- or 15-ton road rollers—an unusual refinement for this section. The county is divided into precincts and a regular allowance of $5,000 per precinct is made for maintenance.

In El Paso County bituminous macadam and asphaltic concrete roads have been tried, and with very poor success. At present several miles of concrete pavement is being laid on county roads—probably the only use of this material in western Texas, or in that part of the Southwest. There are cement mills at El Paso, which was probably one of the deciding factors in the choice of material.

The majority of Texas gravels are of limestone origin and are not so suitable for roads as the granite gravels found farther west.

GRAVEL ROADS IN NEW MEXICO

New Mexico has a state highway department (James A. French, State Engineer) and systematic improvement of roads is in progress. The annual rainfall in this state varies from 8 in. in the lower valleys and plains to 25 and 30 in. in the higher mountain regions. The precipitation in the mountains is mostly in the form of snow. Systematic dragging of the roads is impossible.

Topographically the state may be divided into river valleys, mesas and mountains. The mountains and mesas furnish plenty of material for cheap road building. The mesas are generally formed of deposits of clay and gravel and furnish ideal material. The areas in the river valleys are not so fortunate. The soil there is of three types—sandy stretches, river soil or adobe and the black soil of irrigated tracts.

Roads through the sandy and adobe soils are made mostly of the sand-clay type; in the first case adding clay and sand and in the second only sand or gravel, leaving the mixing and compacting to be done by traffic. In both instances it is possible to obtain fair roads at very small cost, but it is of course difficult to maintain them in good condition. In Valencia County, a few miles south of Albuquerque, A. E. St. Morris, County Highway Director, has improved many miles of road in this manner, in some instances with a wearing surface no more than 3 or 4 in. thick. In irrigated sections gravel roads are constructed more scientifically, being graveled, wetted and rolled. They are also being maintained to a certain extent by dragging, as these lowland roads are not infrequently in a saturated condition owing to retaining rain water and to seepage from adjoining irrigated lands (see Figs. 1 and 2).

ROAD BUILDING IN ARIZONA

The improvement of roads in Arizona is under a kind of dual control. State roads are built under the direction of state division engineers by convict and day labor, while the counties may sell bonds and build roads by contract or day labor as they see fit under the state highway department, the county engineers or through outside con-

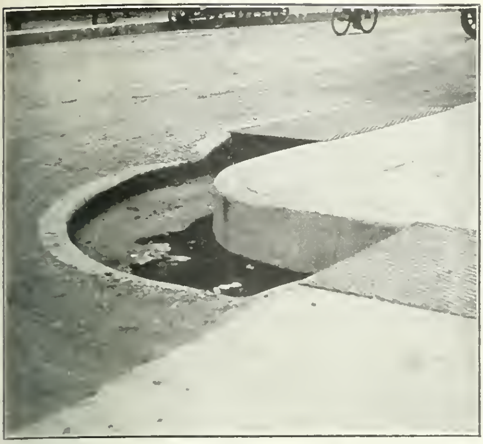


FIG. 4. CURB AND GUTTER DETAIL, CHEYENNE GRAVEL PAVEMENT

sulting engineers. The topographic conditions are somewhat similar to New Mexico, but possibly more varied. The southern counties are near-tropical while the northern ounties in the mountains have plenty of frost and snow.

Pima County (of which Tucson is the county seat) s now building 26 mi. of water-bound macadam, using ocal crushed lava rock known as malapi and screenings. This is the first of several miles of bond-issue roads in he county to be improved in this manner, probably the irst waterbound macadam in any of the arid states. n some instances in Pima County water will be so rare hat it will be necessary to roll the macadam dry and ait until the rainy season for the final rolling and finhing. Bids for the first 26 mi. of these roads were ublished in the Construction News supplement of *Engieering News,* July 6, 1916. Wm. H. Rosecrans & Co., of hicago, are consulting engineers in charge.

A common road-building material in southern Arizona a conglomerate known locally as caliche. It consists gravel and fragments of stone cemented by lime. It spread on the road in the same manner as gravel and nder traffic forms a very hard, smooth surface, but in e long dry spells under a small amount of automobile affic it rapidly loses large amounts of dust binder and its badly. A special method of constructing caliche ads in Maricopa County by use of irrigation water as described in *Engineering News,* May 4, 1916. The pair and maintenance of caliche roads, as of gravel roads this section, consist merely in replacing the material hich blows away as dust with fresh material. State ngineer Lamar Cobb is experimenting with asphaltic ls on caliche roads, and a small experimental stretch of rvia has been constructed in Maricopa County.

Yuma County in the extreme southwest corner of the te is spending several hundred thousand dollars in construction of bitulithic and warrenite (asphaltic ncrete) pavements. In the northern counties good avel is available in most instances.

The best surfaced roads in Colorado are those where a integrated granite gravel has been used. This material found in many parts of the Rocky Mountain states, but t in El Paso County, around Colorado Springs, is about the best. A surfacing of 6 in. of this material, which is like a very coarse sand with loamy binder, will retain a smooth, hard surface for two or three years under a traffic of as many as 50 to 100 motor cars per day.

The dull-red, disintegrated granite found on the line of the Union Pacific R.R. west of Cheyenne, Wyo., known as Sherman gravel, is familiar to engineers who have crossed the continent by that route, for it is used for ballasting many miles of the Union Pacific on either side of Cheyenne. It is an ideal road-surfacing material. The streets of Cheyenne, a city of about 12,000, are surfaced with it, with results almost equal to those of paving. When adequately sprinkled to avoid the dust nuisance this street surfacing seems to be quite satisfactory. Figs. 3, 4 and 5 show some of the Cheyenne streets.

All parts of Wyoming, however, are not so well supplied with road-building material. In the northeastern and central parts of the state black loam and gumbo soils are found and roads in these sections are almost impassable after continued rains. In the southwestern part of the state the soil is largely sandy loam and the roads are in bad condition in rainy weather. Dragging the roads in a country where the population averages 1.5 to the square mile is obviously impossible, so that little advantage is taken of the rainy spells.

ROAD BUILDING AND MAINTENANCE IN UTAH

The State Highway Department of Utah has built a few miles of concrete pavement and with very fair success, but the great part of the state roads are merely graded, or graded and graveled. A method of rapid grading used on these roads was described in *Engineering News,* July 6, 1916.

Utah is one of the few states, possibly the only one, which has tried (experimentally) systematic sprinkling with water carts or trucks as a maintenance measure on gravel roads. Special reservoirs and water stations have been constructed for this purpose in Davis County. It is stated, however, by E. R. Morgan, State Road Engineer, that ordinary sprinkling has proved ineffective, and he proposes during the present year to try out a method of maintenance by which the road will receive a thorough soaking and then a dragging; in other words, he proposes to maintain gravel roads as they are maintained under more favorable climatic conditions by mak-

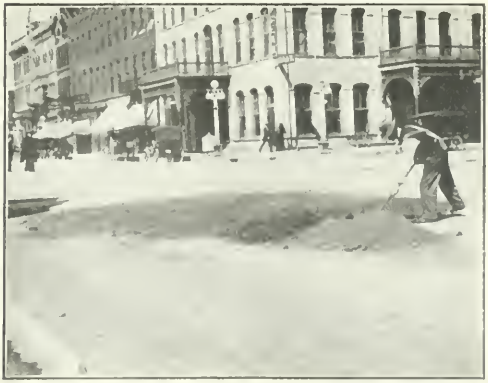


FIG. 5. "REPAIRING" CHEYENNE PAVEMENTS

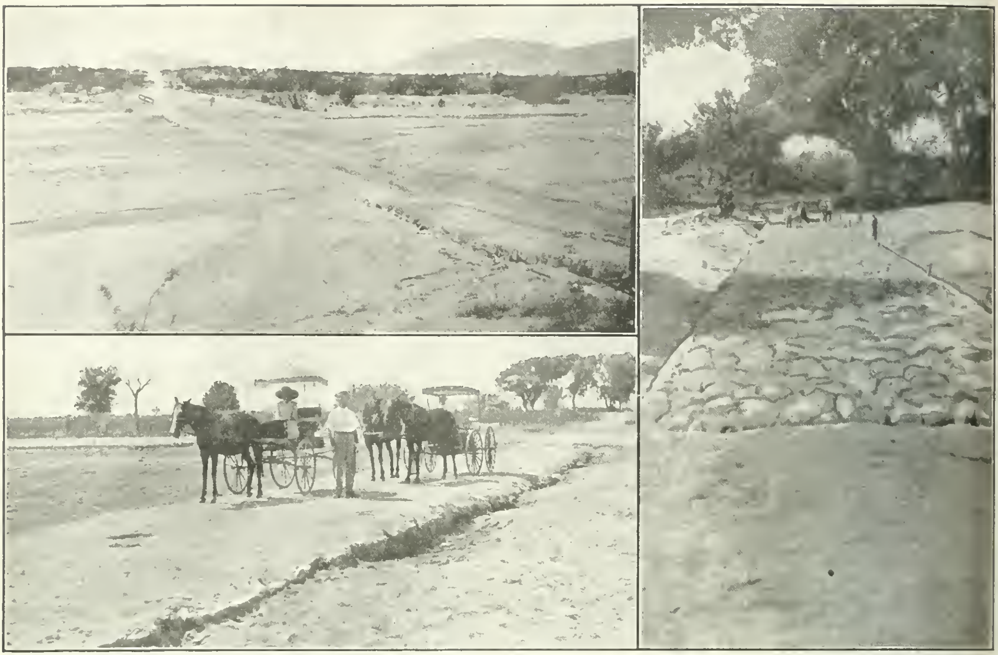


FIG. 6. VIEWS OF ARROYO CROSSING, PIMA COUNTY ROAD, ARIZONA, SHOWING METHOD OF CONSTRUCTION

ing up artificially for the deficient rainfall. These experiments will be watched with interest by highway engineers throughout the west.

Further Notes on Maintenance

The dirt roads of the Imperial Valley in California are maintained by thoroughly wetting them with water from nearby irrigation ditches and then dragging them as is done in the more humid parts of the country after rainstorms. The method is to divide the road along the center line by a dike and irrigate and drag one-half of the road at a time. Such a method, of course, is applicable only in level country and where plenty of water may be taken from irrigation ditches. It would hardly be economical where water had to be pumped or hauled any considerable distance.

In general, the scheme of maintenance of the dirt and gravel roads of the arid West, as already noted, is merely to supply new material as the old blows away in dust. This means the entire resurfacing every three, four or more years, according to the amount and kind of traffic. It is evident that the harder, coarser gravels give the best satisfaction. Between times of resurfacing the roads have to be occasionally recrowned and the ruts removed. This is generally done as frequently as can be afforded. Ordinarily, the roads become so badly rutted that a common road drag or light scraper is out of the question and large road planers or blade graders are used.

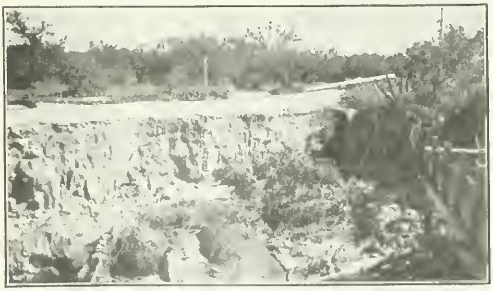
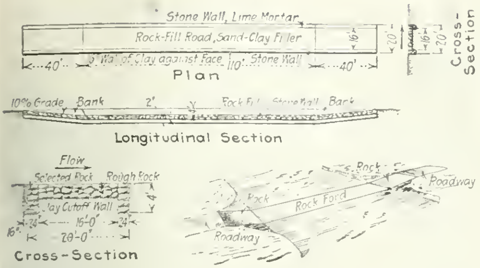


FIG. 7. WASHOUT ON A DESERT ROAD CAUSED BY FAILURE OF WOOD HEADWALL OF PIPE CULVERT

The cost of maintenance as also the cost of construction depends almost wholly on the cost of handling and hauling gravel. Passable material exists in almost every locality and since maintenance is chiefly the continual addition of new material economy of maintenance must be in handling and hauling methods. Motor trucks have been used very largely in Bexar County, Texas, and with economical results. On the other hand experience in Valencia County, New Mexico, with a motor truck has not been entirely satisfactory. When used in uninhabited country far from the base of supplies and from repair shops, or when the roads are soft or inches deep with dust, they have proved anything but satisfactory. In many parts of Arizona and New Mexico native, or rather Mexican, teams and teamsters may be employed for very low rates, at so much per cubic yard per mile hauled, so that motor trucks cannot compete on the basis of economy unless they are in service nearly all the time.

Notwithstanding that most of the roads described are in desert country a great deal of attention has to be paid to drainage. When rains do occur they are generally torrential in character and water courses normally dry



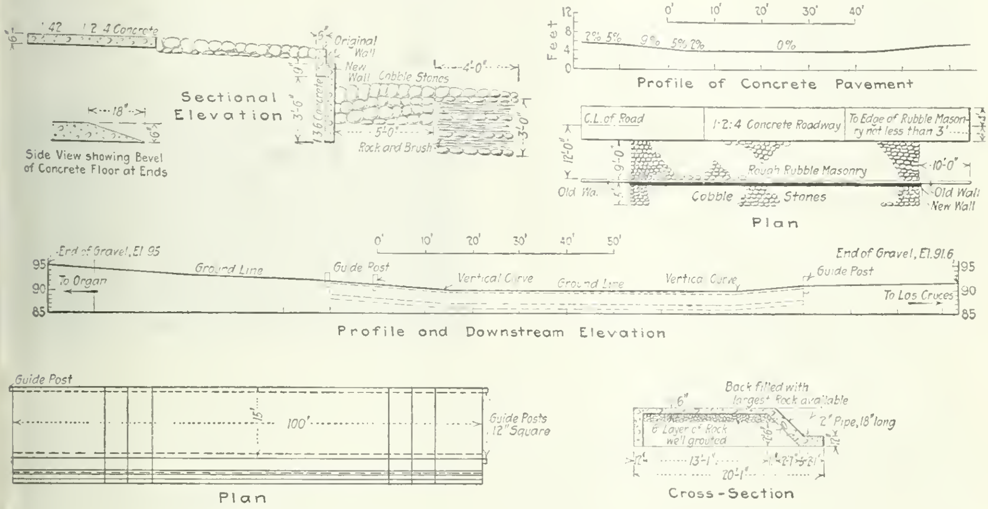


FIG. 8. DETAILS OF THREE ARROYO CROSSINGS ON DESERT ROADS

come small-sized rivers for short periods of time. idges and culverts of a permanent type are something a luxury. In many sections the hauling costs on nent and steel are prohibitive. Culverts on much w construction are of the galvanized, corrugated-iron e type even in sizes up to six or more feet in diameter. Highway structures peculiar to the arid West are paved tions of road across dry washes or arroyos, which are rflowed in times of flood. They take the places of very ge culverts or bridges which would perhaps be in serv- but a few days each year. These overflow sections road are known by various names: weirs, spillways, de crossings (of arroyos) and fords. They are not lly fords since they are dry the greater part of the r.

Arroyo or Dry Crossings

hese arroyo crossings vary all the way from dished tons of road, unpaved and but a few feet across, to borately paved and protected sections of road over ft. long, as shown in Fig. 8. It is very necessary to ect both the upstream and downstream sides of the flow section from scour, for the adobe soil through h many of these roads are built erodes very rapidly n flowing water. Fig. 7 shows what happened to an roperly protected upstream end of a 18-in. pipe culvert in Pima County, Arizona, and shows why arroyo crossings must be paved with so much care.

One of the most elaborate of these arroyo crossings is in El Paso County, Colorado, where the county engineer, C. O. Ford, has built a reinforced-concrete slab 250 to 300 ft. long supported on concrete pile bents 16 ft. center to center. All this except the top of the slab is underground. The object of course is to provide a roadway even if the slab is badly undermined by floods. Other Western highway engineers, however, express doubt as to the economy of thus providing against an emergency. Guard-rails on embankments or even at culvert crossings are practically an unknown luxury throughout the greater part of the far West. The absence of guard-rails and frequent dips in the roadbed at arroyo crossings tend to bring about more cautious and less speedy driving of automobiles than is customary in the East. In fact one advantage claimed for the arroyo crossings described is that an automobile driver must slow up in passing one, and that thus enforcing moderate speed helps materially to prevent the destruction of the gravel road, which is extremely rapid under high-speed automobile traffic.

⁂

The American Fuel-Briquet Industry in 1915 produced 221,537 tons of briquets, valued at $1,035,700, according to a recent report by C. E. Lesher, of the United States Geological Survey. The figure was exceeded, however, in 1914. Most of the mechanical difficulties of manufacture have been solved in this country, and the future growth of the industry now depends upon the development of markets for the product. The producing plants are, however, so widely distributed and the total production is so small compared with that of other kinds of fuel that the conditions affecting the market for the output of each plant are more or less local and peculiar. There were 15 briquetting plants in operation in the United States in 1915, one less than in 1914. One new plant in California reported an output in 1915, and two plants—one in New Jersey, and one in New York—ceased operations. The greatest increase in output was made on the Pacific Coast, the Central States recording little change and the Eastern States a large decline in output.

Effect of Sewer Gas on Concrete in a Chicago Sewer

A new sewer now under construction by the Sanitary District of Chicago in the stockyards district is novel for that locality in that it has a brick arch on a tile-lined reinforced-concrete invert. In deciding upon this type of design the authorities were influenced partly by a condition of deterioration in the concrete of the arch of a neighboring sewer. The condition of the concrete sewer and the selection, after some controversy, of the brick-arch design for the new work have had considerable local publicity, and in order to spread the case before the profession in general, *Engineering News* presents the situation in two ways: First, a report on the condition of the existing concrete sewer, by Benjamin Brooks, of the staff of the International Clay Products Bureau, who made an investigation of that structure and its surroundings and testified as to that investigation before the trustees of the Sanitary District; second, a general description of the new sewer and a personal interpretation of the conditions in the existing sewer by a member of the editorial staff of this journal. Editorial comment appears on another page.

Sewer Gas Affects Concrete Above Water Line

By Benjamin Brooks*

Disintegration of concrete in a large sewer in Chicago offers points of interest both to chemical engineers and to sanitary engineers. The sewer is in Western Ave., is about 12 ft. in diameter, of the comparatively massive monolithic type, and was built about seven years ago.

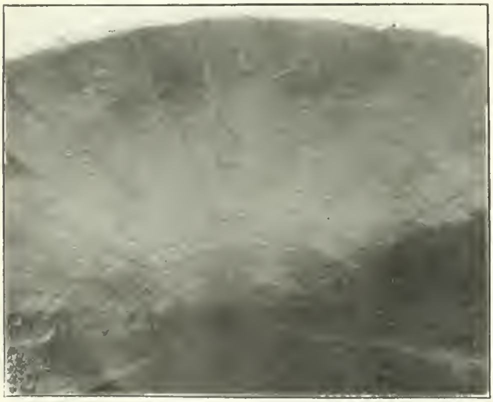


FIG. 1. CONCRETE ARCH OUTSIDE OF AFFECTED ZONE

The concrete is composed of portland cement, sand and gravel. The section where the destruction has been particularly noticed and studied is a stretch of about 500 ft. extending from the mouth of the sewer on the Drainage Canal.

The concrete immediately about the mouth of the sewer is hard and dense. At 15 ft. from the mouth the roof begins to show patches of whitish crumbly crust easily rubbed off by the hands, but the concrete beneath this crust is perfectly sound. Proceeding into the sewer, this incrustation rapidly assumes the character of a disintegration of the concrete, but is apparently only down to the water line. First, it appears like fine, moist gray moss about ½-in. long, which under a pocket magnifying glass shows a distinctly crystalline structure. Farther on, this crystalline structure gives way to a surface of loose gravel held in a wet muddy matrix like half-set plaster of paris, pieces falling at the slightest touch. All these changes occur within about 100 ft. of the sewer mouth. At the same time the concrete in this same part of the sewer, but *below* the normal water line, is smooth and hard, as far as could be determined by pounding it with hammers and scraping it with bars.

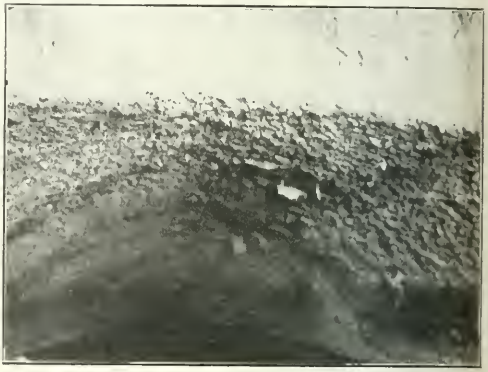


FIG. 2. DISINTEGRATED SURFACE OF CONCRETE ARCH AND BOTTOM OF VENTILATING MANHOLE

The flat, loose patches here are probably scraps of the tar paper that lined the forms

Analyses by the Kansas City Testing Laboratory of the sound concrete and the disintegrated concrete from the tunnel roof are given in the accompanying table.

ANALYSES OF CONCRETE IN WESTERN AVE. SEWER AT CHICAGO

Sample	Sound Concrete, %	Decomposing Concrete, %
Moisture	2.13	4.12
Loss on ignition	19.81	20.21
Silica (SiO_2)	36.38	30.75
Iron (Fe_2O_3)	3.53	1.32
Alumina (Al_2O_3)	9.04	6.10
Lime (CaO)	23.36	17.30
Magnesia (MgO)	3.38	3.49
Sulphur (SO_3)	2.37	16.62
	100.00	100.21
Water soluble	5.12	28.96

Sulphur (SO_3)

In sound concrete	2.37
In decomposing concrete	16.62
In 200-mesh material from decomposing concrete	46.30
In ¼-in. material from decomposing concrete	11.44

The first noticeable feature of this comparison is that the concrete, from some source or other, has absorbed about six times its original content of SO_3. This original 2.37% of SO_3 is not abnormal when it is remembered that the "sound" concrete was not entirely free from the whitish crust, a quantity of which was knocked down by heads and shoulders, working in the limited space available, and mixed with the sample. The moisture and organic matter have naturally increased. The percentage of other items has naturally decreased proportionately, owing to the large increase in SO_3. Some of the lime, being changed into soluble sulphate, has evidently washed away. Different theories as to the cause of this condition may be outlined as follows:

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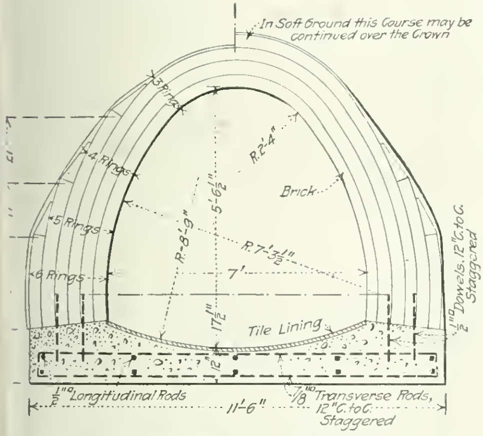
*Engineer, International Clay Products Bureau, 204 New York Life Building, Kansas City, Mo.

Since the city had some difficulty with the contractor who built this sewer, the first explanation of the disintegration of concrete was poor workmanship in the beginning. But no error of this kind would make *all* of the lower three-quarters of a concrete tube good and *all* of the upper one-quarter bad. The disintegration, once started at the point described, is very uniform and complete, not blotchy as in the case of uneven mixtures.

Another theory advanced is that the sewage is unusual n character on account of some acid factory tributary[1] it; but it must be evident that by the time a sewer omes 10 or 12 ft. in diameter its proportionate length ures that it takes sewage from wide areas of various racter. As a matter of fact, chemical analysis of the age shows it to be slightly alkaline—only 350 parts million, expressed in terms of calcium carbonate.


In Soft Ground this Course may be continued over the Crown
3 Rings
4 Rings
5 Rings
6 Rings
R. 2'-4"
Brick
5'-6½"
R.-8'-9"
R. 7'-3½"
7'
17½"
Tile Lining
12"
½"⌀ Dowels, 12" C. to C. Staggered
½"⌀ Longitudinal Rods
⅞"⌀ Transverse Rods, 12" C. to C. Staggered
11'-6"

3. SEMI-ELLIPTICAL BRICK SEWER ON CONCRETE BASE FOR STOCKYARDS INTERCEPTOR, CHICAGO

theory advanced by Mariner & Hoskins, chemists, Chicago, is that some soluble substance in the soil rounding the sewer leaches through it, concentrates evaporation on the inner surface and destroys the crete. Soil samples taken from excavations for the ventilators were submitted to this firm for analysis were found to contain about 0.1% sulphates of magium and calcium. This possibly is enough alkali to ct the concrete if concentrated by evaporation and ld explain most features of the case; but it does not unt for the circumstances that, in the part of the r lying under street pavements properly drained by usual catchbasins and vitrified pipe to the sewer and re the opportunity for evaporation is small, the disintegration is much farther advanced than in that part of the sewer running under the power-plant lawns, where the rain would be more apt to seep through the concrete and where the fresh air has more access to the sewer for evaporation.

The solution of this disintegration of concrete can evidently be found by discovering the source and chemical progress of the excessive amount of sulphur. The most obvious and prolific source of sulphur in connection with a sewer is the hydrogen sulphide which is evolved naturally from sewage during decomposition. The sulphurous gas is oxidized by the air so as to form sulphuric acid, which immediately attacks the lime in the cement and converts it into soluble calcium sulphate. This sulphate, being of larger volume than the original lime, disrupts the concrete in forming, just as alkali crystals or repeated freezings sometimes do. Then it gradually dissolves away, leaving the aggregate to fall out.

A sample of the atmosphere taken just under the sewer arch and about 150 ft. from the mouth showed 2.45 mg. of sulphur per liter of air. This is equivalent to 0.17% by volume in the form of sulphur dioxide or hydrogen sulphide. One part in a million of hydrogen sulphide is enough to be plainly evident to the senses, and 0.17% is sufficient to be very active chemically. In the form of sulphur dioxide it might be even more corrosive.

New and Old Sewers Taking Stockyard Sewage

[STAFF ARTICLE]

The stockyards intercepting sewer now being built by the Sanitary District of Chicago has a brick arch on a reinforced-concrete base forming the invert, although most of the numerous intercepting sewers built by the District are of concrete throughout (either plain or reinforced).

This new sewer extends along the south bank of the Bubbly Creek arm of the Chicago River from Ashland Ave. west to the Western Ave. sewer, a distance of about ½ mi. Its east end is a connection with the Ashland Ave. sewer, though an extension 1 mi. east to Halsted St. is projected, and it will also connect with the Robey St. sewer, besides carrying packing-house wastes from the stockyards district. The sewer will supersede the foul and practically stagnant open channel of Bubbly Creek, which is really a huge septic tank. This part of the creek is now being filled.

The sewer is of semi-elliptical section, as shown in the accompanying drawing, and is in two sizes: 9x9 ft. (for 770 ft.) and 7x7 ft. (for 2,675 ft.). These sections have four and three brick rings in the crown, an additional ring being added if necessary in soft ground. The base is a reinforced-concrete slab, the sides of which form the footings for the arch, while the middle portion of the top is concave to form the invert. This invert will be lined with 1-in. vitrified tile blocks 11¾x24 in. (laid in cement mortar) in order to form a smooth floor and to protect the concrete.

Alternative designs were prepared for all reinforced-concrete and combined brick and concrete construction. The sewage to be carried is exceptionally strong in organic matter, but is fairly fresh. To avoid any possibility of gases from this attacking and causing disintegration of concrete, the engineers proposed a complete tile lining for the reinforced concrete, the tiles for the sides and arch to have dovetailed ribs keying them to the concrete. The lowest bids for these designs (all by the same bidder) were $91,377 for the reinforced-concrete design with tile lining on the invert, $100,619 for this design with complete tile lining, and $104,054 for the brick and concrete design with tile lining on the invert. The engineers suggested the use of concrete, with a complete tile lining, as an insurance worth the additional cost. The trustees of the Sanitary District, however, adopted the brick and concrete design, partly in view of the fact that brick is made and laid by Chicago manufacturers and union labor, while the difference in cost was small.

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[1] he Drainage District engineers state that they never heard of any acid factory in the drainage area of the r nor of any theory ascribing the deterioration of the rete to that cause.—Editor.

In the public hearings as to the desirability of using concrete or brick, stress was laid upon the condition of concrete in the Western Ave. sewer, which at present forms the west outlet from Bubbly Creek to the main channel of the south branch of the river. This carries sewage of a very different character from that which the new sewer will carry, the former being highly septic and being in fact the effluent from what might be called the largest septic tank in the world, receiving over half the entire waste from the packing-house district.

The period of detention in Bubbly Creek is probably from 36 to 48 hr., so that the sewage on reaching the existing conduit is full of hydrogen sulphide. The sewage is therefore most unusual in character and is unique in Chicago, if not in the United States. Inspection shows that action on the concrete has been entirely above the water line. Owing to hydraulic conditions, the flow through this sewer has been more variable than was anticipated, and consequently some deposits have occurred which in turn have produced hydrogen sulphide. The action appears to be largely on the roof, or under side of the arch.

The Western Ave. sewer is of elliptical section, 12 ft. wide and 16 ft. high, with concrete 12 in. thick in the sides and crown. There is no reinforcement, except for about 660 ft., where it passes under private property. This sewer was built in 1909. On 900-ft. of the outfall the surface of the concrete is now largely covered with efflorescence, and there are occasional hollow pockets in the concrete as well as patches where the aggregate is exposed. Some of these places are due apparently to poor workmanship, the aggregate having been left against the form without the proper amount of mortar.

In other patches, however, the concrete is soft and disintegrated, showing high sulphates. This condition is claimed to be due to the action of the sulphuric acid in the gases, causing an efflorescence that expands and gradually scales off the surface, exposing the fresh material to attack. Other parts of the surface still show the original form marks and cement skin, and patches of the tar paper that covered the forms. The disintegration is most marked where ventilation was lacking and does not occur near the inlet and outlet. As originally built, there were no manholes, but these have been provided within the past three months in order to afford ventilation and relieve the foul conditions at the middle of the sewer.

Combination of Plane Table and Transit for Topography

By Holbert T. Johnson*

SYNOPSIS—Use in combination of plane table for plotting in the field and a transit for traversing and stadia work. Analysis to show labor saving in combination.

For ordinary topographic surveys either the transit or the plane table is the instrument usually selected. There has been a good deal of discussion as to which is the best instrument, and it is not the purpose of this article to add to that discussion; for it is apparent to anyone who has used both instruments that each has its share of faults and virtues, and that in general the advantage which one has the other lacks. In an endeavor to combine the good points and eliminate the faults the writer has developed a new method in which both instruments are used in combination. It is not applicable to all topographic work, but under the conditions usually met with, it is believed that it will be found faster, cheaper and more accurate than any of the ordinary methods.

Instruments and Party Required

The instruments used for the combination method are a light transit with a sensitive telescope bubble and a full vertical circle with vernier reading to minutes, a 24x30-in. plane table and a plane-table alidade with striding level and a compass needle.

A flat scale used for plotting distances on the plane-table sheet is notched slightly at the zero mark and a small rubber loop, just long enough to stretch to the notch, is attached to the scale about ¼ in. from its edge. When a pin is stuck through the loop into the board, the scale can be revolved in any direction and the zero point will be held at the pin. The scale is also provided with two sights parallel to its graduated edge. Two pins can be used for these but folding sights are preferable. (See Fig. 2.)

A recommended type of stadia rod is a ¾-in. soft pine board, 11 ft. long, 3½ in. wide at the bottom and 2½ in. at the top. The divisions are as shown in the accompanying sketch, Fig. 1. As there are no figures on the rod it takes some little time for a beginner to read it rapidly, but after getting accustomed to it I have never seen an instrumentman who would use any other. When the heat waves are bad, this rod can be read at distances where the ordinary stadia rod markings would be indistinguishable.

The party for the combination method will usually consist of three rodmen, a transitman and the topographer. If the shots are taken oftener than every 200 ft. two rodmen will be sufficient. If the land requires many vertical angle shots a recorder should be added to the party.

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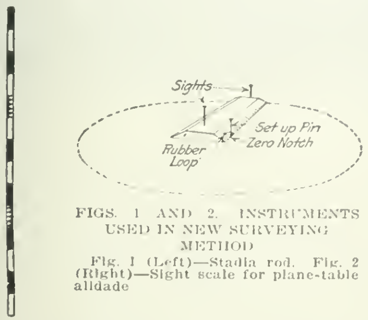
*Assistant Engineer, United States Indian Irrigation Service, in charge of Pyramid Lake Indian Reservation, Nixon, Nev.

TABLE SHOWING OPERATIONS OF TWO MEN AT THE INSTRUMENT IN TAKING A SIDE-SHOT

	Transit Method		Plane-Table Method		Combination Method	
	Transitman (telescope level)	Recorder	Topographer	Recorder	Transitman (telescope level)	Topographer
Ordinary shot in flat country. Rod cut by upper, lower or middle wire	1. Sights on rod 2. Reads rod aloud 3. Turns tangent screw till distance can be read 4. Reads distance aloud 5. Moves tangent screw till wire cuts rod at original reading (this leaves telescope level for next shot) 6. Signals rodman "all right' 7. Reads azimuth aloud 8. Calls special features	1. Records rod 2. Records distance 3. Computes elevation 4. Records azimuth 5. Records features and makes sketches	1. Sights on rod, keeping ruler edge of alidade against setup needle 2. Levels up telescope bubble 3. Reads rod aloud 4. Moves tangent screw till distance can be read 5. Reads distance aloud 6. Signals rodman "all right" 7 Draws line along alidade edge 8 Moves alidade 9. Sets zero of scale at setup needle and plots distance 10. Records elevation on the map 11. Draws in contours and special features	1. Records rod 2. Records distance 3. Computes elevation 4. Calls elevation	1. Sights on rod 2. Reads rod 3. Turns tangent screw until distance can be read 4. Reads distance aloud 5. Turns tangent screw until wire cuts rod at former rod reading (leaving telescope level) 6. Records distance 7 Records rod reading 8. Figures elevation calling it aloud	1. Sights on rod with scale 2. Plots distance 3. Signals rodman "all right" 4 Records elevation on map 5. Draws in contours and special features
Vertical Angle shot	1. Sights on rod 2. Turns tangent screw till distance can be read 3. Reads distance aloud 4. Sights middle wire on rod reading used for obtaining the vertical angle 5. Signals rodman "all right" 6. Reads azimuth aloud 7. Reads vertical angle aloud 8. Calls special features	1. Records distance 2. Records azimuth 3. Records vertical angle 4. Records special features and makes sketches 5. Computes difference of elevation 6. Computes elevation	1. Sights on rod, keeping ruler edge of alidade against setup needle 2. Turns tangent screw until distance can be read 3. Reads distance 4. Sights middle wire on rod reading used for obtaining the vertical angle 5. Signals rodman "all right" 6. Reads angle A on vertical circle of alidade aloud 7. Levels up telescope 8. Reads angle B on vertical circle of alidade 9. Draws line along alidade edge 10. Moves alidade 11. Sets zero of scale at needle and plots distance 12. Records elevation on the map 13. Draws in contours and special features	1. Records distance 2. Records angle A 3. Records angle B 4. Computes vertical angle difference of A and B 5. Computes difference of elevation 6. Records difference of elevation 7. Computes and calls elevation	1. Sights on rod 2. Turns tangent screw until distance can be read 3. Reads distance aloud 4 Sights middle wire on rod reading used for vertical angle 5. Records distance 6. Reads vertical angle aloud 7. Records vertical angle 8. Records difference of elevation 9. Figures elevation calling it	1. Sights on rod with scale 2. Plots distance 3. Signals rodman "all right" 4. Figures difference of elevation calling it aloud 5. Records elevation on map 6. Draws in contours and special features

The field procedure is as follows: Set up, level and orient the plane table, using the alidade. The elevation of the plane table H.I. is then obtained by a reading on a turn or benchmark, and the alidade removed from the board. A pin is stuck at the point on the map representng the station occupied and the sight scale pivoted to it. The transit is set up about 5 ft. from the plane table and its H.I. obtained by another reading on the turn or benchmark. This elevation is checked with the plane able H.I. by measuring the difference in the elevation of he instruments.

When a rodman holds up his rod the transitman takes he rod reading and notes the distance, calling the distance oud; the topographer sights on the rod with the scale, gnals the rodman "all right" and plots the point at the oper distance on the graduated edge of the scale. By this time the transitman has computed the elevation, and he calls it out, whereupon the topographer marks it on the plotted point. A good plan is to record the even feet to the left and the tenths to the right of the point so that besides showing the location of the shot it will also serve as a decimal point for the figures.



FIGS. 1 AND 2. INSTRUMENTS USED IN NEW SURVEYING METHOD

Fig. 1 (Left)—Stadia rod. Fig. 2 (Right)—Sight scale for plane-table alidade

The transitman records the rod readings, distances and elevations, and the topographer sketches in the contours and special features as fast as the shots are taken. As the directions are all obtained with the sight scale no horizontal angles are read on the transit.

The turns are taken as in plane-table work, the alidade again being used to level and orient the board and to check the turn elevations and distances obtained with the transit. This checking saves much time and labor as many errors are picked up which would otherwise be carried to the side-shots following. Checks for elevation and location should be made about every mile. In this distance the error in levels should not exceed 0.2 ft. and the error of closure of the plane-table traverse about 1 in 300. The fact that the transit is not coincident with the plane table introduces a slight error, but where scales of 1 in. = 200 ft. or more are used this is negligible.

Comparison of Transit and Plane-Table Methods

To show the distribution of labor and the comparative field speeds of the three methods the accompanying table analyzing the operations necessary for each side-shot has been arranged. It will be seen from this that the transit and the combination methods are just about equal in field speed, and that both are far ahead of the plane-table method.

In the office the transit topographer does not have such plain sailing. In rough country, unless the shots have been well chosen and close together, it is often necessary to send a man again into the field to sketch in contours at doubtful places.

The office work for the plane-table and the combination methods consists merely in checking and inking the elevations and tracing the topography. In steep country the topographer does not always have time to draw in all of the contours, but there will be enough so that the rest can be accurately located. The field sheets made by the combination method are much cleaner than the regular plane-table sheets, as the substitution of the sight scale does away with the brassy smear from the bottom of the alidade.

The elevations obtained with the transit are usually more accurate than those taken with the alidade, because its bubbles are more sensitive. The use of both instruments combines this advantage with that of field sketching. In this regard it is even better than the plane table, as the topographer has more time to watch the country and to do his sketching.

With the plane-table or combination method it is often possible to pick up errors on side-shots which would pass unnoticed in transit work. Errors on turns which are often a source of trouble in plane-table work are practically eliminated by the use of the two instruments.

In windy weather the combination method is much superior to the plane table, as the transit is less sensitive to the wind. I have seen a plane table vibrate so in a wind that the alidade would "walk" clear across it, while a transit alongside was hardly affected at all.

TOPOGRAPHIC SURVEY OF DUCK VALLEY PROJECT

During the season of 1915, while investigating an irrigation project for the Duck Valley Indian Reservation in northern Nevada, the writer made a survey of a large tract of the irrigable lands by the method described above. A 2-ft. contour interval and a scale of 500 ft. = 1 in. were decided upon for the topography, which was to be used for designing the entire canal and lateral system. The United States Land Office had made an accurate resurvey of all the land on the reservation in 1911 and 1912, and this was used as a basis for all topographic work.

A system of benchmark levels for the topographic control was run in from a United States Geological Survey benchmark on one side of the tract. A 25-mi. primary circuit was run and secondary circuits closed on this until elevations had been established at all of the quarter-section and section corners on the north and south section lines. There were in all about 105 mi. of these levels run. All the circuits closed well within the limits of the formula: Allowable error in feet = 0.05 $\sqrt{\text{dist. in mi.}}$ The best day's record for this work was $11\frac{1}{4}$ mi. in $7\frac{1}{2}$ hr. The last 6 mi. was in very level country and was run in just three hours. The total distance walked on this day was 17 mi. The party consisted of a level man, two rodmen and a man to hunt corners.

Fieldwork on the topographic survey was started about the middle of April and finished early in August. The survey covered in all 17,500 acres, most of which is in rolling country. The land was covered with sagebrush about 3 ft. high, which interfered very little with the work. A large part of the area was over two hours' drive from the nearest camping place, so that considerable time was lost in traveling.

The average day's run was about 650 acres with 500 side-shots. On one day when the air was exceptionally clear and the country very level, we used three men on horseback for rodmen and took 500 side-shots and 2,200 acres of topography in seven hours' working time. Most of the country was so rough, however, that the shots could not be taken more than 250 ft. apart.

The salaries paid on this work were as follows:

	Per Month		Per Month
Topographer	$150	Rodman	$75
Transitman	90	Teamster	65
Head rodman	90	Cook	75

Subsistence amounted to 50c. a day and was paid for by each man.

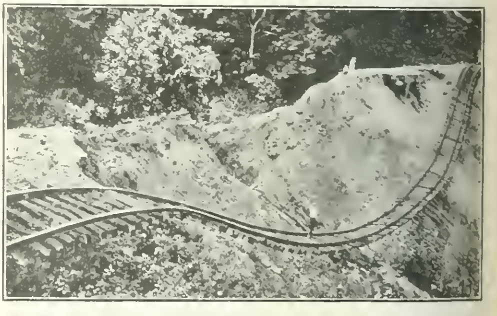
The total cost of the survey including supplies, camp expense, control levels, fieldwork and the completed tracings was $2,460, and the total number of side-shots taken was 33,000. This gives a unit cost of 5.2c. per acre and an average of 0.7 shots per acre.

The cost of topography of similar accuracy, taken with the plane-table or the transit method usually amounts to at least 8c. an acre, so that the combination method has a decided advantage in this respect over either of them.

*

Rail Joints Subjected to a Severe Test

The accompanying view shows one of the extensive washouts that occurred along the line of the Southern Ry. at the time of the heavy floods near Asheville, N. C., in July. As shown in the photograph, when the earth embankment was washed away the track was left suspended, was moved downstream some distance from its original position and was left hanging from the embankments on either side when the floods subsided, the total length of the hanging track being over 250 ft. As seen in the photograph, nearly all the ties remained attached to the rails.



WASHOUT ON THE SOUTHERN RY., 21 MI. EAST OF ASHEVILLE, N. C., ON THE BLUE RIDGE DIVIDE

This long "suspension bridge" is a graphic testimonial of excellent work in track maintenance at the point where the washout occurred and demonstrates the remarkable strength of modern rail joints and track bolts. We are indebted for the photograph to the courtesy of F. A. Weakley, of the United States Engineer Office at Nashville, Tenn.

Granite-Block Pavement for a Residential Street

An innovation in the paving practice of the Borough of Brooklyn, New York City, has been introduced in the use of a 4-in. grouted granite-block pavement on a section of Bedford Ave., which is here a strictly residential street of good-class apartment houses, although a much used through route. This is the first pavement of 4-in. granite block to be laid in Greater New York other than the few hundred yards of experimental pavement on Second Ave., Manhattan, and the specifications contain a number of interesting features.

The specified dimensions of the blocks are: Not less than 7 nor more than 11 in. long, not less than $3\frac{3}{4}$ nor more than $4\frac{1}{4}$ in. wide, and not less than $3\frac{3}{4}$ nor more than $4\frac{1}{4}$ in. deep. They are so dressed as to be laid with $\frac{3}{8}$-in. joints. The concrete base is of 1:3:5 mix, 6 in. thick, and on this is spread a $\frac{3}{4}$-in. bed of clean, coarse, dry sand mixed with portland cement in proportions of one part cement to four of sand. After the blocks are laid and rammed, they are sprinkled with clean water and the joints then filled with 1:1 grout, which is broomed into the joints. The operation is continued until the joints will take no more grout and are filled flush with the tops of the blocks.

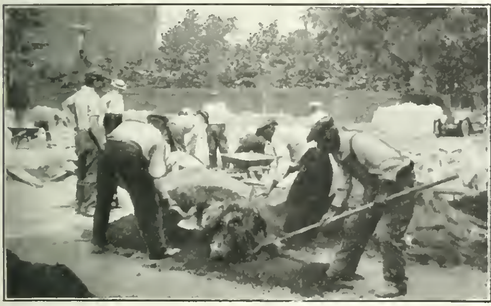


FIG. 1. MIXING DRY SAND AND CEMENT FOR ¾-IN. BEDDING COURSE

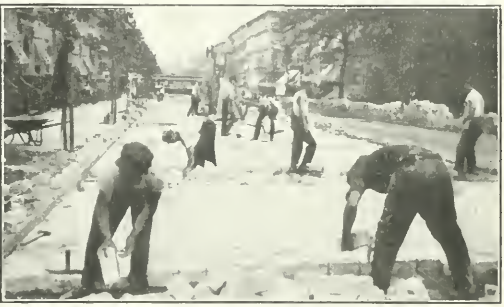


FIG. 2. LAYING 4-IN. GRANITE-BLOCK PAVEMENT ON BEDFORD AVE., BROOKLYN

Another significant feature of the specifications is that which requires the contractor to complete the pavement on one-half of the street and allow time for this completed half to be opened to traffic before beginning work on the other half. This requirement is necessary, as Bedford Ave. is a connecting link between important parts f the borough and there is no parallel street to which to ivert traffic. The monolithic character of the pavement s not lessened by this method of construction, because f the care taken to dovetail the two halves of the pavement together and because the thin mortar bed ($\frac{3}{4}$ in.) revents any appreciable difference in the setting of the locks on either side of the center line. Some of the more important contract specifications are given in full:

The granite paving blocks shall be of fine-grained granite howing an even distribution of constituent minerals, of uniorm quality and texture, without seams, scales or disintecration, free from an excess of mica or feldspar. The granite hall have a toughness of not less than 9 and a French coeflient of wear of not less than 11, as determined by the method mployed by the United States Office of Public Roads and ural Engineering.

The blocks shall be laid not more than 25 ft. in advance the ramming; no blocks or other material must be thrown or deposited in such manner as to displace the blocks on the face of the work, and no carting will be permitted over the surface of any unfinished portion of the pavement.

The grout shall be mixed in a machine mixer, approved by the engineer. The character of the mixer shall be such that the mixing of the grout shall be continued until the instant that it is poured into the joints.

The filling of the joints shall be carried forward until an advance area of 15 or 20 yd. has been grouted, when the same force and appliances shall be used to regrout the same space in a like manner.

The work shall be kept lightly sprinkled with water ahead of the sweepers, to avoid the possibility of the grout becoming too thick at any point.

To insure penetration of the grout into the joints of the pavement a squeegee 15 or 18 in. in length, in addition to the brooms, shall be used upon the last application of the grout.

After the grout between the joints has fully subsided and the initial set is taking place, the whole surface shall be lightly sprinkled with water and the surplus grout left on top shall be swept off.

After the grouting is completed and a sufficient time for hardening has elapsed, so that a coating of sand will not absorb moisture from the cement mixture, ½ in. of sand shall be spread over the whole surface.

Should the bond between the blocks become broken before the work is accepted, the joints shall be cleaned out, even if it is necessary to take up and relay the blocks, and such defective work shall be regrouted and relaid.

Before letting this contract the chief engineer of the Bureau of Highways of the Borough of Brooklyn, H. H. Schmidt, called the contractors before him and distinctly stated that specifications would be strictly enforced to the letter, for the pavement is in the nature of an experimental one and its adaptation to conditions will be closely watched. The contract price was $1.30 per sq.yd.

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The Foreign Trade of the United States for the year ending June 30, 1916, exceeded 6½ billion dollars. This is far in excess of the foreign trade ever recorded by any other nation. It was not until the year 1913 that the total foreign trade of the United States exceeded four billion dollars. The most noteworthy feature of the year's trade, of course, is the enormous excess of exports over imports. The total exports from the United States were $1,345,000,000 and the imports were $2,180,000,000. Thus in a single year there was a balance of trade in favor of the United States of $2,165,000,000. Under normal conditions, international trade balances are settled by the transfer of gold, but if European countries, exports to whom produced this enormous debt to the United States, were to transmit gold to the United States in payment of this balance, their entire stock of gold would hardly cover a couple of years' business. The entire amount of gold held by the great government banks of Europe was estimated not long ago to be less than $1,000,000,000. It is out of the question, therefore, for Europe to pay its trade balance to the United States in gold for any considerable length of time. Europe's debt to the United States for this huge volume of exports has been settled by the transfer of a small quantity of gold, by the floating in the United States of foreign loans and by the issue of notes against American securities held abroad.

Timber and Gravel Coffer-Dams on the Troy Dam

By D. A. Watt[*]

SYNOPSIS—The dam across the Hudson River at Troy, N. Y., required a number of coffer-dams in order to lay dry successive sections of the river and to permit free flow and sectional construction. This article describes the timber box coffer-dams and the gravel fills built in front of the old dam just prior to removing it. A later article will be devoted to the sheetpile cylinder coffer-dams built around the lock site and around a part of the main dam.

The lock and dam at Troy, N. Y., built in 1913-15 by the United States with hired labor forces, forms the connection between the New York State Barge Canal and tidewater in the Hudson River. The new works were built to replace an existing timber dam and a lock of small dimensions, situated about a quarter of a mile downstream, and the channel improvement required as the last feature the removal of this dam, which was about 1,100 ft. in length. The construction thus had to be carried on in the pool water of the dam, which could not be dispensed with until the last moment, owing to the large and steady traffic passing into and out of the connecting state canals. All masonry is of concrete, founded on Hudson River shale. Fig. 1 shows the general plan of the structures and the location of the coffer-dams required to lay dry the construction areas. The lock, with a width of 45 ft., a length of main walls of about 624 ft. and a depth of 16 ft., on miter sills is on the Troy side of the river and is tied into the concrete gravity dam, varying from 17 to 50 ft. high, which extends across the river on the broken line shown. Its total length is about 1,291 ft.

The considerable depths of water in which the coffer-dams had to be constructed, varying from 10 to 27 ft. at low water, the exposure to floods and heavy drift ice and the limited time in which the whole work had to be completed enforced the adoption of some special expedients in design and construction. In all, eight different coffer-dams were employed, two being of timber framing, three of steel piling and the remainder banks of gravel and sand from the river bed. The natural conditions of low banks and flood ranges prescribed that these structures need not rise above the pool level more than 8 or 9 ft.; that where they were to remain over winter in any exposed position they must be of a type to withstand the attacks of floods and the battering of running ice; and that they must not occupy much of the river for any length of time, lest they aggravate flood conditions in the thickly settled neighborhood above.

Fig. 1 shows the numbers corresponding with the sequence in which the various coffer-dams were completed. No. 1, around the west end of the dam, and No. 3, inclosing the west section of the dam, are of the wood-frame box type; Nos. 6, 7 and 8, in front of the old dam and used to lay dry that structure prior to its destruction, are of gravel and sand fill. These five cofferdams will be described in this article. The remaining three dams, Nos.

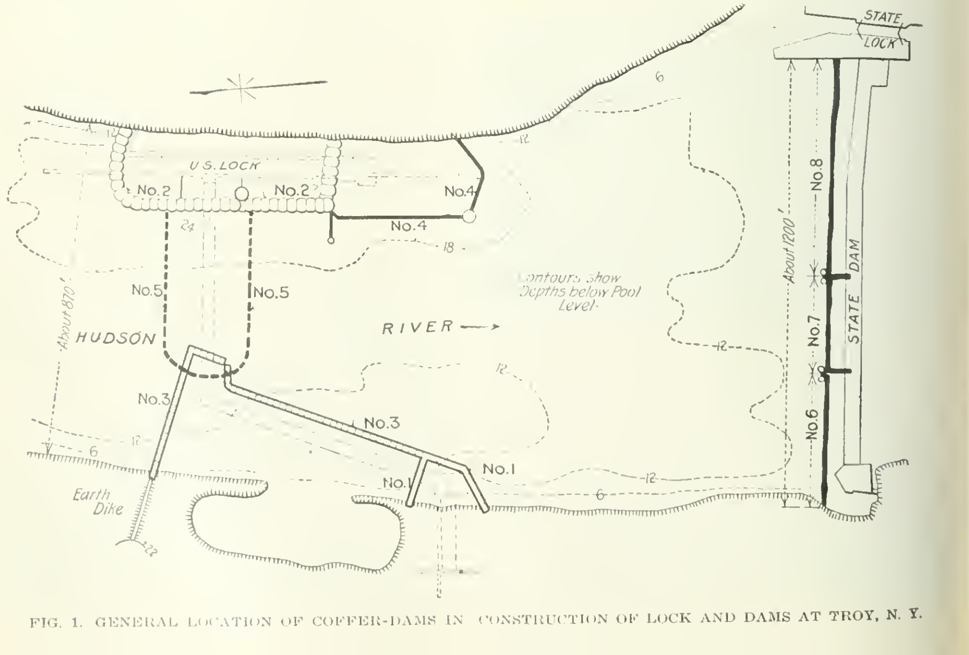

FIG. 1. GENERAL LOCATION OF COFFER-DAMS IN CONSTRUCTION OF LOCK AND DAMS AT TROY, N. Y.

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[*] Principal Assistant Engineer, United States Engineer Office, Albany, N. Y.

2, 4 and 5, around the lock and the east part of the dam, are of sheetpiling of varying design, and their description will be reserved for a later article.

Main Timber Coffer-Dams

The first of the timber coffers is that shown in Fig. 1 as No. 1, inclosing the site for the bulkhead on the west bank, the general design being modeled on one that had been successfully used elsewhere. It was a timber structure of the box or wale-and-sheeting type, about 400 ft. ong on the center line, and of cross-section as shown in ig. 2.

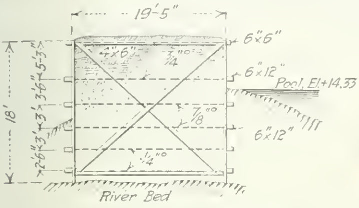


FIG. 2. SECTION THROUGH BULKHEAD COFFER-DAM (NO. 1)

The other wooden coffer, No. 3, inclosed the west arm f the dam. The first lock coffer-dam was at that time locking up more than a third of the river's cross-section, nd it was therefore desirable to block up as little more possible during the season of high water. It was deded to begin the new coffer-dam as soon as the spring ods had gone, making it of a type that could be quickly nstructed, and then to build the masonry in the inosure as fast as possible and remove the coffer-dam fore the fall and winter floods set in. The box type, used for the bulkhead, was chosen as being simple d inexpensive, and the design was modified to suit the pth of water, which ran from about 11 to 17 ft. at low ter (Fig. 3). The distance from the masonry was de such that concrete could be delivered by the floatg mixers to towers and be spouted into the forms, reiring a rehandling only for the tops of the sections.

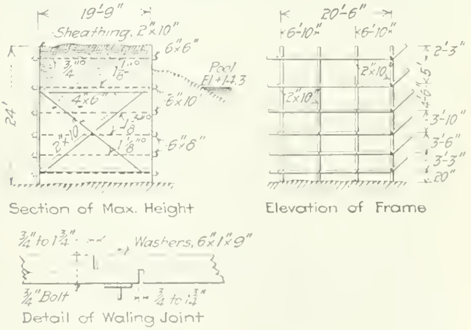
Building Timber Coffer-Dam from Barge

As the length of the structure was to be about 1,040 ft. ne plan of construction had to be devised more speedy n the usual one of setting the walings one by one by lerrick boat. The method adopted consisted in laying izontally and loosely the two separate sets of walings a 20½-ft. section on two corresponding frames or dles lying opposite each other on the deck of the workbarge. Each cradle was provided with projecting s bolted on at distances corresponding to the spacing he walings and supporting the latter when the cradles e set up. The feet of the cradles were lashed to the k of the barge by slack loops of wire line, and when was ready the first cradle was hoisted to the vertical the outer end and guyed in position. The opposite lle was next hoisted; tie-rods and spreaders were ated, and connection was made to the preceding section; new-made crib was then lifted slightly, allowing the les to clear and be lowered again to the deck of the e. The fleet was then warped along until the new had slid into proper position over the side of the e, and the operation of attaching another section was m.

The maximum lift for the derrick boat in this movement was about 5 tons. The process is illustrated by Figs. 4, 5 and 6. The walings, spreaders, etc., were all cut to length and bored on shore, so that when stacked on a barge, the derrick boat had merely to lift the pieces one by one and set them in proper position on the cradles. The method was found to give excellent results. After the force became accustomed to the work, they could build and launch 100 ft. of straight cribwork in two 8-hr. shifts, using a single derrick boat. This rate, the maximum attained, would have been exceeded considerably but for the fact that the holes for the tie-rods, bored from ¼ to ½ in. large, according to the size of the rod, with the view of avoiding binding, were not always bored straight, although boring machines were used. There was therefore a good deal of delay in working the tie-rods through, especially at the joints. It is believed that the holes for such work should be made from ¾ to 1 in. larger in diameter than the rod, so as to prevent this difficulty.

For launching the cribwork two 12x12-in. timbers were hinged to the side of the barge, as shown in Fig. 6. Their ends rested on the bottom and slid over it as the barge moved along the line, the framework sliding in turn down the timbers and moving off their ends to rest upon the river bed. A special design of waling joint had to be made to avoid binding, as shown in Fig. 3. From ¾ to 1½-in. play had to be allowed for the free hinge movement of the walings during launching; and where the piece was halved on the outer side, one or two bolts, according to location, were used to prevent longitudinal splitting from the bending strain.

For the sizes of the woodwork it was assumed that hemlock or spruce would be used, this being the cheapest local timber. The length of sections was made 20½ ft., so as to use standard 22-ft. lengths, and the walings were spaced to secure as far as practicable an equal unit stress in each and in the sheathing. They were figured as simple beams of lengths equal to the distance between adjacent tie-rods. The sheeting, which could more safely stand an over-strain without risk of disaster, was figured as continuous beams supported at each waling. The water elevation on the river side was taken as 14.33 (equivalent to pool level) and on the inside as below the base of the coffer. The extra loads induced by floods were to be covered by the general factor of safety. No reduction of loads on the timberwork from the support of the outside banking was allowed for, since the latter might

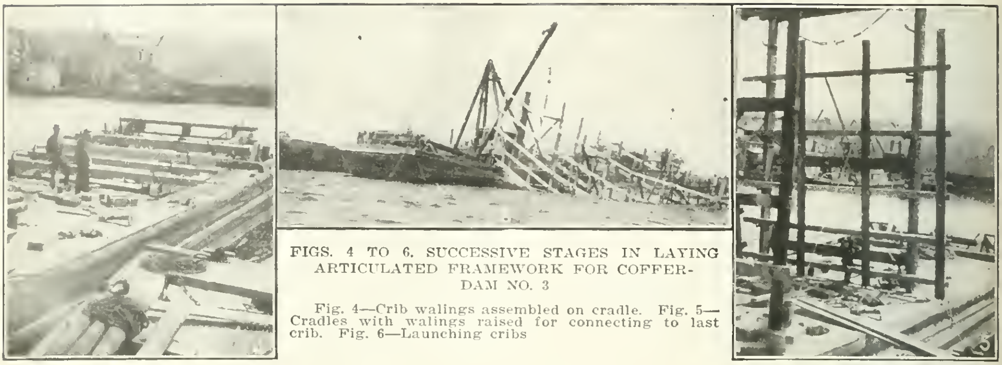


Section of Max. Height

Elevation of Frame

Detail of Waling Joint

FIG. 3. DETAILS OF COFFER-DAM FOR WEST ARM OF DAM (NO. 3)



FIGS. 4 TO 6. SUCCESSIVE STAGES IN LAYING ARTICULATED FRAMEWORK FOR COFFER-DAM NO. 3

Fig. 4—Crib walings assembled on cradle. Fig. 5—Cradles with walings raised for connecting to last crib. Fig. 6—Launching cribs

be eroded more or less by floods, but the riverward pressure of the inside filling upon the walings was reduced by the opposing water pressure, making a considerable saving in sizes (see Fig. 3). The design reduced the total waling cross-section 25% as compared with that used for the same height on coffer No. 1. The weight of the filling (dredge-placed gravel and sand) was taken as 120 lb. per cu.ft. for the whole height, and its wedge of pressure against the sides as sliding on a base of inclination of 1 vertical to 2½ horizontal, the formula used being Rankine's. With the spacings shown, the stresses under the foregoing assumptions varied in the walings from 860 to 1,240 lb. per sq.in. and in the sheathing from 700 to 1,270 lb. per sq.in. The maximum stress allowed in the tie-rods was 21,000 lb. per sq.in. of the area at the root of the thread.

This coffer-dam fulfilled its purpose entirely satisfactorily. The timberwork was begun at the north-bank end on May 12, 1914, and was practically completed, including the sheeting, by July 1, using only one derrick boat. The sheeting accompanied the main timberwork, and the filling and banking by the hydraulic dredging followed, commencing on May 25 and being completed on July 31, ten days after unwatering had begun. The outer sheeting was driven only a foot or so into the river bed, as the latter was of gravel and the plank would not penetrate it far without splitting; the inner sheeting rested on the river bed. Pumping was begun on July 21 with one 10-in. and one 12-in. centrifugal pump, and the water was lowered sufficiently by July 29 to begin excavation on that date. The only leaks of consequence were through porous strata under the coffer at the outer angles. As the banking became seasoned there, this leakage gradually lessened until the 10-in. pump alone was able to keep the water down, although the lift between water surfaces was about 23 ft. and the area of the inclosure below the river level was between 6 and 7 acres. The masonry, about 800 ft. in length, was begun on Aug. 20 and completed on Oct. 24. No rise exceeding 2 ft. occurred during the life of the coffer. It was finally flooded through the north sluice on Oct. 26, and the greater portion was removed by the dredge and derrick boats before the following December.

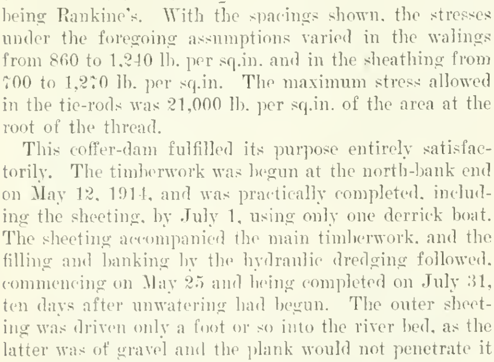


FIG. 7. DETAILS OF COFFER-DAMS IN FRONT OF OLD STATE DAM

The cost and materials were as follows:

Lumber (spruce), 170,000 ft. b.m. @ $27 f.o.b. Troy (about $4.60 per ft. run)	$4,590
Tie-rods, bolts, etc., 96,400 lb. @ about 3.85c. threaded, etc. (about $3.60 per ft. run)	3,700
Handling framing and placing lumber and placing iron (about $6 per ft. run, or $36.50 per M ft. b.m.)	6,200
Filling and banking by hydraulic dredge, 46,500 cu.yd. @ 12.2c. (about $5.60 per ft. run)	5,670
	$20,160
Length of coffer-dam, 1,040 ft.; cost per ft. run	$19.40

The foregoing are field costs of construction only and do not include depreciation charges nor supervision above the grades of foreman, nor district-office costs. Ordinary running repairs are included. The removal is not included, as it was done at odd times, and much of the filling and of the remains of the timberwork was washed away by floods.

GRAVEL COFFER-DAMS AT OLD DAM

Subsequent to the construction of the dam inside the timber coffers described, the lock and end of the dam were built inside of the steel coffer-dams to be described in a later article. The last piece of work was the construction of the gravel dams just upstream of the old lock and dam.

These three coffer-dams (Nos. 6, 7 and 8) were used for the removal of the State dam and consisted of banks of river material, the bases being placed by the hydraulic dredge, and the tops in part by the dredge and in part by derrick boats. A cross-section of No. 6 is shown in Fig. 7, and the others were similar except that a plain gravel top was used, without plank. The removal of the old dam required the excavation of about 50,000 cu.yd. of riprap and timbers. All this work, including the making of the coffer-dams, had to be done during the winter of 1915-16, so as not to interrupt navigation.

The steel-pile cylinders were used to protect the corners from erosion before and after the cutting of the coffer-dams. They were filled by the hydraulic dredge, after a 5-ft. layer of riprap had been thrown inside. No. 6 was closed first; and when the section of dam under its lee had been nearly all removed, No. 7 was completed. High water constantly troubled the work, but the banks stood safely although nearly topped more than once. Finally, on Dec. 26, 1915, about three weeks after the close of navigation, No. 6 had to be cut in order to save the rest of the work from a high flood. The head between the two pools was 11½ ft. at that time, and the 230 ft. of bank washed out in less than an hour, leaving a clear gap for the passage of the river and reducing the head to 5 or 5½ ft. The end of No. 7 was eroded somewhat by backlash, but further damage was stopped by riprap.

as latter coffer was cut about a month later, and the er washed it away piecemeal.

No. 8 covered the remainder of the dam. After the al vicissitudes from cold weather and high water, avation was practically completed by the end of March. e of the highest floods in several years came a day or t later and, topping the bank, washed down its crest 1 to 15 ft. The difference of level between the er surfaces before the flood reached this crest was than a foot, as compared with 11½ ft. when the work removal had been begun about four months before.

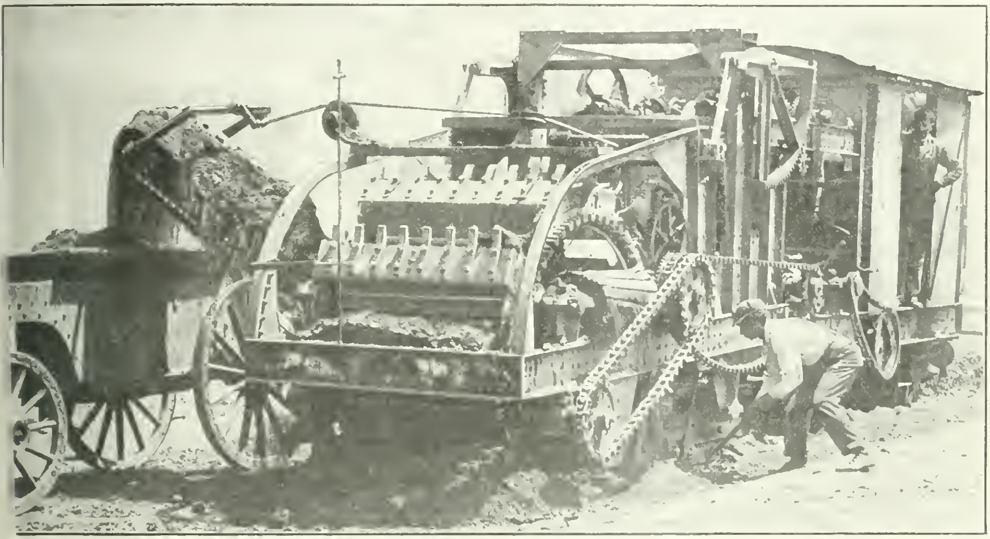
Engineers in Charge of Work

he work was performed under the supervision of eral (then Colonel) W. M. Black, now Chief of Enㅤers, United States Army, with Captain R. D. Black cal engineer officer, succeeded in 1911 by Major M. J. Donough. The fieldwork was commenced by Assistant ineer A. C. Harper and continued by Junior Engineer . McCabe. The mechanical work was under Wm. O. llivan and the office work under Junior Engineer . Fifer. The writer supervised the work locally.

Excavator for Street Grading

A new type of excavator and wagon-loader has been used in grading North Broadway, Chicago, south from Devon Ave. The machine has a steel frame mounted on caterpillars and having a wide-tired steering wheel at the rear. It is shown in the accompanying view.

At the forward end is the excavating device. This consists of a pair of circular frames carrying a series of horizontal shallow buckets fitted with teeth on the cutting edges. The buckets passing over the top of the circular frames drop their contents upon a belt conveyor. At the side of the machine this conveyor is carried by an inclined boom, high enough for wagons to drive beneath it and receive the material. The front portion of the frame, carrying the excavator wheel, is pivoted and is adjustable vertically to regulate the depth of cut and also to enable the buckets to be raised so as to clear manholes and street intersections. This frame is raised and lowered by means of the pinion and quadrant gear shown.



EXCAVATING MACHINE FOR GRADING STREETS

On the rear end of the main frame is an opposed-cylinder gasoline engine which operates the excavating and propelling mechanism through gears and chain drives. The machine could grade a length of about two blocks per day, and kept 35 wagons busy removing the excavated material. The grading was done by J. A. McGarry & Co., of Chicago. The machine was built by the Koehring Machine Co., of Milwaukee, Wis.

⁂

Stalactite Cave Moved from Arizona to New York—A beautiful stalactite-lined cavern was recently broken into at the Copper Queen mine at Bisbee, Ariz. The company placed the cavern at the disposal of Doctor Hovey, curator of geology at the New York Museum of Natural History, and he with three assistants, packed the cavern into 50 boxes and dispatched it to New York, where it has been reassembled. The age of the grotto is estimated at 25,000 years. One of these stalactites is 11 ft. high by 15 ft. in diameter at the base. Some of the stalactites and stalagmites removed weigh [illegible] lb.—"Engineering and Mining Journal."

Countersunk Rivets

By R. Fleming[*]

This article is the outcome of a research of the literature on the strength of countersunk rivets.

Much of the literature on riveted joints has been written from the standpoint of the shipbuilder and the boilermaker. Strength is given in terms of efficiency. By the efficiency of a joint is meant the ratio of the strength of a given width of joint to that of a solid plate of equal width. The structural engineer rarely uses the word "efficiency." He wants to know the shearing and bearing values of rivets so that he may put a sufficient number in his connections to take care of the stresses. These values are well defined for ordinary rivets. What value shall the structural engineer assign to countersunk rivets? He may read in an old Haswell,

> Countersunk riveting does not impair strength of joint as compared with external head.

and in the latest (1915) edition of Smith and Mark's "Machine Design."

> Countersunk rivets make a much weaker and less reliable joint than the ordinary form, and should only be used when it is absolutely necessary that the surface of the plate be free from projections.

In his "Steel Construction" Burt writes

> It is to be noted that countersunk rivets are not as strong as rivets with button heads and are much more expensive, consequently they are not used unless absolutely required by the conditions.

The usual American practice for countersinking rivets in bridge and building work is to make the depth of head one-half the diameter of shank and the slope 30° from axis of shank. The practice is different in shipbuilding. For many years the English Lloyd's "Rules and Regulations" has contained the clause,

> The countersinking of the rivet holes is to extend through the whole thickness of the plate or angle when the thickness is less than 0.60 in., and when the thickness is 0.60 in. or above the countersinking is to extend through nine-tenths the thickness of the plate. The size of the countersink is to be in accordance with the figured dimension shown in Table 20.

The American Bureau of Shipping has the rule,

> The countersinking of all plates and angle bars to extend to within $\frac{1}{32}$ in. of being through the plate or angle bar.

The slope varies according to diameter of rivet.

Early Tests with Countersunk Rivets

The earliest recorded experiments on the strength of riveted joints were made in 1838 by Hodgkinson under the direction of Fairbairn. They are given in detail in a paper entitled "An Experimental Inquiry Into the Strength of Wrought-Iron Plates and Their Riveted Joints as Applied to Shipbuilding and Vessels Exposed to Severe Strains," by William Fairbairn, Esq., in the "Philosophical Transactions" of the Royal Society of London for 1850. This paper has had a remarkable influence in determining practice for riveted joints. Regarding countersunk rivets Fairbairn writes,

> The system of countersinking the rivets is only used when smooth surfaces are required; under other circumstances their introduction would not be desirable as they do not add to the strength of the joint but to a certain extent reduce it. This reduction is not observable in the experiments, but the simple fact of sinking the head of the rivet into the plate and cutting out a greater portion of metal must of necessity lessen its strength, and render it weaker than the plain joint with raised heads. This must appear evident from the fact of the sectional area of the plate being diminished, and the consequent reduction of the heads of the rivets, which in this state are less able to sustain the effects of an oblique or transverse strain.
>
> It is, however, satisfactory to observe that countersinking the heads of the rivets does not seriously injure the joint in its powers of resistance to a direct tensile force; but the rivets are liable to start when exposed to collisions or a strong impinging force, such as the sides of ships are frequently doomed to encounter.
>
> On referring to experiments (Table XI), the same results as to strength are obtained with the countersunk rivets as those with rounded heads; they are rather under the mean of the former experiments; but not more than is easily accounted for by the reduced section of the countersunk plates.

The experiments of "Table XI" were with ⅝-in. rivets countersunk in plates 0.22 in. thick.

Masterly papers and reports on riveted joints, by Baron Clauzel, Professor Unwin and Professor Kennedy, may be found in the "Proceedings" of the Institution of Mechanical Engineers (London) for the years 1881 and 1885. An "Account of Some Tests of Riveted Joints for Boilerwork," by C. H. Moberby, may be found in Vol. LXIX (1882) of the "Proceedings" of the Institution of Civil Engineers. The tests were carried out by Kirkaldy. In Vol. XVI of the "Transactions" of the Institution of Civil Engineers of Ireland, Stoney has a valuable paper "On the Strength and Proportions of Riveted Joints" which he has partly embodied in his book "The Theory of Stresses in Girders and Similar Structures." Extensive tests of riveted joints have been made at the Watertown Arsenal and recorded in government reports; the index alone occupies several pages. Another series of tests of exceptional interest and value is reported in the 1905 "Proceedings" of the American Railway Engineering and Maintenance of Way Association. It is to be regretted that countersunk rivets are not mentioned in any of the foregoing papers.

Recent Tests Give Conflicting Results

In "The Strength of Plates and Rivets Used in Shipbuilding," by J. G. Wildish, "Transactions" of the Institution of Naval Architects, Vol. XXVI (1885), there are recorded some shearing tests made with ¾- and ⅞-in. steel rivets in ½-in. steel plates and 1-in. rivets in ¾-in. plates. With pan heads and countersunk points the ¾-in. rivets sheared at a pull of 11.160 to 12.500 tons per rivet, and with snap points at 10.825 to 11.049 tons. The ⅞-in. rivets sheared at 14.910 to 15.792 tons with countersunk points and at 14.787 to 14.953 tons with snap points. The 1-in. rivets sheared at 19.475 to 21.986 tons with countersunk points and at 18.861 to 19.420 tons with snap points.

> Half of these tests had the countersinking stopped $\frac{1}{16}$ in. short of the full thickness of the plates, and in the other half the countersinking extended right through; but the results were on the whole as good one way as the other, and there was but little variation in them individually.

Further tests on the frictional resistance of riveted joints showed that taken altogether the friction was greatest for the countersunk rivets.

Textbooks on mechanics and strength of materials, a long array, are silent on the subject. It is taken up, however, in a few books on shipbuilding.

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[*] American Bridge Co., 30 Church St., New York City.

"Shipbuilding in Iron and Steel," 1869, by E. J. Reed (afterward Sir Edward J. Reed), has a chapter, "Rivets and Rivet-Work," recording some tests of countersunk rivets. The remark

> It also becomes evident that countersunk riveting causes much less friction than the other systems. On comparison it will be seen that in nearly all cases steel plates and rivets give less friction than iron.

is interesting to read. In those days there was a distrust of steel rivets. Their use was prohibited by the Lloyd's Committee.

In his book, "The Design and Construction of Ships," 1908, Biles gives the results of a series of tests made at Glasgow University (probably under his direction). The ultimate shearing stress of $\frac{5}{16}$-in. countersunk rivets in 1⅛-in. plates ran from 14.63 to 20.83 tons per sq.in. while snap-headed and pan-headed rivets ran from 18.28 to 18.64 tons. The ultimate shearing stress of countersunk ⅜-in. rivets in 1⅛-in. plates ran from 14.87 to 19.0 tons and pan-headed rivets ran from 17.27 to 18.73 tons.

Hovgaard has a chapter, Calculations for Riveted Joints, in his "Structural Design of Warships," 1915, in which the efficiency of joints with rivets countersunk according to Lloyd's rules is determined theoretically. The effi·iency of plates and rivets is given in percentages. That these are of little value to the engineer in search of working stresses may be seen from the statement at the ·lose of the chapter,

> There is in shipbuilding no established practice as regards he working stresses allowed on the rivets in the ship-girder; he complexity of the problem and the empirical nature of the trength calculations have so far prevented the adoption of ny definite limits.

WHAT VARIOUS MODERN SPECIFICATIONS PRESCRIBE

The majority of specifications for bridges and buildings ive but little if any consideration to countersunk rivets. 'he Cooper "Specifications for Steel Highway and Elecric Street Railway Bridges" reads,

> Rivets countersunk in material of less thickness than the iameter of the rivet, shall only be given a value compared to iat of a regular rivet equal to the proportion of the thickness f the metal countersunk to the diameter of the rivet.

The specifications for highway and electric railway ridges compiled by the State Engineer of New York ·ad,

> Rivets shall not be countersunk in any plate whose thick·ss is less than one-half the diameter of the rivet. In calcuting the value of countersunk rivets the effective thickness the plate which receives the countersunk head shall be ·nsidered as ¼ in. less than the actual thickness of the ate for ¾-in. rivets and as $\frac{5}{16}$ in. less for ⅞-in. rivets.

A number of railroad specifications make mention of ·untersunk rivets, though often only by a sentence like 'ountersinking must be neatly done, all holes of the me size, and countersunk rivets must completely fill e holes." The Atlantic Coast Line specifies,

> Rivets countersunk on one or both heads will not be lowed except where they cannot be avoided.

The Queen & Crescent Route specifies,

> Rivets with ⅝-in. flat heads shall be preferred to counternk rivets and countersunk rivets shall not be used in ma·ial less than $\frac{7}{16}$ in. thick. Countersunk rivets shall be conlered to have but half the strength of round-head shop cts.

The "General Specifications for Steel Structures" of Southern Railway Co. contains the clause,

> No value will be given to ⅞-in. rivets countersunk in tes less than ⅝ in. thick, nor to ¾-in. rivets countersunk plates less than ½ in. thick.

The Scranton & Binghamton Railroad Co. specifies,

> The effective bearing area of pins, bolts or rivets shall be the diameter multiplied by the thickness of the piece, except for countersunk rivets when half the countersink shall be omitted.

The Pennsylvania Railroad Co. in its "Standard Specifications for Steel Bridges" has the provision,

> Rivets with countersunk heads shall be assumed to have three-fourths the value of corresponding rivets with full heads.

The specifications of the Chesapeake & Ohio Railroad Co. contain the same clause. It is also found in a number of building specifications.

The New York Central Lines specify,

> Field-driven rivets, countersunk rivets and turned bolts shall be increased in number 25% over the number of full-headed shop-driven rivets required.
>
> The effective bearing area of a pin, a bolt or a rivet shall be its diameter multiplied by the thickness of the piece, except that for countersunk rivets half the depth of the countersink shall be omitted.

The Buffalo, Rochester & Pittsburgh Railway Co. and the Long Island Railroad Co. have the same provisions.

The "General Specifications for Railway Bridge Superstructure" of the Osborn Engineering Co. contains the clause,

> In deducting rivet holes to obtain the net section of riveted tension members, the rivet hole shall be taken with a diameter ⅛ in. larger than the undriven rivet for full heads, and ¼ in. larger for countersunk rivets in plates ⅝ in. or less in thickness.
>
> Where rivets are countersunk the bearing of the head shall not be counted.

Godfrey in his "Steel Designing," 1913, specifies,

> The shearing or bearing value of countersunk rivets in plates ⅜ in. thick and over will be taken as one-half the full value. Countersunk rivets in plates less than ⅜ in. thick will not be considered as taking any of the stress

The specifications of the Isthmian Canal Commission for the coaling plants at Cristobal and Balboa contain a clause reading,

> Countersunk rivets in metal ⅜ in. or less in thickness shall not be considered as resisting shearing or bearing. In metal ⅜ in. to ⅝ in. they shall be considered as having half value, and in thicker plates full value.

Waddell in his recent treatise, "Bridge Engineering," chapter LXVIII, specifies:

> Rivets with flat heads shall be preferred to countersunk rivets; the height or thickness of the flat head shall be three-eighths of an inch.
>
> In important members rivets shall not be countersunk in plates of thickness less than one-half of the diameter of the rivet. Rivets with flattened heads shall be assumed to have only eight-tenths of the strength of rivets that have full heads.

RULE RECOMMENDED BY THE AUTHOR

The rules in the specifications quoted must be followed until further experiments are made. The writer gives preference to the Pennsylvania Railroad Specifications modified to read as follows:

> Rivets with countersunk heads shall be assumed to have three-fourths the value of corresponding rivets with full heads, but no value shall be allowed for countersunk rivets in plates of a thickness less than one-half the diameter of the rivet.

For rivets with flat heads the writer suggests the following, being a slight modification of Waddell's specifications:

> Rivets with flattened heads of height not less than three-eighths of an inch, or one-half the diameter of the rivet for ⅝-in. rivets and less, shall be assumed to have nine-tenths the strength of rivets that have full heads.
>
> When heads are flattened to less than these heights they shall be assumed to have the strength of countersunk rivets

Providing Water-Supply for a Large Militia Camp

SYNOPSIS—How the 22nd Engineers, without previous experience as a unit, laid out a 425-acre camp site, providing water and sanitary conveniences for 25,000 men, in 44 days.

The duties of military engineers on active service have been a prolific subject for speech and writing, both by men who know and by men who do not know. These duties for the New York Engineer Corps are exactly the same as those of the United States Army Engineer Corps, and their scope is stated with brevity and precision in the United States Army Regulations. One of these duties is to prepare camp sites for occupation by troops. How this particular and by by no means simple work is done was recently shown by a notable performance of the 22nd New York Engineers—Lieut.-Col. Eugene W. Van C. Lucas, commanding—which in little more than a month transformed an unimproved state tract into a healthful camp capable of supporting a full military division.

Military leaders are interested mainly in results, or at least that is the popular notion. They want a camp for some thousands of men ready by such and such a date. The task of providing this is put up to the chief engineer officer assigned to the division. How it is accomplished is the concern of the officer just mentioned and not of his superiors.

The point selected for the summer mobilization of the National Guard of New York was an 825-acre state tract located near the excessively rural community designated Beekman. Camp Whitman, as it was named, is adjacent to Green Haven, a stopping point daily for four trains of the Central New England Ry., which crosses the state land. Here, at Green Haven Station, the division quartermaster's depot was established. The town of Beacon, on the New York Central main line, is 17 mi. distant from the camp.

Colonel Lucas had been ordered on May 16 to have the camp ready for occupation by July 9, and on May 19 a detachment of 12 men and two officers came to Green Haven and established Camp Whitman. On June 18 came the President's order for instant mobilization of the National Guard, pushing the date of occupancy forward three weeks and increasing the engineering difficulties by several hundred per cent. By June 30 the water-supply was available, and a number of the units were encamped.

The necessary work divided naturally into four classes: (1) Camp survey for determining regimental locations and for laying out systems for water-supply and roads; (2) the development of an adequate water-supply—the most important and absolutely essential work of all; (3) the development and construction of an adequate road system; and (4) the reconnoissance and mapping of 64 sq.mi. of adjacent farmland to be used for maneuver work during the proposed encampment. Many minor problems had also to be taken up and disposed of.

Camp Survey for Regimental Location

The camp survey was worked out by Lieutenant Stockwell and consisted of a stadia survey with 10-ft. contours, plotted to a scale of 200 ft. to the inch. Lieutenant Stockwell's work was completed in a thorough and effective manner, as was demonstrated on several occasions when organizations arriving at the camp without previous notice were promptly located.

The object of this survey was to determine a sufficient area for all the organizations of the division—each regimental camp to be situated on land free from woods

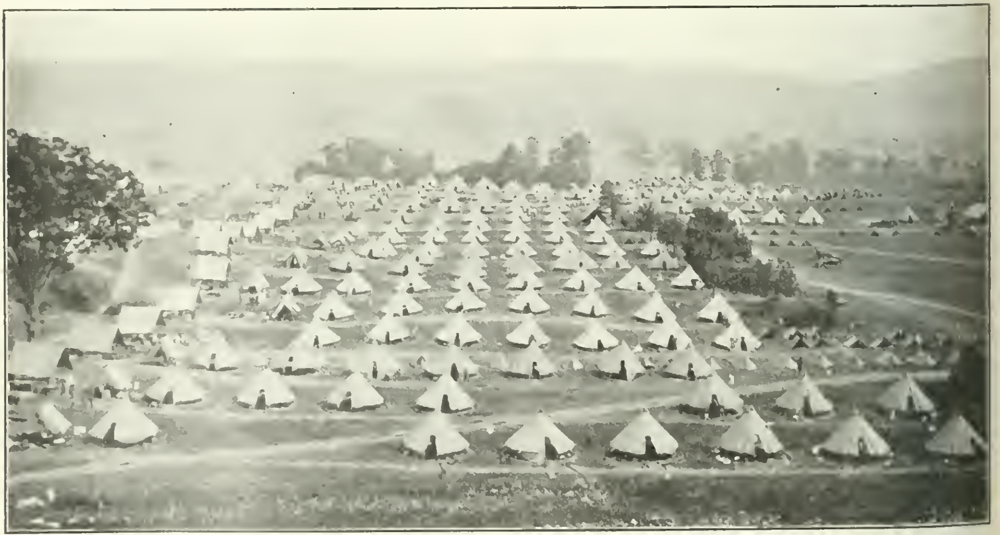

FIG. 1. ENCAMPMENTS OF 10TH AND 65TH INFANTRY AT CAMP WHITMAN, N. Y.

or swamp and below the ridge on which the water tanks were to be built. The survey covered an area of 425 acres and served as a general working drawing on which the locations for each regiment were made. This map was also used for laying out the communications generally and for working out the water-supply arrangements.

THREE WATER-SUPPLY SYSTEMS AVAILABLE

To obtain water for the camp, it was necessary either to pipe it from Fishkill Creek or to sink wells. The water of Fishkill Creek is used for the water-supply f Beacon, located at the confluence of the creek with he Hudson. It was not deemed advisable, however, o trust to surface water for a camp of from 15,000 to 0,000 men; the chances of pollution were too numerous. ecision was therefore made in favor of wells. The ork was outlined on May 30, and on June 7 the orders ere placed for the necessary materials for pumping tation, supply line and tanks. The time between these ates was occupied in meeting necessary requirements, uch as calling for bids and opening them. Previous to June 16, material orders were placed by the chief quartermaster, but after that date by the chief engineer.

The services of two local well diggers were secured, and water deposits were found at two localities—one a short distance north of the state road near Green Haven crossroads and the other near the western boundary of the tract, about 300 yd. south of the state road. When first found both deposits were of equal promise, but the second did not develop a sufficient quantity of water and was abandoned. The former gave better results and was developed by Lieutenant O'Connor until a daily supply was obtained of about 200,000 gal. from five or six wells.

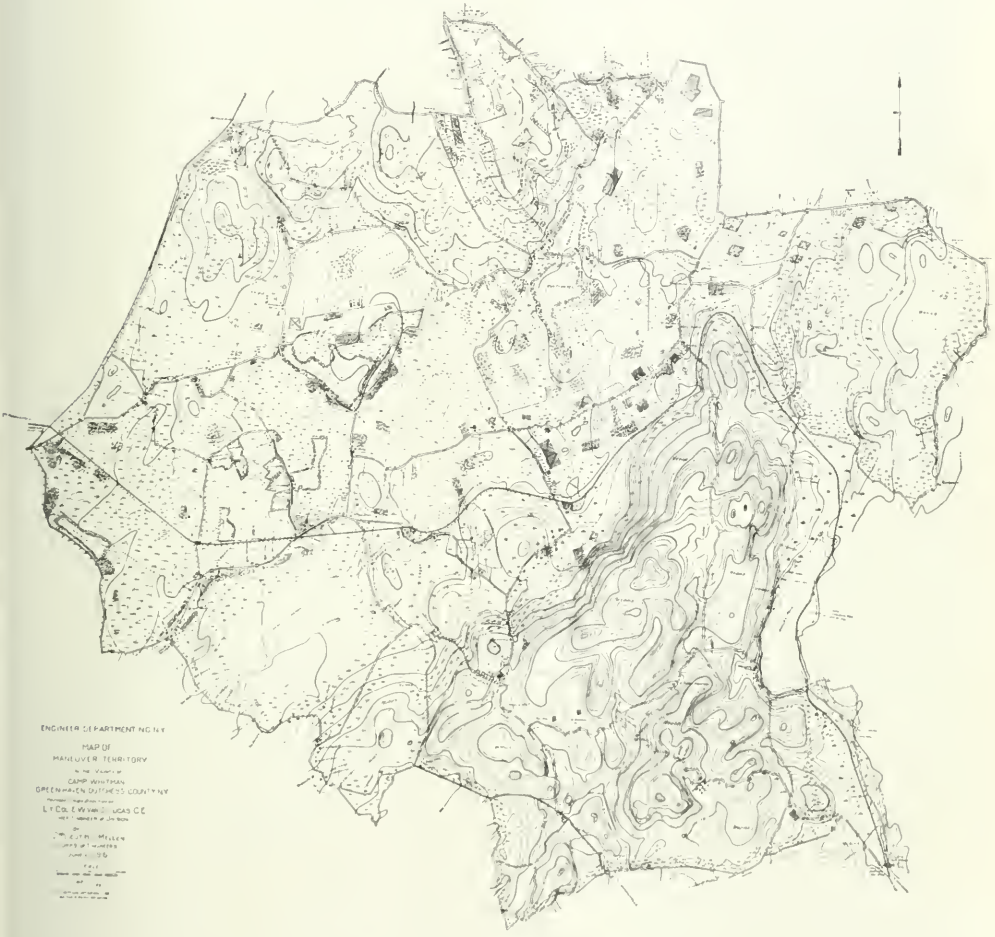

FIG. 2. RECONNAISSANCE MAP MADE IN THE FIELD BY THE 22ND ENGINEERS OF NEW YORK

This supply was brought into service on the morning of June 29 and constituted the main source for about 10 days. After a week's use the gravel pocket had been cleared of fine sand and the pipe system of grease, etc., and the water was officially pronounced fit to drink. This source of supply was never regarded as a satisfactory primary source and was replaced by the Carter group of wells, described hereafter, as soon as the latter were available. The O'Connor group then became a first reserve supply. The wells of this group were about 35 ft. deep, of 6-in. casing, with a 4-in. pipe inside. The inner pipe extended down to within 1 ft. of the bottom of the casing. No strainers were used, the sand dropping into a pipe sump that had to be cleaned several times daily. The wells were connected together and worked by a plunger pump of Fairbanks-Morse manufacture, which had a capacity of 250 gal. per min. It was driven by a 10-hp. single-cylinder 4-cycle gasoline engine of the same make. At full capacity, the wells had dried.

Meanwhile an offer had been received from Ralph B. Carter, of the Ralph B. Carter Co., of New York City, to make a systematic exploration of the subsurface water possibilities of the whole camp site, the method being a series of 2-in. wash borings put down at the rate of about three daily. The fifth boring, made by Mr. Carter on the night of June 27, discovered the water deposit later developed as the primary supply for the camp—a series of flowing wells tapped at a depth of 45 to 50 ft. below about 30 ft. of clay and pronounced by the experts of the State Department of Health an absolutely pure water. The capacity of this deposit was estimated at 1,000,000 gal. daily and was utilized to the extent of about 250,000 gal. daily, by means of a gang of 15 to 20 two-inch wells connected at the top.

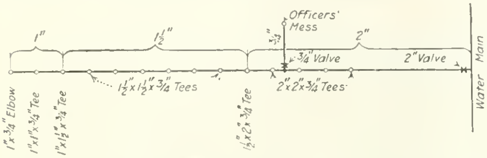

FIG. 3. REGIMENTAL WATER-SUPPLY LINE

Before the development of the first water-supply and just after the President's call for the National Guard the demand for an adequate water-supply became so acute that it was not deemed wise to trust entirely to a successful development of a subsurface water-supply, which is necessarily a slow process. Accordingly, while the subsurface work was continued, it was determined, on the morning of June 22, to bring in also as a final reserve the water resources of Fishkill Creek, estimated to provide a minimum supply of over 2,000,000 gal. daily. For this surface supply, with the approval of the representatives of the State Department of Health, a chlorination plant was installed at the pumping station on Fishkill Creek. It was never necessary to utilize the Fishkill Creek supply, but as the project stands there are available three sources—first, the Carter development, brought in on June 28; second, the O'Connor group of six wells first used; and finally, the surface supply from Fishkill Creek.

A 50,000-Gal. Wood-Stave Tank Erected Overnight

Mr. Carter made some further exploration and discovered an additional deposit equally as good as the primary supply and located on the western edge of the state land near the railroad track. It is estimated that a sufficient water-supply for 100,000 to 200,000 men can readily be obtained at this location. Water requirements are estimated on the basis of 20 gal. per man per day.

The project included the erection of two 50,000-gal. tanks, of which only one was built. It is a wood-stave tank 20 ft. high by 22 ft. in diameter. The site decided upon for it is on the top of a hill, requiring a lift of 160 ft. from the water main. The foundations consist of four concrete piers 4½ ft. deep, 20 in. wide at the bottom and 18 in. at the top. Concrete for the first pier was mixed by hand, native sand and gravel of fairly good quality being used. A pat test of this concrete gave poor results. Foraging unearthed a small tumbler, or hand mixer, owned by a farmer, about 8 mi. distant from the site. This was obtained, repaired by the local blacksmith, belted to a 4½-hp. gasoline engine, and turned out 20 batches an hour. The foundations were placed by a gang of 12 men. Foundations were also placed for the second 50,000-gal. tank.

In the course of the foundation work, material for the wood tank arrived and was stored on a hill near-by. With apparently unskilled labor the tank was erected in 36 hr., the last 16 of which were consecutive and at night. This work included building a scaffold for putting on the hoops, which came four sections to the hoop. Power lights, or gasoline flares, were used at night. Corporal Fogarty, a former chief petty officer in the United States Navy, was in direct charge of the erection, under the supervision of Lieutenant Bregenzer.

The main and distributing system aggregates more than 10 mi. of piping. The mains are 6-in. "Universal" pipe, furnished by the Central Foundry Co., of Newark, N. J., while the laterals are 4-in. "Universal" and 4-in. wrought iron. The distributing lines vary from this size to ¾ in. The piping for the most part is laid in trenches and has about 1 ft. of cover. A 3-in. line to the base hospital and 69th Infantry was an emergency job and was laid on top of the ground. It is over 2,000 ft. long and was laid complete in one afternoon by working parties from companies A, B and D, 22nd Engineers.

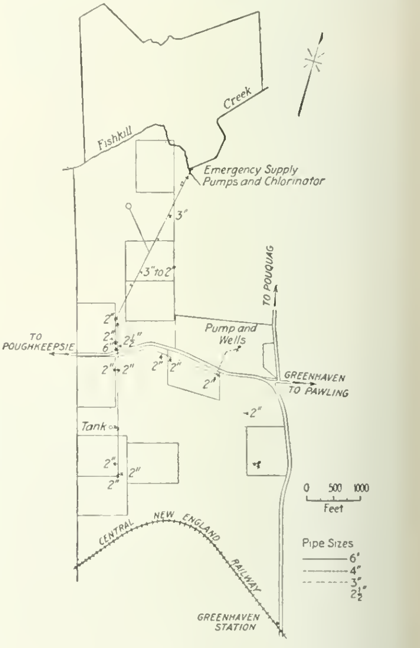

FIG. 4. LAYOUT OF WATER MAINS AT CAMP WHITMAN

Fig. 3 shows the water requirements for a regiment in camp. Inside the area occupied by the unit there must be fifteen 1-in. faucets, so that each company has a faucet; and there is one for the machine-gun detachment and another for the kitchen. There is a faucet for the noncommissioned staff and hospital corps, and one for officers. Each regiment is provided with a shower-bath house having 18 outlets.

The water-supply system was laid out by Lieut. J. E. Baker, and its installation was under his immediate supervision as special assistant to Colonel Lucas. It was through Lieutenant Baker that the valuable coöperation was secured of Westinghouse Church Kerr & Co., by whom he is employed in civil life.

Lieut. M. H. Gray rendered important service as quartermaster and in many special ways, being the only officer besides Colonel Lucas who was connected with the work from start to finish.

Time Only for Emergency Roadwork

Previous to the arrival on June 20 and 21 of the 22nd Engineers as an organization the available force 15 to 50 men) was too small to undertake roadwork; ut on June 22 the roadwork was assigned to the first attalion, and a good start had been made when, on une 24, the first battalion was ordered mustered into he United States service. Thereafter it was not possible or the regiment to do any further roadwork other than f an emergency nature, as its entire available energy as required on the development of the water-supply stem up to the time of its muster into the United tates service and departure for the Mexican border.

While there was little opportunity for road building repair, there was a certain amount of widening to be one before freight could be passed over the road from e railway station. One of these jobs was completed om the Green Haven post office toward the station—distance of 400 ft.—in 1½ days. The principal requirement of such work is adequate drainage.

The work was done by hand, the tool ratio being 2 ovels to 1 pick, a gang of 100 men being used. Among e men were discovered two highway inspectors, and ese were placed in charge of sections, the corporals ndling the subgangs. The work was carried on by ree classes of men. The excavating gang constructed le ditch and shoulder, while rock layers lifted stones om a wall along the road and placed the larger of se as edging. The smaller stones were used to build the road and shoulder and to line the ditch, thus oviding blind drainage. A casting gang disposed of excavated material, which, being principally of sand l gravel, was used to fill the interstices in the stones l as a preliminary binder. Two gravel teams spread vel to a thickness of 2 in. over the top.

Reconnaissance Work

On June 1, four field parties were organized, each nprising a topographer and an assistant. The function these parties was to make a reconnaissance survey the control of the elaborate topographic map, reproed herewith (Fig. 2). In assigning daily work to parties the maps of the United States Geological vey were found extremely useful, but their scale was small to allow them to serve as military maps. The trol map was constructed on a scale of 3 in. = 1 mi., and showed roads, fields and houses. The plane-table method was used, and the work went on rain or shine, water having no injurious effect upon the thin sheets of celluloid used in place of sheets of paper on the sketching boards in wet weather. The topography of Camp Whitman and vicinity is uneven; there are mountains, plains, woods and farmhouses. The topographic party taking the mountain section used an aneroid; the other parties took elevations with tapes and a balanced clinometer. The work of the day was closed in every night on the control. Corp. F. O'Brien deserves special mention as he made the high record, sketching 12 mi. of road in one day. The control points were along the road radiating from Green Haven as a center. The control map was finished in five days, of which four were rainy. The work was organized and conducted by Lieut. C. E. Bregenzer.

LIEUT.-COL. E. W. VAN C. LUCAS

Lieut. H. L. Mellen took hold of the work on June 13, filling in the topographical data, shown in Fig. 2. This work proceeded for six days without any special haste, when the rush order came. At once 15 to 20 parties were sent out, and the entire 64-sq.mi. area had been thoroughly mapped in four days.

The map was finished in five days, requiring the equivalent of 72 parties—that is, 18 parties per day for four days and one day's work in the office at the end.

The work of the engineers also included laying out the necessary spur tracks, three in number, for the service of the quartermaster's depot at Green Haven station. This layout was made by Lieut. M. H. Gray, working with the engineers of the Central New England

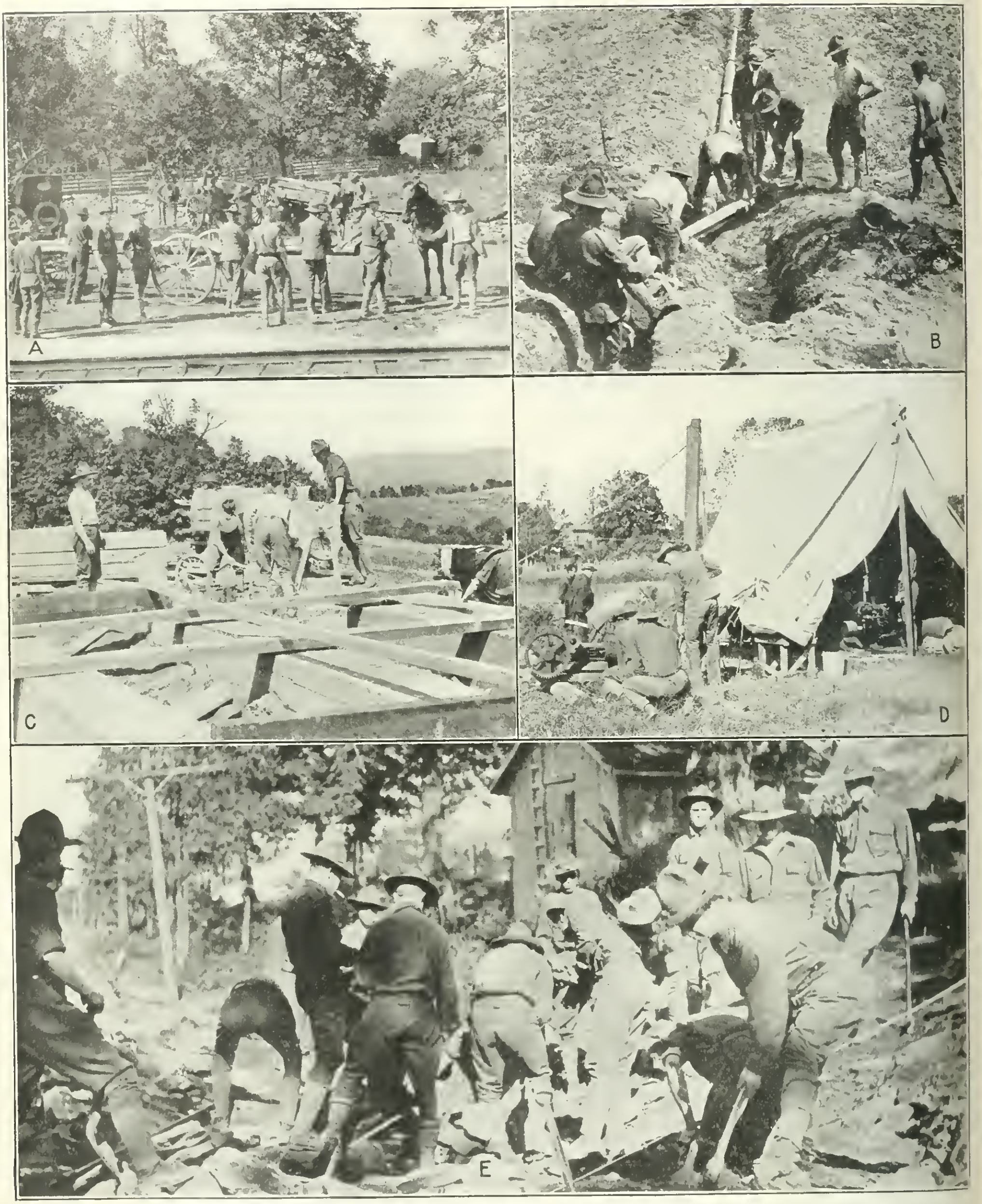

FIG. 5. 22ND ENGINEERS PREPARING WATER-SUPPLY AND ROADS AT CAMP WHITMAN, N. Y.

A—Loading pipe for water mains. B—Laying 6-in. "Universal" in shallow ditch. C—Building foundations for 50,000-gal. wood-stave tank; hand mixer at work. D—Pumping plant of 6-well secondary supply. E—Repairing road, using stones from an adjacent wall

Ry., and the work itself was done by the railway company. Deliveries of material were at first slow, but after the working organization had been established and the placing of orders taken over from the Quartermaster Corps by the Engineers, the reverse was the case. On one occasion 2,500 ft. of 6-in. pipe arrived from Newark 21½ hr. after placing the order by telephone, and in another case a 60-hp. gasoline engine and a two-stage centrifugal pump were received from Aurora, Ill., by way of Chicago, in 30 hr.

The actual work of preparation of the camp site began about May 22, after the establishment of the camp, and for a month the detachment was small (15 to 50 men) and its personnel constantly changing. After June 21 the entire 22nd Engineers was available until the muster-in of the battalions, and assistance was also furnished by the 69th Infantry and the 2nd Infantry. As a rule, the engineers carried the water mains to each camp, and the interior piping was laid by each regiment for itself.

Material assistance was furnished by the State Department of Health through Chief Engineer Horton, Assistant Engineers Sanborn and Chase and Dr. Van Winkle; by the State Department of Highways through Assistant Engineers Waite, Bixby and Howe.

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Goose Lake Valley Irrigation System, Oregon

By Kenneth A. Heron*

The Goose Lake Valley in south central Oregon consists of about 60,000 acres of agricultural lands surounded on the east, north and west by the high Sierra Nevada range and foothills. Originally covered with a hick growth of sagebrush, in later years a small area as been cleared for farming purposes and a limited ortion of this, in wild hay, has been irrigated from the everal streams flowing to the lake.

Seven years ago the Oregon Valley Land Co. projected reservoir and canal system that would supply water or irrigation purposes to practically all the irrigable ands in the valley, and construction that has since been complished by that company and its successor, the oose Lake Valley Irrigation Co., has advanced to a age that insures its completion in the near future. he system consists of a reservoir formed by a dam on rews Creek, the North Drews canal, the South Drews nal and various laterals.

During a period of 15 yr. the annual precipitation s not averaged more than 11 in. Of this 80% falls September to May, when of little value to growing ops.

North Drews Canal and Structures

Beginning just below the Drews Dam (Fig. 1) the orth Drews canal runs along the steep cañon sides mi. before it reaches the west edge of the valley and rns north and skirts the foothills for 30 mi. A prosed extension is shown on the map.

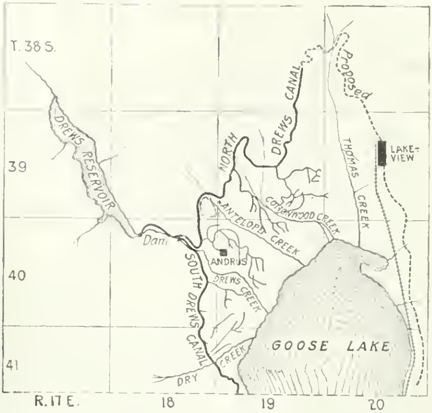

FIG. 1. MAP OF GOOSE LAKE VALLEY IRRIGATION SYSTEM, OREGON

The reservoir outlet tunnel is located on the south le of the creek about 16 ft. above its bed. The canal carried over the cañon by a 12x7-ft. timber flume th a capacity of over 700 sec.-ft. After leaving this me the canal is located in two places through an earth l gravel formation for short distances, and for the nainder of the distance along the cañon side the canal carried through rock cuts and timber flumes set on a le shelf cut out of the rock. Five of these flumes built. One of them is shown by the view, Fig. 2. avoid a long solid rock cut in one place tunneling s resorted to for a short distance at a point about ni. below the dam. After leaving the cañon there are no structures of importance for 7 mi. Here another large timber flume is employed to avoid the necessity of a long canal through difficult material. Flume 600 (Fig. 3) as this is called is 8x5½ ft. in section and 900 ft. in length.

Beyond this point the canal capacity decreases gradually and a number of semicircular steel flumes (Figs. 3 and 4) are constructed. The largest of these crosses Cottonwood Creek and is 9.6 ft. in diameter and 2,100 ft. in length. It is supported on piling and framework of heavy timbers. All of the steel flumes on the system have flaring intakes of flume metal and concrete outlet structures.

A timber-lined tunnel 900 ft. long just west of Cottonwood Creek was built instead of a 2½-mi. canal around a high ridge. (See Fig. 3.)

South Drews Canal and Laterals

On account of the topography of that portion of the valley south of Drews Creek the elevation of the south canal is about 75 ft. below the north canal and the former heads on Drews Creek about 2 mi. below the dam. It follows the creek on the north side to the point where the higher canal leaves the cañon and then turns in the opposite direction (Fig. 1.) The canal consists of sections of timber flumes, solid rock cuts, masonry walls and earth and gravel cuts. Where the canal turns south and crosses Drews Creek a semicircular steel flume 6.1 ft. in diameter and 575 ft. long, on a wooden substructure, has been built. Seven other creeks and depressions are crossed by flumes of this kind.

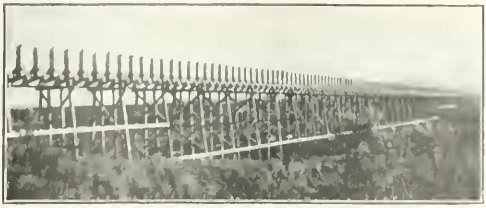

FIG. 2. TIMBER FLUME, NORTH DREWS CANAL

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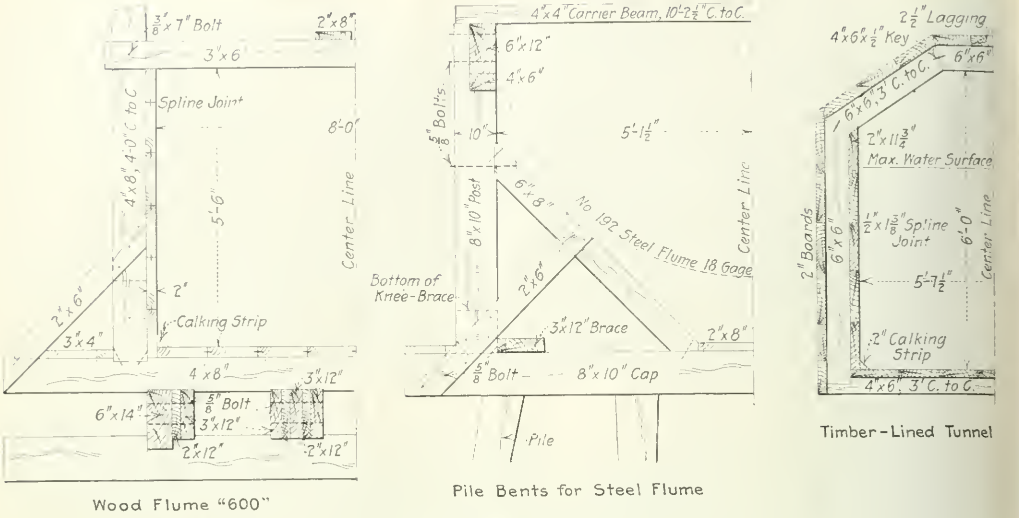
*Chief Engineer, Goose Lake Valley Irrigation Co., Lake- w, Ore.



Wood Flume "600"

Pile Bents for Steel Flume

Timber-Lined Tunnel

FIG. 3. DETAILS OF WOOD FLUME, STEEL FLUME ON TIMBER BENTS AND TIMBER-LINED TUNNEL, NORTH DREWS CANAL

Work has been in progress on the main canals since 1910. In 1914 the north canal was completed and in 1915 water was first turned into the south canal.

Prior to the summer of 1915 only two short laterals had been constructed for distribution purposes. Since then main laterals have been located to irrigate all of the territory on the west side of the lake and during the spring of 1916 construction was pushed as fast as possible in order to deliver water to as large an acreage as can be irrigated this season. It is hoped that by fall all parts of this area will be within striking distance of a lateral.

All the timber used for the dam, flumes and other structures on the canals has been milled by the company at its mill near the Drews Dam. On account of poor facilities for bringing in material from Alturas, Calif., a distance of 65 mi., at the time most of the work was done materials for construction purposes were limited to timber and cement at a very high price. Later the Nevada, California & Oregon Ry. was extended to Lakeview from Alturas, and this has made possible the use of such other materials as are necessary.

The company's own telephone lines extend to the principal points on its irrigation system. Most of the lines consist of No. 9 galvanized wire strung on poles 175 ft. c. to c. Eight-foot cedar stubs are set from 3 to 4 ft. in the ground and 18-ft. pine posts are wired to these.

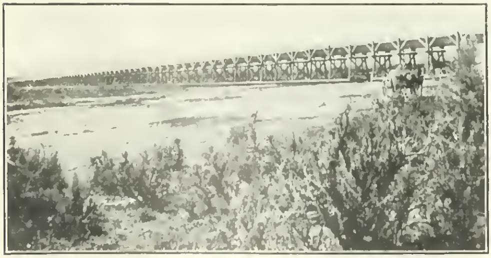


FIG. 4. COTTONWOOD CREEK STEEL FLUME

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New Boulevard Overlooking San Francisco

The new Twin Peaks Boulevard in San Francisco, from a scenic standpoint the most notable road on the San Francisco peninsula, is now rapidly nearing completion. It starts at the intersection of St. Germain and Burnett Ave., ascends and encircles near their summits the two hills known as Twin Peaks, at an elevation of 825 ft., and thence descends to terminate in Corbett Ave. at a point about 900 ft. distant from the westerly boundary line of the San Miguel Rancho.

The roadway consists of an asphalt pavement 25 ft. wide, with a 7 ft. 6 in. rock shoulder adjoining it on each side, giving a total width of 40 ft. The pavement is composed of a concrete base 6 in. in thickness, covered by a binder course 1½ in. thick and a 1 in. asphaltic wearing surface. Before constructing any pavement, the subgrade was thoroughly compacted by rolling with a 12-ton road roller.

Surface drainage is carried off by 12-in. corrugated steel culverts, encased in concrete, underlying the roadway at required points. Water collecting in side ditches is discharged into concrete inlets and thence through the culverts. A guard rail, consisting of two 2x6-in. surfaced pine rails nailed to 6x6-in. surfaced redwood posts 8 ft. apart was constructed in the shoulder adjoining the fill side of the roadway.

The contract for the construction of that section of the boulevard extending from St. Germain Ave. through the City Reservoir site was awarded in 1915, to Eaton & Smith, for the estimated sum of $24,058. This portion of the boulevard is approximately 2,800 ft. long and

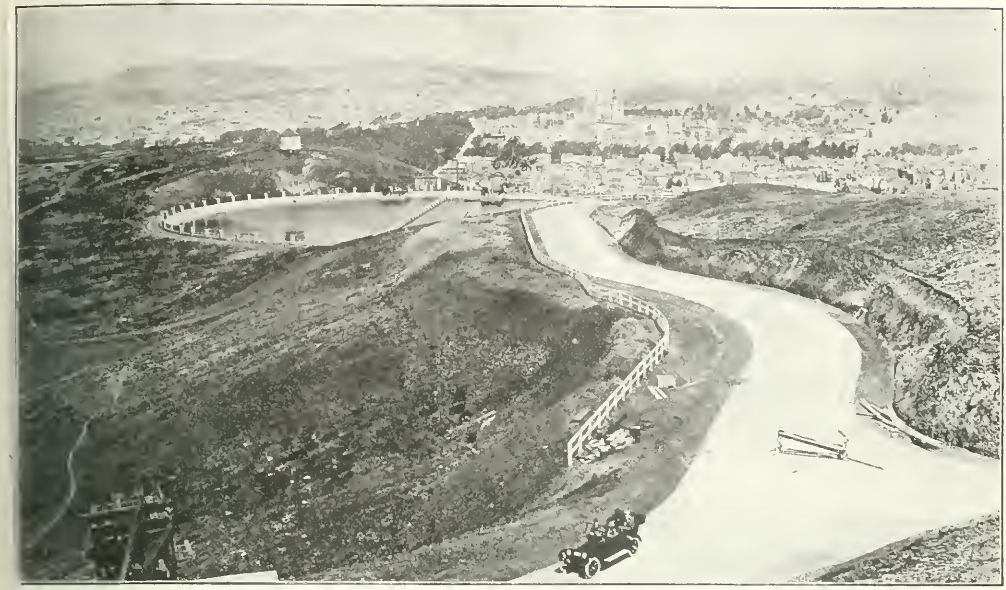


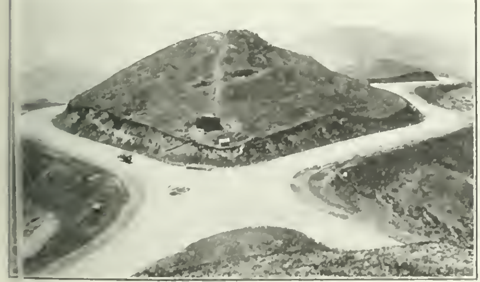
FIG. 1. LOOKING NORTH ON TWIN PEAKS BOULEVARD, SAN FRANCISCO. RESERVOIR IN FOREGROUND. RICHMOND DISTRICT AND PRESIDIO IN DISTANCE

s construction necessitated the excavation by steam ovel of approximately 30,000 cu.yd. of rock and earth, e construction of 70,000 sq.ft. of pavement and 2,730 n.ft. of guard rail.

The maximum grade on this section of the boulevard 9% and the sharpest curve has a radius of 60 ft. The adway on curves is superelevated to insure safe and sy riding, the maximum superelevation on the curve entioned being 11 in.

One of the most notable features of the boulevard is a rve forming a full semicircle or horseshoe, 3,173 ft. length, with a center line radius of 68 ft. To elimite accidents on this curve, 3,000 cu.yd. of rock were avated in the interior core within the horseshoe to e a clear and unobstructed view across same.

The contract for the second section of the Twin Peaks ulevard, extending from the City Reservoir site to rbett Ave., was awarded on Sept. 20, 1915, to F. R. tchie & Co., for the estimated sum of $51,745. This it of the boulevard is about 7,900 ft. long, 6,821 ft. of this being built on an acquired right of way. The contract included the excavation of approximately 6,300 cu.yd. of rock and earth and the construction of 202,124 sq.ft. of pavement, 960 lin.ft. of 12-in. culvert and 8,000 lin.ft. of guard rail.



G. 2. LOOKING SOUTH ON FIGURE EIGHT SECTION OF TWIN PEAKS BOULEVARD

Excavation was performed by a steam shovel. For fills the excavated material was placed in the piles by means of scrapers and dump wagons and thence rolled in layers by a 12-ton road roller. One of the fills underlying this roadway is 60 ft. deep. The surface of the side hills underlying the fills was thoroughly plowed before placing any material for fill.

An unsurpassed view of the City of San Francisco, the Pacific Ocean, Bay, Marin and Alameda County hills is obtainable from the summit of the boulevard.

The work has been done under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

⁂

Widening Japanese Railways to standard gage has recently been announced in press dispatches as likely soon to be undertaken. The basis for this report is probably a recent public speech of the Premier of Japan, in which he announced himself as strongly in favor of the change of gage. From official sources "Engineering News" has ascertained that no early action in the matter is likely. The subject is still under discussion pro and con, as it has been for half a dozen years past, and the Japanese Parliament has made no appropriation for the work. The Imperial Railway Bureau, which operates the government railways of Japan, has been urging the widening of the gage to standard for six years past. In building all new bridges, tunnels, etc., during that time it has made them wide enough for standard-gage rolling stock. The large expense involved in the change of gage, however, causes widespread opposition to the plan, its opponents urging that the increased traffic could be more economically handled by steamers than by rail, nearly all the important cities of the Empire being on tidewater. They also urge that if a change of gage were made it would be necessary at the same time to expend a large amount in cutting down grades and reducing curvature. The difficulty in raising capital on account of war conditions and the high prices of engineering materials, rails, etc., will have its part in delaying any definite action on the change of gage.

Field and Office

Contractor talks on night work—Heaviest concrete girder in Philadelphia poured in three lifts—Pulling sheetpiles with locomotive crane and with hammer—Two-ton traction derrick weighing but 10 tons—World's tallest piledriver

Cost of Night and Day Work

By H. B. Whitney*

The editorial in *Engineering News* of Aug. 17 on comparative cost of night and day work brings to mind the experience of 30 years on double shift, covering several kinds of construction work. I was employed on river and harbor-improvement work for eight years, operating single shift, and was a licensed master of steam vessels for the Mississippi River and tributaries, and a pilot on the upper Mississippi River. Thus I had some acquaintance with night work through piloting, and was versed in the difficulties of that kind of work before I was called upon to operate day and night continuously.

My first experience was during 1886 in connection with dredging for the United States Government, as captain and pilot of a towboat handling scows. I expected to do nearly as well at night as on the day shift; but I found that the nights were more calm, and every month averaged a small per cent. better at night than by day, when high winds caused slow handling of the scows.

On dam and shore-protection work the force was on duty during the day only. Nights were devoted to delivering the empty barges at various quarries and brush camps and bringing loaded material to the dam. The day shift handled short tows and delivered barges to and from the dam. We always got as good service from the night work as from the day work, but arranged our schedule to suit the conditions.

I have handled betterment work on railways with double shift, and the same conditions exist; that is, the work must be picked for the night crew. There is no profit in night work unless the conditions are such that the night force can be favored. For opening up a borrow pit and fill, plans should be so made that the night force will have a clean dump and small crew. Then 100% efficiency can be secured. The day force will raise track and do all work requiring hard labor.

On drainage work, where kerosene lamps and torches were used we usually averaged 80% efficiency at night. With electric lights there is very little difference in the two shifts, provided the day shift is careful about making repairs, so that the night crew will not meet with accidents from breaks caused by not being able to see loose bolts, etc. I have before me the daily reports of a dredge operating day and night. The record shows the following progress in length of ditch:

Aug.	Day, Ft.	Night, Ft.	Aug.	Day, Ft.	Night, Ft.
1	190	150	7	160	140
2	190	190	8	100	150
3	190	200	9	30	110
4	190	150	10	160	300
5	150	150	11	160	210
6 (Sunday; crews changed shifts)					

The day crew consists of three men, besides one to boat coal and a cook. The night crew has three only, the coal man and cook not being necessary. The day crew attends to repairs and all extra work. These figures show that the day crew cut 1,520 ft. of ditch and the night crew 1,750 ft. The ditch is 6 ft. wide in the bottom and from 7 to 13 ft. deep, with 1 to 1 slopes. The 300-ft. run of the night crew was cleaning up the bottom, the day crew having moved the dredge back for them.

My experience is that a man cannot stand up to night work and perform hard labor and give the value on his services that he can on day labor. Bright, active men can give 100% efficiency at night if the work is properly laid out for them. My steam shovels gave just as good results at night as by day. Train service was about 90% value at night. The dump gang was just sufficient to dump from trestle or raised track. I avoided all shoveling as far as possible.

A crew working single shift will generally handle more than half the material that a double crew can put out, but with overhead expense and other incidentals the cost per cubic yard excavated is less with double crew than with single crew. Every job has its own peculiarities and its own average of relative cost of night and day work. The work mentioned above is from a 1-yd. dredge. I find better results from night crews on larger dredges. Much more depends on the comforts furnished a night crew than a day crew. They must be well fed and have good sleep to get high efficiency. A contractor at or near a city loses control of this feature if the night crew board themselves. But night work pays if taken in hand properly and if conditions are fair, and it pays better if favored by the plan of work giving the difficult part to the day shift.

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*Contractor, Emmetsburg, Iowa.

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Deep Concrete Girder Poured in Three Lifts

By Louis Muhlhausen*

A 57-ton concrete girder spanning 42 ft. has been built in the new Stratford Theater, Germantown Ave. and Venango St., Philadelphia, to span the proscenium opening. The girder is 21 in. wide by 100 in. deep. It was built by Ketcham & McQuade, contractors, of Philadelphia.

The reinforcement comprises twelve 1⅛-in. square rib bars (half of them bent) and two 1-in. square rib bars, bent. The vertical reinforcement comprises 31 ½-in. round stirrups. There are also six ½-in. square rib bars as horizontal side reinforcement, three on each side in the depth of the girder. Slag concrete was used for the girder.

This construction is especially interesting because it is the first reinforced-concrete proscenium girder in any Philadelphia theater, all others being steel plate girders fireproofed with concrete. Its weight exceeds by nine tons any existing concrete girder in the city.

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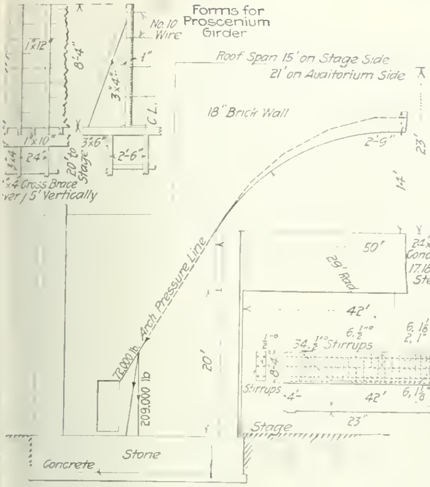
*Engineer to Ketcham & McQuade, Contractors, 1029 Brown St., Philadelphia, Penn.



LARGE CONCRETE PROSCENIUM GIRDER, AND RELIEVING ARCH OVER

A relieving arch had to be built over the girder under provisions of the Philadelphia building law. This a plain brick arch, but it was complicated a little the fact that the line of action had to avoid the stage r. The arch was made of such rise that the weight the blank wall between proscenium opening and stage r brings the line of thrust down and keeps it in the id brickwork at a safe distance from the opening.

A plain box form was built, as sketched in the drawing. The stirrups were placed in the form, then two of the straight 1⅛-in. bars and these wired to all stirrups. The other four straight bars were placed loose. Separators 4 ft. apart, each a short length of 1⅛-in. bar, were laid across this first layer, and the bent bars laid on them, the two outer ones being wired to the stirrups. The ½-in. side bars were then also wired to the stirrups.

Pouring the concrete was done in three installments. A tower about 100 ft. away spouted the concrete directly into the form. The first few batches were made with fine slag—about ⅜-in.—and were mixed very wet. After the top layer of the tension steel was covered, the slag was changed to ¾-in. material. The pouring continued to a depth of 3 ft.

At this time the concrete was diverted to another part of the roof, so as to allow the 3 ft. of concrete in the girder to set partially. Then the second lift was added, and after a similar interval the third. The one day's work completed the girder and the adjacent roof sections.

Contractor's Traction Derrick

A traction derrick has been built that will find employment by contractors of almost every description. It weighs 19,500 lb., has a lifting capacity of 4,000 lb. and dimensions that bring it within railway and highway clearances, so that it will travel almost anywhere a motor truck can go. In addition to its work as a derrick it can be equipped with a bucket for excavating or unloading and can spot cars by means of a winch-head.

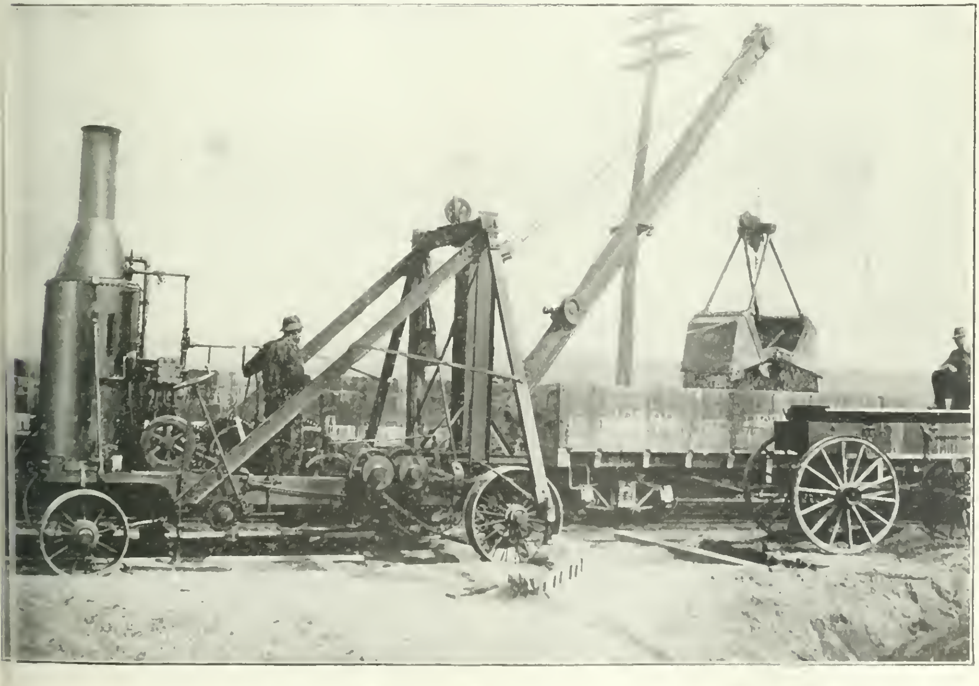


FIG. 1. BYERS' "AUTO-CRANE" ON A MUNICIPAL ROAD JOB AT FLINT, MICH.

The four-wheeled car body is 17 ft. 4 in. long by 6½ ft. wide, with a 15-ft. 4-in. wheelbase and a height from ground to top of A-frame of 12 ft. Either a ½-yd. clamshell or a 12-ft. orangepeel can be used at the end of a 20-ft. boom.

The forward or propelling wheels are 38 in. in diameter with 10-in. face and ¾-in. tires. On these wheels are sprockets driven by a heavy steel pintle chain. There is also a differential. The steering wheels are 30 in. in diameter and are mounted on a pivoted axle and steer by handwheel and worm. An emergency hand brake is provided. The wheels are drilled for attaching spuds, if desired. The propelling speed forward or reverse is 200 ft. per min.

The machine is built with three power friction drums for use with clamshell or orangepeel. Where the outfit is used only as a derrick, the same frame is employed with but two power drums, space being provided for a third drum, so that the extra drum can be added in the field, if desired. Housing is provided in the form of an all-steel cab.

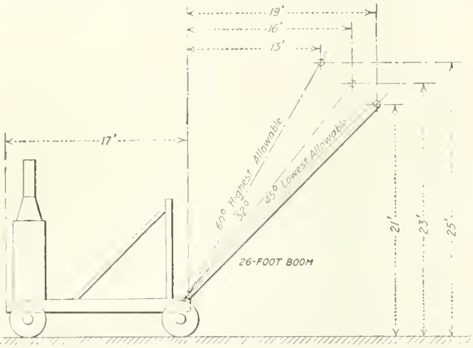


FIG. 2. BOOM HEIGHT AND RADIUS AT DIFFERENT ANGLES OF BOOM OF BYERS' "AUTO-CRANE"

The boom is an 8x10 stick having a three-rod steel truss the full length. If the contractor desires a bucket to be furnished with the outfit, he should describe the general character of the work on which it will be used. For sand, gravel, screenings and similar loose material almost any light standard bucket is satisfactory, but with crushed rock, slag or other large or heavy materials it is important to have a high-powered bucket, in some cases fitted with teeth. The manufacturer, the John F. Byers Machine Co., of Ravenna, Ohio, guarantees one round trip per minute of boom and bucket.

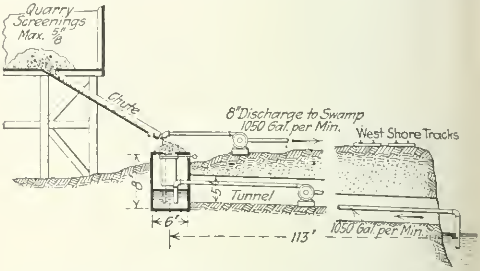
⁂

Centrifugal Pumps Dispose of Quarry Waste

The disposal of large amounts of quarry screenings (⅝ in. and smaller) constitutes a troublesome problem at a number of crushing plants. The Upper Hudson Stone Co., Marlborough, N. Y., has devised an unusual method for wasting this material. It is pumped from a sump to marsh lands.

The plant is situated on the west bank of the Hudson River, its screenings storage being not more than 150 ft. from the water. Under the tracks of the West Shore R.R. and extending from the river to the plant is an old tunnel about 5x5 ft. in cross-section. A centrifugal pump was placed in this tunnel, as shown in the sketch, drawing water from the river and discharging into a covered sump or cistern, 6x6 ft. in plan by 8 ft. deep. The waste screenings are chuted to the top of this cistern, being dumped inside through a sliding trap controlled by a handle, as illustrated. When the door is slid open, the screenings fall through a canvas bag into the water, as shown. This arrangement, in addition to eliminating the usual dust, is also quite flexible.

The mixture in the cistern contains about 15% solids and is pumped out and wasted by means of a second pump outside. A maximum of 45 yd. per hr. can be handled. An 8-in. spiral riveted asphalt-dipped discharge pipe has been used with very good results in handling this abrasive material.


Quarry Screenings Max. 5/8"
Chute
8" Discharge to Swamp 1050 Gal. per Min.
West Shore Tracks
8'
5'
Tunnel
6'
113'
1050 Gal. per Min.

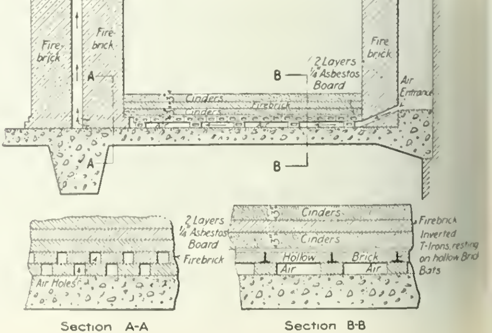
HOW QUARRY SCREENINGS ARE WASTED AT UPPER HUDSON PLANT

Each of the pumps has a capacity of 1,050 gal. per min., and the swamp is 1,800 ft. distant. This arrangement was worked out by Anderson Dana, of the Upper Hudson Stone Co., and R. L. Sites, of Brown & Sites Co., 30 Church St., New York City.

⁂

Insulating a Concrete Floor Under Boilers*

Two new boilers were installed on a reinforced-concrete floor. After being used for a short time cracks were noticed in the concrete, caused by expansion due to the excessive heat. A little later a brick wall that separated the two boilers had to be taken out because the heat was so intense that the wall started to give way. This



DETAILS OF CONCRETE-FLOOR INSULATION

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*Reprinted from "Power," Sept. 5, 1916.

wall was 34 in. thick, with outer layers of firebrick and the interior of common brick, and rested on the concrete floor. The concrete under the wall was found to have begun to dehydrate. On taking up some of the insulation under the combustion chambers, which consisted of a 1-in. layer of 85% magnesia over the concrete, two layers of common brick and a top layer of firebrick, it was found that the magnesia had become pulverized and the concrete dehydrated on the surface.

Asked to suggest some method of overcoming the difficulty, the Ferro Concrete Construction Co., Cincinnati, Ohio, proposed the method shown in the accompanying ross-section. The method depends for its protection argely on the circulating air space between the combusion chamber and the floor, and in the separating wall. loles were punched through the outer wall to allow the utside air to enter, pass under each boiler setting and up through the slot in the center wall.

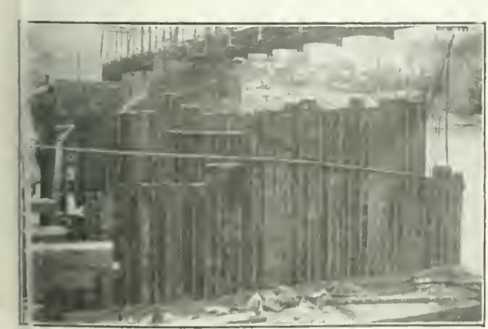
This air space under the boiler setting was formed by nverting $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{5}{16}$-in. steel tees, placed the length of brick apart, and held up by pieces of hollow brick 2 ft. part. The tees were covered by a layer of hollow brick, hus forming an air space above the brick. The surface f this brick was flushed with a sealing of clay, which was overed in turn by two layers of $\frac{1}{4}$-in. asbestos board, ection *BB*. Over the board was placed a 3-in. fill of nders, a layer of firebrick and another 3-in. fill of cinders. Under the brick wall, the air space was formed by acing the two lower layers of brick as shown in section *A*, leaving air spaces between the bricks. When the ill itself was replaced, it was built of firebrick.

The boilers have now been in operation for some months d no further trouble has been experienced. A vigorous rrent of outside air is constantly drawn through the r holes. The roof of the air space formed by the hollow ick is pretty hot, but the bottom formed by the conete has a temperature of about 250 deg., as measured a pyrometer at various points. This temperature is t high enough to do any damage to the concrete.

⁂

Locomotive Crane on Trestle Pulls Coffer-Dam Piles

The piers of the Susquehanna River Bridge of the iladelphia & Reading Ry., at Milton, Penn., were built steel sheetpile coffer-dams 20x40 ft. in plan, about ft. deep with about 10 ft. penetration in the sand of river bottom.



G. 1. COMPLETED PIER COFFER-DAM FOR READING BRIDGE AT MILTON

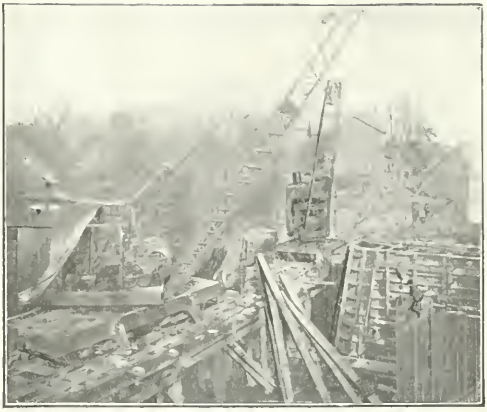


FIG. 2. LOCOMOTIVE CRANE PULLING SHEETPILING, MILTON, PENN.

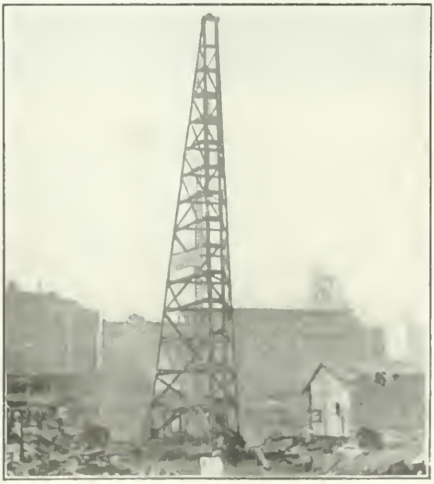
The concrete was placed from a timber working trestle built along the line of the bridge. When the piers were completed, it was decided to recover the piles by means of a McMyler locomotive crane already on the job. Fig. 2 shows this work in progress. No serious difficulty was experienced, and the piling was recovered at a low cost.

This was an excellent opportunity to use an inverted steam hammer, but the most suitable make of hammer for this service was not on the job. The Robert Grace Contracting Co. built the piers and pulled the coffer-dam sheetpiling. F. P. Kemon was superintendent.

⁂

World's Tallest Piledriver for 115-Ft. Piles

The new Southern Pacific general-office building bounded by Market, Steuart and Spear St., San Francisco, requires in the foundation work approximately 2,500 piles 115 ft. long, driven until the heads are 15 ft. below street level. For this work, the Healy-Tibbitts



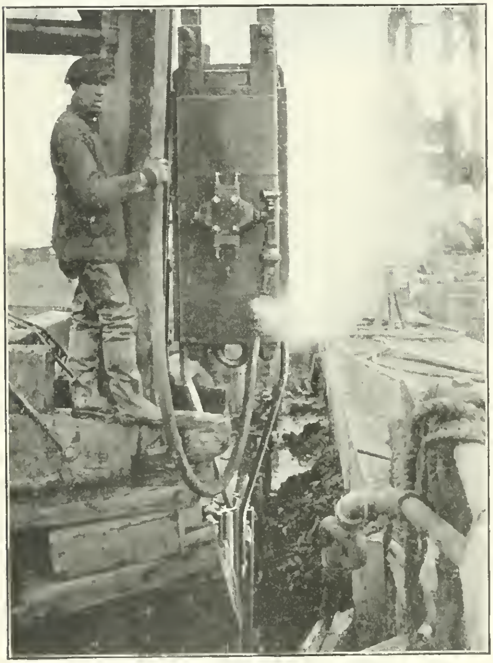
TALLEST PILEDRIVER PUTTING 130-FT. PILES 15 FT BELOW STREET

Construction Co., contractors for the foundation, have built, and now have in operation, a piledriver believed to be the tallest on record. It is 133 ft. from the bottom of the sill to the top of the headblock. A second driver—a duplicate of the first—is in course of construction, and will be in operation in a few days.

⁂

Coffer-Dam Piles Easily Pulled by Inverted Hammers

The construction of the intake and discharge condensing-water tunnels at the new power house for the Buffalo General Electric Co. requires 344 tons of steel sheetpiling in 35-ft. lengths for coffer-dams. This piling was driven and redrawn several times by an inverted McKiernan-Terry hammer. This hammer weighs 5,000 lb. and is shown pulling in the accompanying view. The work is done by the Stone & Webster Construction Co.

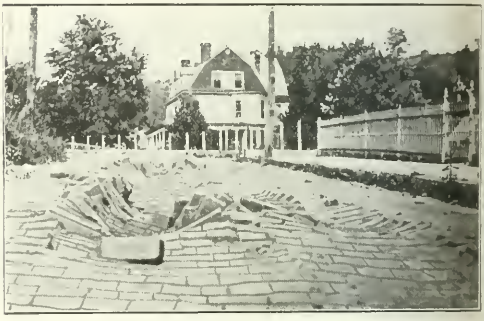


PULLING SHEETPILES AT BUFFALO

NOTES

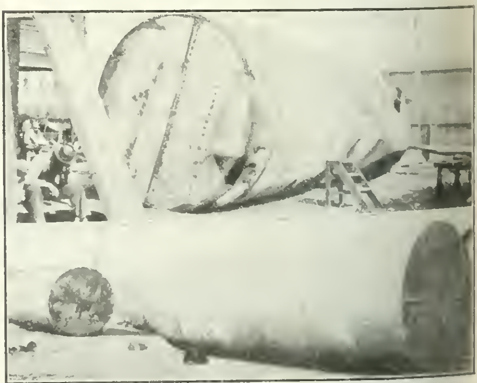
Spot Test for Purity of Creosote Oil—The absorption spot test for the purity of creosote oil is defined by Homer Cloukey, of the Forest Products Laboratory, Madison, Wis., as follows: "Allow six drops of the sample of oil to fall upon the surface of clean, white blotting paper. If tar, carbon or dirt is present it is very easily observed, as it quickly segregates at the center. The paper should be laid away in a flat position for a few hours in a place free from dust. If then examined, foreign matter will be observed in a distinct zone in the center of the spot; the outer zone will very readily indicate the character of the oil." In order to establish some idea of the sensitiveness of the test for tar, carbon or dirt in creosote oil and to make it fairly quantitative, Mr. Cloukey made a series of six tests using carbon-free creosote oil and adding to it in definite graduated amounts carbon in the form of lampblack. The results of the series obtained showed an increasing density of the free carbon ring in the center of the spot as the amount of the lampblack was increased, and further indicated that an amount of carbon so small as 0.005% is easily shown by this test. In percentages greater than 0.5%, however, the amount of foreign matter in an unknown sample would be difficult to determine by comparison. The admixture of tar to creosote oil in actual practice can be roughly estimated by the size and density of the inner zone and the general character of the spot. The heavy tar does not diffuse with the same rapidity as that of the lighter creosote. The absorption spot test has been adopted by the Diesel Engine Users Association of England for the examination of oils used for fuel in this type of engine.—Thomas F. Murphy, Republic Creosoting Co., Indianapolis, Ind.

What Happened to a Brick Pavement without a concrete foundation or adequate underdrainage, when it was subjected to a few days' traffic of a 7-ton motor truck loaded with new paving brick, is shown in the accompanying illustration of a street in Morgantown, W. Va. Unfortunately the city has many miles of pavement similarly constructed.—C. S. Pratt, Morgantown.



BRICK-PAVED STREET IN MORGANTOWN, W. VA., UNDER MOTOR-TRUCK TRAFFIC

Repairing Damaged Oil Tanks—Twelve oil tanks 30 ft. long by 10 ft. in diameter that had been badly damaged by explosions during a fire were recently repaired by the Johnson & Barry Steel Co., North Birmingham, Ala. The tanks were completely cut apart and straightened out, the rivets being removed by "rivet busters," and then the plates were riveted again. Information of this job is furnished by the Chicago Pneumatic Tool Co., whose tools were used.



ONE OF THE DAMAGED TANKS BEFORE AND AFTER REPAIR

Editorials

Sewer-Gas Effect on Sewers Needs Investigation

The possible disintegration of concrete in sewer arches nder the action of sewer gas is the subject of contro- ersies of infrequent but insistent recurrence. The very reat preponderance of concrete sewer structures abso- itely unharmed by any such action would make almost egligible the few cases where decomposition has been ported, were it not for the fact that all too frequently nphasis is laid on the actual case rather than on its rity. There has been a tendency to follow this course the case of the Chicago stockyard sewer, which is the bject of an article on another page of this issue. Con- lerable local publicity has been given to the case, and is probable that the commercial interests in competi- n with concrete will, with business sagacity, endeavor bring it to the attention of as many engineers as ssible. For that reason we have thought it worth while present the facts of the case as they appear to a repre- itative of the clay and brick interests and to present the same time a statement prepared by one of the tors of this journal.

In a consideration of the conditions here shown, engi- rs should remember that the sewage passing through stockyard sewer is by no means of an ordinary char- er. The sewer forms the outfall for the very stale uent from what is practically a huge septic tank formed an arm of the Chicago River, into which sewers dis- rge and which has a sluggish flow to this outfall. is channel is now being filled up and will soon cease xist, but at present the sewage flowing through it is bably as strong as any in this country. It is far se than the ordinary discharge in a low-grade sewer re there is sluggish flow. If concrete decomposition e to be expected anywhere, it would be here.

t the same time comparable sewage conditions do un- btedly exist elsewhere, especially in purification tanks, re no structural deterioration has been noticed. The e fact, then, that the Chicago sewer is affected is of idiary importance. What is important is to find out, , if the same sewage would in time have a similar t on concrete or brick of the highest excellence and, nd, how the concrete as it exists in the Chicago sewer ld be affected by sewage of varying quality. Such nvestigation should repay the Chicago authorities.

eanwhile, lacking these comparable data, the conclu- s to be drawn from the Chicago case appear to be tically the same as those which have been drawn from other reports of disintegration in sewer arches. These that if given a high enough sulphur content, the ge will throw off gases which, when mixed with the en of the air and in the presence of moisture, form cid sufficiently strong to attack concrete of ordinary rity. Furthermore, this same action will take place nly in the mortar between brick or tile lining, but rick and tile lining itself under certain conditions. cases where it does occur, however, are so few that it is fair to assume that with a concrete of sufficient density or one protected by some special coating or waterproofing, or with a brick or tile of sufficient glazing or high enough burning, the probability of disintegration is quite small.

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Prompt Unloading of Freight To Prevent Car Shortage

There is good reason to believe that the present fall will witness the most serious car shortage that has ever taken place in the history of American railroading. While the crops of 1916 are not as heavy as in previous years, they command a high price and the surplus will be moved to market as rapidly as the cars can be obtained. In addition to this, business is at a high pitch of activity the country over—the iron and steel mills are working to the limit of their capacity, an enormous volume of manufactured goods from all parts of the country is being carried to the seaboard for export, and congestion in handling freight at tidewater makes more or less delay necessary there.

In years of previous car shortage there has been a tendency to throw the whole blame upon the railway companies for not providing cars enough to meet every possible demand of shippers. At the present time business men, appreciating what the railway companies have recently gone through and what they are now facing, will not be quite as ready as formerly to expect everything from the railways and to forget their own obligations. The fact has been forced home upon the business public that car shortage may be due quite as much to delay of shippers in unloading and loading cars as to delay of the railways in moving them. Warnings have been issued by the Federal Trade Commission, the Interstate Commerce Commission and various state public-utility commissions urging receivers and shippers of freight to hold cars the least possible time in the interest of the public welfare.

To make this warning effective, however, something that will appeal to the individual shipper from the dollars and cents point of view is necessary. The Demurrage Committee of the American Railway Association, after a conference with the National Industrial Traffic League, is seeking authority from the Interstate Commerce Commission to raise demurrage rates to a point that will give receivers of freight a larger incentive to unload cars promptly. It is proposed, after allowing two free days for unloading, to charge $2 for the third day, $3 for the fourth day, $4 for the fifth day and $5 for the sixth and each succeeding day the car is detained.

Another excellent means of utilizing cars to the best advantage is pointed out by the Universal Portland Cement Co. in a statement issued Aug. 30. If purchaser in ordering cement by the carload will make their order read "one car, any size," "two cars, any size," etc., it will permit the cement companies to load up to the limit of their capacity whatever cars are obtainable from the railways. Where an order is for a fixed number of barrels, however, it is often necessary to send out a car only partly loaded. This practice not only raises the cost of freight on the cement, but utilizes cars inefficiently at a time when every car ought to be rendering its maximum service.

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Making Water Consumers Pay for Sewer Service

How many other city departments should a water-works support in addition to its own? Reports from different cities show no unanimity of practice. If the water-works department alone were consulted, there would be general agreement that it should be self-supporting and stop at that. Unfortunately, many water-works departments are compelled to turn their revenues into the general city fund and to accept with as good a grace as possible what the city council appropriates to them for operation and maintenance. Although the city accounts are generally so kept as to yield no certain knowledge of actual financial results, beyond a few crude data, it is common for the city council to grab all the water-works receipts it dares and use them to keep down taxation.

George G. Earl, general superintendent and chief engineer of the Sewerage and Water Board of New Orleans, La., a man well known in the water-works field for his valuable studies of water rates, cheerfully concedes in his annual report for 1915 that sewerage operation and maintenance may rightly be met from water revenue; but he balks at saddling drainage expense also on the water-works, as the city authorities appear to be doing in no small degree. It may be explained that the water-works, sanitary sewers, surface and subsurface drainage of New Orleans are all under the board of which Mr. Earl is engineer.

Mr. Earl's consent to meeting sewerage costs and argument against meeting drainage costs from water revenue are as follows:

> It is logical that water rates should cover the cost of maintenance and operation of both the sewerage and water-works systems. The function of the sewerage system is to carry away the water which has been delivered by the water-works system after it has been used, and in most cases the benefits derived from the sewerage system are actually in proportion to the consumption of water. This argument, however, does not hold as to the drainage operation and maintenance, in which the benefits derived by individuals bear no relation whatever to their consumption of water. The rapid substitution of subsurface drainage and the throwing of the burden of the cleaning and maintaining of such subsurface drains upon the Sewerage and Water Board without a sufficient budget to properly attend to it are responsible for the growing cost of drainage maintenance; and the inability of the city to provide a fund to accumulate for the renewal of machinery and for emergencies necessarily involves an increasing cost of drainage operation. Water rates established only to maintain and operate the water-works system cannot possibly take care of sewerage operation and maintenance in addition and also meet these increasing demands for the maintenance and operation of the drainage system.

Every water-works man will agree with Mr. Earl's plea against supporting drainage works from water receipts; and most will concede that there is considerable force in the argument that sewerage benefits are proportionate to water consumption. Granting all this, we should be surprised if many water-works engineers or superintendents would agree to having water rates cover sewerage as well as water-works operation. Conditions at New Orleans may make this permissible or even desirable. Elsewhere there has been general agreement that there should be no annual charge for sewerage service and that the operating and maintenance charges should be met by general taxation—however the first cost may be distributed.

There is much to be said for having each municipal service stand on its own bottom. Nevertheless, Mr. Earl's reasoning is worthy of thought. If water consumers must bear the burden of other city departments, the sewers may perhaps be loaded onto the water taker's back with more ease and less injustice than any other city service.

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Modernizing Specifications in the Navy Department

In times past the requirements in connection with bids for Navy Department supplies have been so numerous and complicated that on the smaller contracts it was often the case that the only bids received were from men who had made a special study of these requirements and who bought goods from regular dealers to fill the contracts. The Government was thus obliged to pay a profit to a middleman, in addition to the regular retail price, to cover the cost of complying with its red tape.

The Chief of the Bureau of Yards and Docks of the Navy Department, Admiral Harris, has recently made some radical departures in that bureau's specifications to bring them into line with general practice in letting contract work elsewhere. These changes are embodied in the specifications for the structural shop at the Norfolk navy yard, for which bids were opened on Sept. 2.

The first notable innovation in the specifications is the abandonment of lump-sum bids and the adoption of unit prices in their place. The specifications contain an estimate of the quantity which will be required under each item, with a statement that the United States reserves the right to increase or decrease the quantities without change of price per unit, provided the variation does not exceed 25%. It is of course evident that this clause decreases the risk to the contractor, since he is certain of receiving payment for the actual amount of work performed. The change is furthermore of great advantage to the engineer, since it enables him to alter the plans for the work as construction proceeds, as very often becomes necessary to secure the best results, without feeling that he is either placing on the contractor undue hardships or giving him unearned benefits.

Another feature which is particularly noteworthy is that the time of completion of the work is not specified. Each bidder is required to give his own estimate of the time in which he will guarantee to finish the work. Liquidated damages are fixed in the specifications for each day that the work is delayed beyond the time named by the bidder. In comparing different bids for completion at different times they are valued on the basis of the time element and penalty.

In the specifications for the new Norfolk shop the liquidated damages are fixed at $250 per day, this being considered as a fair rental charge which the Government will lose by every day the building is unavailable for use after the date when it should have been completed. The contractor may obtain an extension of the allowed time in case of unavoidable delays. These are defined as delays resulting from causes beyond the control of the contractor, "such as acts of Providence, fortuitous events, inevitable accidents, abnormal conditions of weather or tide, general strikes, or delays caused by acts of Government." On the other hand, delays in securing delivery of materials on account of rejection of materials on inspection, or changes in market conditions, or time taken in submitting, checking and correcting drawings, or inspecting materials are not regarded as unavoidable.

While the specification provides, as above stated, a enalty for noncompletion of the work within the agreed ime, it does not provide a bonus in case the work is inished in advance of the agreed time. If the liquidated lamages for delay in fulfillment of the contract are nade only equal to the fair rental value of the completed vork, it seems clear that the contractor should be entitled o a bonus for anticipating the specified date, as well as ubjected to a penalty for delay.

Water Refining for Cities

Recent advances in water-purification are summed up the two words "water refining" by Prof. William T. edgwick in an address published in the July number of e "Journal" of the New England Water-Works Associa- on. Water refining includes disinfection ("final sani- tion"), clarification, toxination (of algæ by copper lphate), decolorization, deodorization, softening and ferrization.

Aside from disinfection, all these methods of water eatment are aimed to meet the demands of "taste and mfort" rather than health. It signifies great progress at a people who a decade or two ago could hardly be axed or driven into providing money necessary to save emselves from typhoid fever should now be demanding sinfection to make assurance doubly sure and insisting many refinements besides.

It is well to bear in mind that disinfection is a mat- of water refining rather than a primary agent of rification. Rightly used, it is extra insurance against her a light and occasional possible pollution or else inst temporary aberrations in a filtration plant— ides, of course, catching and killing the few straggling ms that invariably escape filtration. When pollution heavy and constant, recourse should be had to filtra- n; disinfection will still be in demand as a refinement.

Because there has been so much advance in water-refin- methods and because so many cities have adopted one more of them, it should not be thought that little ains to be done in the water-purification field. Hun- ds of cities have not yet adopted even the crudest of primary processes, and thousands have yet to enter n water refining. Practically all surface supplies t ultimately be filtered, and there are few even now t should not be at least subjected to disinfection—a arkably cheap and highly effective form of insurance. C gulation and sedimentation are found to be extended, the beneficent effects of long-time storage of sur- supplies will also gain in practical recognition. tening and iron removal have only made a start in erica and are bound to progress rapidly. The removal nanganese, a refinement not mentioned by Professor gwick, may or may not be needed often; but prob- the very few plants for the purpose now built or er construction will be increased many fold.

The 22nd New York Engineers Make Good in the Field

Constructing Camp Whitman—the mobilization point of the National Guard of New York—was perhaps the most extensive operation ever performed by a militia engineer organization, and it is proper that the excellent work of the 22nd New York Engineers, now at McAllen, Tex., be not only described but commended. Many New York engineers will recall the surprise of the public at Governor Glynn's order, of Dec. 24, 1914, disbanding the 22nd Regiment. According to reports only 15 of the old officers were retained and something like 25% of the enlisted men were discharged. The daily press of New York City was rife with caustic allusions to tango soldiery. That these allusions were not without justification is proved by Major-General O'Ryan's statement which he made at the time. He is quoted as saying:

> The 22nd Regiment is steeped in old infantry methods. All the officers and men capable of performing the services expected of engineers will be assigned for duty after the regiment is disbanded and the battalions reorganized.

All officers retained in the unit had first to win the approval of Lieut.-Col. Lucas, Chief Engineer Officer of the New York militia, who as president of a special examining board passed upon the qualifications of the officers. Colonel Lucas reorganized the two battalions and thereafter commanded them. During his régime 18 new officers have been appointed, the officers of the corps now numbering 37.

Quebec Bridge Suspended Span Collapses

Just as this page of *Engineering News* goes to press on Sept. 11 a member of its editorial staff sends the following dispatch from Quebec:

> Center span collapsed and fell in river at 10:50 a.m. Cantilevers intact. No structural evidence left. Only circumstantial evidence available as to cause.

The engineering world was amazed when the south cantilever of this great bridge fell nine years ago; but words are inadequate to express its sensations at the news that again this great bridge enterprise has suffered an unprecedented disaster. It is true that the process by which this huge 5,000-ton span was to be hoisted off the scows and lifted bodily nearly 150 ft. in the air was unprecedented in the annals of engineering. It is also true, as those who followed the description of the process in *Engineering News* of Aug. 31 can understand, that every step of the process had been carefully planned in advance, and to all appearance its success was as fully assured as is possible with any piece of engineering work, even work carried out as ordinary routine.

On later pages of this issue will be found a description of the span which collapsed and as full details as are available of the disaster. Engineers may well suspend judgment on this most deplorable event until full information can be given.

This latest failure can only delay for a short time the completion of the great bridge. The suspended span is after all of moderate proportions compared with the gigantic cantilevers which it will connect; and in no long time the successful placing of a new suspended span will be recorded.

Letters to the Editor

Venturi Meters on Lively Lines

Sir—Mr. Hazen's article, "Venturi Meters Inaccurate on Lively Lines," in *Engineering News*, Aug. 17, 1916, is very interesting, and his illustration and explanation of the theory showing that over-registration would be, under the conditions of his example, as high as 41%, appear very plausible; and this is the theory that has been held for a long time by many of those experienced in this class of work. The writer, however, has never been perfectly satisfied with that view, for the reason that venturi-meter registers are designed to measure the flows directly by integrating the square root of the head, and these integrations are in the nature of a differential proposition, practically instantaneous. The only reason why Mr. Hazen's theory would be effective is that there is a certain lag between the movement of the mercury and the movement of the register. Nevertheless, his statement is correct that under rapidly fluctuating flows the result is an over-registration.

There are two practical methods of correcting this. One is by the use of well-charged air chambers, and the other is by means of a compensating device consisting in attaching to the two small venturi-tube and register-connecting pipes a U-tube of very large dimensions in comparison therewith and in which is kept a heavy liquid, whose difference of surface level will fluctuate very little compared with the fluctuation of difference in pressure in the two small pipes, the quieting effect being due to the inertia of the heavy liquid. The writer views the difficulty as one of inertia, and it has its analogy in the current meter and from the fact that in a turbulent river a raft will float downstream faster than the average velocity of the surface of the water. The explanation in the case of the current meter is that velocities greater than the average will be impressed on the moving vane; and if there were no friction, the vane would revolve at the speed corresponding to the maximum velocity. While this difficulty may be overcome by a certain form of construction of the current meter, it is certain that for the ordinary type those that are light in construction give more accurate results in a turbulent stream.

Mr. Hazen infers that makers of venturi meters may have obtained their coefficient of tubes by tests with reciprocating pumps. This is quite unlikely. Some of the principal firms manufacturing this type of instrument have made very exhaustive tests by means of gravity flows through venturi tubes of various sizes and ratios, the water being weighed in the most accurate manner in well-equipped hydraulic laboratories, and the venturi heads being obtained by means of water columns, using air, tetrachloride of carbon, and directly by means of hook gages. In many cases, all these methods were used simultaneously, while at the same time the results of weighing were checked by measuring the discharge from the venturi tube through a triangular-notch weir. The results, to the writer's personal knowledge of at least one of these firms, are unquestionably accurate. They show that there is a variation in the coefficient depending on the ratio of the venturi tube. In some cases the coefficients are as high as 99%; in others as low as 95%. If we were going to take a fair average we would use about 97½%. But the coefficient varies slightly at velocities above 4 ft. per sec., through the throat and quite materially below this, the coefficient being less at the low velocities, and the variations corresponding to a rather typical curve.

J. W. Ledoux,
Chief Engineer, American Pipe and Construction Co.
Philadelphia, Aug. 18, 1916.

Sir—Mr. Hazen's note on this subject in *Engineering News*, Aug. 17, 1916, interests the writer, as he had some experience of a similar nature during the development of the apparatus for integrating the flow through a Deacon waste-water meter. An integrating meter of this type, known as the Kelvin bulk meter, is now manufactured and sold by the Palatine Engineering Co., of Liverpool. The natural movements of the pencil in a waste-water meter are very lively, and a short trial was sufficient to show that it was impossible with any degree of accuracy to integrate the corrected movements direct with a clock-driven time disk, as the under-registration or slip was so considerable. The lively movements were subsequently reduced to as small an amount as desirable by the interposition of a cataract, and no further trouble was experienced.

The important point, however, to notice in these waste-water meter experiments is that the error in registration was in the opposite direction to that referred to by Mr. Hazen and was proved to be due to another cause which is of general interest, as it must also affect any case of integration with a time disk where the friction roller of the registration counter is impressed with lively lateral movements.

An experimental apparatus was prepared in which the friction counter wheel was mounted upon a vibrating mechanism with adjustments so that both the speed and the frequency of the lateral vibrations and the weight on the counter wheel could be varied. This apparatus was put upon a clock-driven time disk and its true registration determined without the lateral movements. These figures were compared with the subsequent registration when lateral movements of various amplitudes and frequencies were impressed upon the counter. It was found that the slip increased both with the frequency and the amplitude of the lateral movements of the counter to such an extent that it might be inferred that with very high vibrations no registration whatever would take place. The weight upon the friction wheel did not appear to have much to do with the amount of slip. The movements produced somewhat the same effect as smoothing down and lubricating the time disk. A somewhat parallel case occurs when opening or closing a telescope tube, where it is found that by a slight rotating movement in addition to the direct effort the tube can be much more easily moved longitudinally.

It would appear that both the over-registration referred to by Mr. Hazen and the under-registration referred to here may be made negligible by checking the lateral movements of the registration counter; and this should be very easy with the venturi meter, as it is only necessary to put partly closed cocks or orifices in the communication pipes between the venturi tube and the float chamber in the same way as is frequently done with pressure gages on lively lines.

W. Gore, Consulting Engineer,
John ver Mehr Engineering Co., Ltd.
Toronto, Ont., Aug. 29, 1916.

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Dangerous Timber Roofs Due to Incompetence

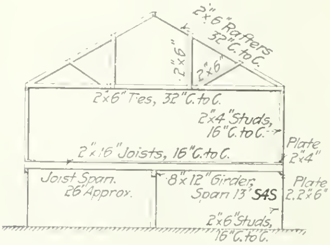
Sir—The editorial in *Engineering News,* July 13, 1916, with regard to the failure of the Atlanta, Ga., skating rink, and that at Salt Lake City, is to the point. While, owing to the lack of plans of the buildings, it may be impossible to determine the initial cause of the failures, yet the lack of longitudinal truss and roof bracing is so apparent in the Atlanta building as to warrant suspicion as to responsibility for the failure. Unfortunately, lack of bracing is too common a fault of many structures of this type, and results largely from failure on the part of the owner to investigate the capability of his architect, coupled with a desire to get the cheapest building possible. This statement does not, of course, excuse the lack of proper inspection of the plans by the building departments.

Were sufficient information available, it would be interesting to know the stresses in the truss members. With the very flat curve of the truss, the chord stresses must have been of considerable amount, even with the small weight of roof supported. Laminated chords, especially when but sparsely spiked, as these are described to be, are not efficient as columns. The spiking is subject to a large initial stress in holding the boards to he constrained position as arcs of the curve of the truss, and a small addition of load in the chords must have ncreased the stress in the spikes sufficiently to allow hem to give slightly and the individual boards to slip past each other. Thereafter the strength of the chord would be the sum of the strengths of the boards acting as separate columns. These small columns would also have to resist bending in addition to axial stress, due o the eccentricity of the thrust or pull on the mid-secion between panel points. The photographs show the hords bent to a more or less sinuous curve without racture.

Lack of a tie at the floor line is also a criminal omision, and the fact that the ties provided were an afterhought indicates that neither the architect nor the inpector who passed the plans (if they were ever examined y the building department) had any conception of arch ction.

The writer wishes to call attention to another feature f the trusses. As far as can be judged from the photoraphs, none of the web members are dapped into the hords, and apparently the only way in which the webs ould transmit their components of stress into the chords as by means of whatever friction existed plus the reistance of possible toenailing. Possibly the architect believed, as the writer has found not a few designers (including an engineer or two) to hold, that the web stresses in a timber truss go chasing themselves down one diagonal and up another in a vain attempt to find ingress to the chords, until they come to the end of the truss, when they give up the chase in despair, and conclude to remain in the webs.

The writer had occasion recently to examine a dance hall, concerning which complaints had been made in regard to its swaying while dancing was in progress. The hall proper was about 52x80 ft., the dance floor being the second floor. The typical construction of the building is shown by the accompanying sketch. The construction indicated illustrates the common way of framing a wooden building on this coast; that is, constructing a stud wall, cutting and capping it, laying the floor joists on the caps, placing the plates of the second story on the joists, framing the second-story studs, capping and placing the ceiling joists and roof rafters on the caps. Ordinarily the cross-partitions, diagonal wall sheathing, etc., furnish the necessary stiffness to the building. In this case there were no cross-partitions, and even the end partitions were of doubtful rigidity, due to openings.


2"x6" Rafters, 32" C. to C.
2"x6"
2"x6"
2"x6" Ties, 32" C. to C.
2"x4" Studs, 16" C. to C.
Plate 2"x4"
2"x16" Joists, 16" C. to C.
Joist Span. 26' Approx.
8"x12" Girder, Span 13' S4S
Plate 2.2"x6"
2"x6" Studs, 16" C. to C.

CROSS-SECTION OF FRAMING OF DANCE HALL, UNSAFE

The roof, with a span of 52 ft., was carried by partially trussed 2x6-in. rafters and ceiling joists, 32 in. on centers, the trussing in the center portion being omitted, with the result, of course, that all the trussing was ineffective. For good measure, apparently, the architect had built real trusses, of two 2x8-in. chords, 2x8-in. compression webs, and steel tension rods. These trusses were 10 ft. on centers, approximately. Unfortunately, as the "trussed" rafters ran the same way as the real trusses, the latter were prevented from accomplishing any results in the line of supporting the roof, despite their latent usefulness. It is hardly necessary to state that there was not a vestige of bracing between the walls and roof, or for that matter in any portion of the building with the exception of two kneebraces underneath the second floor, and in the line of the second-floor girders, or in the stiffest way of the building.

The second-floor joists were found good for a live-load of 87 lb. per sq.ft., and the second-floor girders for 36 lb. per sq.ft., both figures being at 1,800 lb. per sq.in. bending stress. The result of this construction was that the roof between end walls had settled very perceptibly, and the somewhat ornate plaster ceiling was quite badly cracked. Not only did the floor vibrate very unpleasantly, but the movement in the walls was very perceptible while dancing was in progress.

Engineering News is rendering a real service in giving publicity to failures such as the Salt Lake and Atlanta collapses, and the accounts of these should be brought to the attention of the public at large, to the end that any structure for public use be made safe beyond the shadow of a doubt. H. D. Dewell.

58 Sutter St., San Francisco, Calif., July 19, 1916.

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Unit Prices for Street Mains in the Buffalo Gas Case

Sir—Through personal knowledge of the facts involved, I have been particularly interested in the article in your issue of Aug. 24, "The Determination of Unit Prices in Appraisals for Rate Making," by Judson C. Dickerman.

Permit me, from a knowledge of the facts and in defense of the engineering profession, to comment on Mr. Dickerman's statement, as based on the opinion given by the Public Service Commission, 2nd District, State of New York, in the Buffalo Gas case.

The opinion was written by F. W. Stevens, after he had retired from the commission of which he had been chairman. Mr. Stevens' opinion of the estimates of numerous engineers as to unit prices, Mr. Dickerman says,

> ends up with the clear and forceful statement that fixing a unit price for an extensive system of gas mains from data submitted by engineers or inferred from contractors' bids on other jobs is nothing but a guess, and the commission declined to make the guess.

Mr. Dickerman's last paragraph, as his article is condensed in your paper, is as follows:

> The valuations as of date of appraisals are based on unit costs which are so much the result of the judgment of the engineers making them that they are little better than opinions. And the opinion of no one man or associated group of men, particularly where such group or individual is liable to be influenced directly or indirectly by the interests employing him, can be taken with safety as to a fair and reasonable value.

Unfortunately, the case as presented by Mr. Dickerman is plausible. But what are the facts? To commence with, Mr. Stevens' opinion not only ignores facts but contains statements as to the testimony which, to speak in guarded language, are misleading.

I have before me a complete analysis which I made of the opinion at the time it was first placed in my hands. This analysis shows that Mr. Stevens made many comparatively unimportant errors in quoting facts and figures from the testimony. Even these minor errors serve to show, however, that Mr. Stevens' statements need to be carefully checked before acceptance.

But let me pass to more serious errors. I wish particularly to refer to the evidence as to unit costs of street mains, as that is the point emphasized in Mr. Dickerman's misleading article. On p. 47, Mr. Stevens gave a table of unit prices for street mains which he says were testified to by a gas company's witness in the previous 1907 case, and then he compares that table with the unit prices testified to by the gas company's witness in the case now under consideration. On this comparison and the failure to agree between the two statements, both of which he ascribes to the gas company's witness, he bases most of his ridiculous criticisms of engineers' testimony.

At first we of the gas company were puzzled to discover the source of the 1907 unit prices, as quoted by Mr. Stevens and falsely attributed to the gas company. We were unable to find any warrant for these unit prices in our testimony, but finally we found that these unit prices were those testified to in 1907 by the late W. D. Marks, *a witness for the city.* In passing, I may state that Mr. Marks' unit prices failed to contain certain necessary costs of laying, which fact we demonstrated in our cross-examination of this inexperienced witness.

The error here introduced by Mr. Stevens is carried through page after page of his subsequent arguments against the company. Time after time he refers to this Marks' testimony as the testimony of the gas company. There is no misunderstanding, therefore, upon which to base an apology for Mr. Stevens.

I now come to a part of Mr. Stevens' opinion which I do not care to characterize. Mr. Stevens attempts to show that the unit prices testified to by the company were simply opinions, that these opinions varied, and so "the commission declined to make a guess." On page 68, Mr. Stevens says:

> It (the commission) has no evidence as to the general character and conditions of the soil to be encountered in making excavations; . . . there is nothing showing what the cost of labor would be . . . no engineer sworn before us knows anything about the conditions to be encountered of soil or obstruction in the streets.

On page 100—"General Conclusions":

> 3. There is no means of ascertaining the actual present conditions of the street mains which constitute the larger part of such property if such condition is material in determining what if any depreciation should be deducted from the cost of reproduction new.

Without quoting further from this remarkable opinion, it may be claimed that Mr. Dickerman was justified in assuming that the unit prices for street mains were based upon opinion and not upon any evidence of fact. That is, Mr. Dickerman was so justified in adopting the views he expresses, based upon this one opinion, if he feels that the "opinion" of a commissioner can be accepted on its face value and without examination of the evidence itself.

The fact is that the evidence submitted on the condition of the mains was unusual for its completeness. I offered to have the streets opened wherever the city or the commission so desired, provided the representatives of the commission, the city and the gas company were present together when all the examinations were made.

While these witnesses were testifying, Mr. Stevens had in his hands the report of the commission's engineer who took full part in the examination. Mr. Stevens afterward acknowledged to me personally that the paper he was constantly referring to was this report and that his report agreed practically with the testimony of the gas company's witness. He also expressed his dissent at the methods employed by the city's witness above referred to.

Samples of pipe taken out of the streets were produced in court by the gas company, and a few samples which were too bulky to be so examined were examined by Mr. Stevens at the gas works, Mr. Stevens and I walking together to the gas works from the courtroom.

If there ever was testimony offered in a rate case which was based upon the facts laid bare to all parties, it was this testimony of the Buffalo Gas Co. on street mains. Furthermore, the gas company's testimony was not opinion testimony, but it was supported by the estimates constantly being made in my office in connection with the extensions authorized, and later checked by the construction costs. What better testimony could be given, especially when presented by honest men of the widest experience as operators? If this is not valid testimony, there is no such thing, and engineers' estimates of cost are valueless indeed.

In conclusion, let me say that I am not particularly interested at this late day in this question on behalf of the Buffalo Gas Co., but I am concerned for fear the estimates of capable engineers may be discredited.

Alexander C. Humphreys,
President, Buffalo Gas Co.
165 Broadway, New York City, Aug. 26, 1916.

Full-Load Secondaries Were Eliminated at Quebec

Sir—In an editorial on the work at Quebec in your number of Aug. 17, there is a slight error.

The bridge is so designed that the trusses have the intended geometrical shape—with straight chords and straight, continuous web members—when the main span is fully loaded and the anchor arms are unloaded. For this loading the main members of the cantilever arms have all practically their maximum stresses. With this loading the only secondary stresses from vertical loads in the main members of the cantilever arms are those from pin friction, especially at the large pins at the main shoes. These are provided for by additional section in the bottom chords near those pins. When the main span is unloaded, there will be considerable secondary stresses in the bottom chords of the cantilever arms, but these are of no importance since they do not coexist with maximum primary stresses.

The bottom chords and the inclined end posts of the anchor arms also have their maximum stresses for the above loading, and they also are so set as to become straight under that loading. Their only secondary stresses from vertical load are those due to pin friction, and these are alone of much importance near the main shoes, where they are provided for by additional section.

There arise also secondary stresses from lateral deformation by wind pressure. These are also considered where they are of sufficient importance to call for increase of section under the provisions of the specification, when added to the other secondary stresses. This specification allows larger unit stresses for the sum of all the stresses than for the sum of the primary stresses. Secondary stresses are therefore only considered where they are a large percentage of the primary stresses.

A very important kind of secondary stress, especially in compression members, arises from differences of temperature of different parts of the same member, when some are exposed to the sun, some in the shade. A temperature difference of 25° F. was assumed, and the large secondary stresses arising therefrom were considered.

More in detail, the elimination of secondaries due to vertical load was accomplished as follows: The lengths of all the main members of the cantilever system were so chosen in the shop that with the main span loaded with 10,000 lb. per lin.ft. of bridge and the anchor arms unloaded, these members have what we call their geometrical lengths, or the lengths which would be the proper shop lengths if there were no deformations. With this loading all the panel points of the chords and those of the web members continuous over two panels will be in straight lines.

This loading produces nearly maximum primary stresses in all the main members of the cantilever arms and in the chords and inclined end posts of the anchor arms and suspended span. With it the secondary stresses in these members are very small. What secondary stresses there arise are due to the moments of the pin friction at pin connections. The pins are lubricated and the pin friction coefficient is less than 2% at the start, but will gradually increase. The friction coefficients were ascertained by tests at McGill University. The members will adjust themselves to such mean positions on the pins that the opposing friction moments balance.

It was assumed that the coefficient of pin friction will increase until the tangential force at the pins produced by the friction is 40% of the axial force. At most of the pins turning will come to a stop under the increasing friction, but at the main shoes it will continue under extreme loads.

Only those secondary stresses are of importance which increase the sum of all coëxisting stresses in a member. Secondary stresses which occur with loadings giving small primary stresses are not of importance. When the bridge is unloaded there will be large secondary stresses in the bottom chords and end posts of the anchor arms and in all the main members of the cantilever arms, but these do not coëxist with maximum primary stresses and they are smaller than the maximum moving-load stresses in these members.

When the main span is fully loaded, the anchor arms unloaded, there are no secondary stresses in the anchor arm except from pin friction and other than moving and dead loads. When the anchor arm is fully loaded and the main span unloaded there are secondary stresses in the anchor arm, but as regards the chords and inclined end posts they are of no importance because the primary stresses are small. In the web members the secondary stresses coëxist with maximum primary stresses, but, as these members are slender, their secondary stresses (with a few exceptions near the main shoes) are not of sufficient size to demand an increase of section.

When the bridge is fully loaded there are secondary stresses of considerable size in the inclined posts of the anchor arms which join the main shoes. The corresponding bending moments go to the shoes, not to the cantilever arm. The secondary stresses in the top chords and in the tension members going to the top of the vertical main post from the anchor arm are very small. They produce small bending moments in the top chords and tension members of the cantilever arms, which are negligible.

The essential principle is to reduce those secondary stresses which coëxist with maximum primary stresses. This can not be done where, as in stiff laterals, opposite and equal stresses occur.

The wind stresses and those from differences of temperature are of opposite signs, and the resulting secondary stresses occur together with maximum primary stresses and must be considered.

A slight inaccuracy results from the fact that the load assumed in calculating the deformations of the members was 10,000 lb. per ft. of bridge while the load used in calculating the primary stresses is 5,000 lb. per ft. of track followed or preceded or followed and preceded by two of Cooper's E60 engines.

Joseph Mayer,
Principal Assistant Engineer, Board of Engineers,
Montreal, Aug. 21, 1916. Quebec Bridge.

Concrete Ocean Pier Built in Form of Hollow Triangle

By C. L. Roberts*

A reinforced-concrete pleasure pier recently completed at Redondo Beach, Calif., is peculiar in that in plan it consists of two separate piers extending from the shore diagonally toward each other and meeting at the ocean end in a platform or cross-pier. The site is at a submarine cañon extending from several miles off shore to within about 500 ft. of low-water mark, forming a wide navigable channel to deep water. The beach to the north and south of this cañon runs to sea on a gradual gradient of 6%, but the cañon bottom has approximately a 1:1 slope to indeterminate depth. Years ago a wooden pier was built from shore out along the side of the cañon to accommodate shipping, but in 1913 heavy seas wrecked the structure. Bonds were thereafter voted in the sum of $125,000 to replace the old pier with a modern reinforced-concrete municipal pier.

This structure, shown in Fig. 1, extends out to sea about 600 ft. As shown in the drawing, the out-to-out distance along the shore between the legs is about 700 ft. Each leg is 36 ft. wide, and the outer platform is about 200x160. The combined pier and shore frontage permit a continuous promenade of about three-quarters of a mile in length.

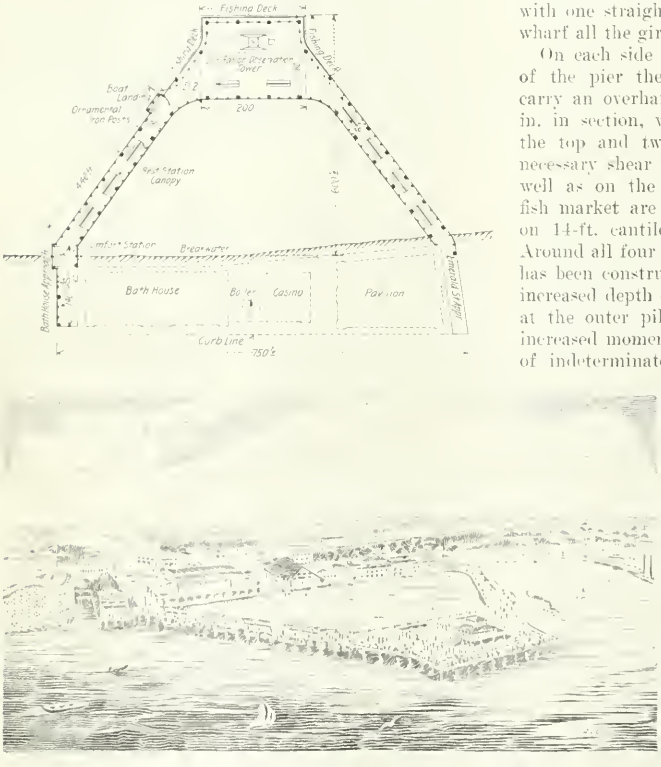

FIG. 1. PLAN AND SKETCH OF NEW MUNICIPAL PIER AT REDONDO BEACH, CALIF.

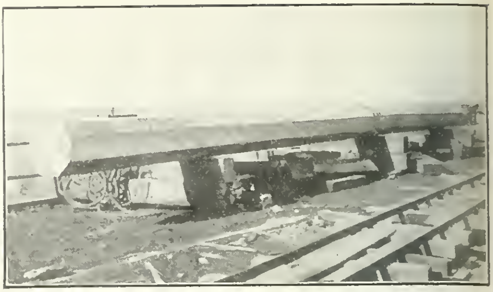

FIG. 2. ONE OF THE CONCRETE PILES, REDONDO BEACH PIER

The structural design is a straight beam-and-girder type; that is, bents made up of three transverse reinforced-concrete piles tied together by longitudinal tie-beams carry a transverse floor-beam and joist system on which the reinforced-concrete floor rests. The piles, Fig. 2, varying in length from 20 to 85 ft. and in diameter from 20 in. (reinforced with $\frac{5}{8}$-in. bars) to 24 in. (reinforced with $1\frac{1}{8}$-in. bars), with a spiral hooping of 4-in. pitch, were precast and driven by jetting. The tie-beams are of 12x24-in. section reinforced with four $\frac{1}{2}$-in. rods, while the transverse floor-beams are 16x24 in. in section, reinforced with four $\frac{5}{8}$-in. square twisted rods. Running into these floor-beams are 4x10-in. joists reinforced with one straight and one bent $\frac{5}{8}$-in. bar. In the outer wharf all the girders are 16x24 in. in section.

On each side of the approaches as well as on the legs of the pier the structure has cantilever beams which carry an overhang in the floor. These beams are 16x42 in. in section, with reinforcement of two 1-in. bars at the top and two $\frac{3}{4}$-in. bars at the bottom, with the necessary shear stirrups. On the southerly approach as well as on the southerly leg a comfort station and a fish market are provided. These structures are carried on 14-ft. cantilevers duly designed for the extra load. Around all four sides of the outer wall a 10-ft. cantilever has been constructed to serve as fishing platforms. The increased depth of the transverse and longitudinal beams at the outer pile line acts not only to provide for the increased moment in shear, but as a haunch to take care of indeterminate stresses thrown into the structure on account of the heavy seas which predominate in March. The whole pier was designed for a live-load of 100 lb. per sq.ft. plus the dead-load, and the city reserved the right to place a test load of 200 lb. per sq.ft. upon any selected panel. Owing to the fact that in actual construction the entire wharf area had to be used for material loading and carrying, the test was omitted. The whole structure contains approximately 3,500 cu.yd. of concrete and 300 tons of reinforcing steel. A new method had to be devised in building the pier because the frontage of the work is the main-line right-of-way of two railways where constant travel did not permit any permanent organization for the casting of piles.

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*Superintendent of Construction, MacArthur Brothers Co., Redondo Beach, Calif.

handling concrete materials, or storage. In consequence the first lot of piles were cast on the small areas available and were transported to the work and driven. On the part of the pier thus constructed, platforms were erected on which the subsequent pile casting and concrete mixing were carried out.

The piledriving equipment consisted of two heavy piledrivers of the skid type, one 36 ft. high and the other 50 ft. high, with a Worthington heavy-duty pump used for the jetting. The pump was placed on a platform midway between two legs of the pier and connected up with the power plant of the bath-house, water being piped through 6-in. pipe out to and onto the two legs of the pier, an additional pipe being laid as the work progressed. Pressure was maintained at about 100 lb. at the pump and was entirely adequate until penetration reached 20 ft.; then it became difficult to overcome the friction with this pressure. Jet lines were run from the main pipe lines to the driver by means of two 2½-in. fire-hose, then to the tops of the gins of the drivers by two 2-in. pipes and then to the jets.

The jets were handled by having a pair of lines leading from the head lines of the drivers and to the drums of the engine By keeping the engine on the driver running constantly the jet man could plunge the jets up and down in much the same way as the well driller works his drills. The jets themselves were bushed down to a 1-in. nozzle and acted like a hydraulic giant.

Falsework for carrying the piledrivers out over the permanent work consisted of 12x12-in. caps 10 ft. long on bents of five piles each. These bents were driven on 10-ft. centers and so placed that the concrete bents came between the wooden-pile bents. This prevented any endency on the part of the jet to sluice out any of the wooden piles. Great care had to be exercised in order to avoid such an occurrence.

The wooden-pile bents were sway-braced with 4x12-in. imbers, and longitudinal girts of the same size timbers were run out. For the transportation of the piling

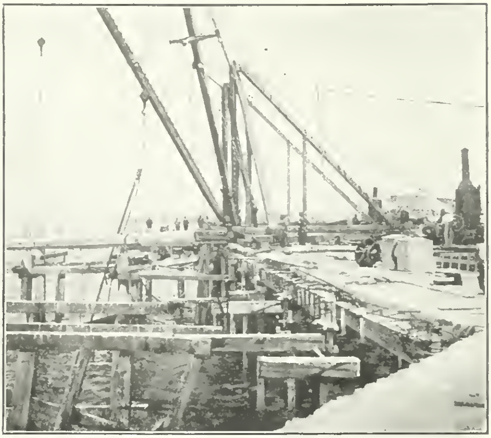


FIG. 4. SWINGING ONE OF THE CONCRETE PILES INTO PLACE

12x12-in. timbers were used for railroad-track stringers. These timbers were taken out as the piledriving progressed and utilized for forms to hold up the concrete floor. As soon as a wharf area was constructed, a pile platform was laid and piling cast on the completed work. The concrete equipment included two small mixers which permitted constant moving out onto the work as it progressed. The material was handled to these mixers by means of small 24-in. gage tracks, and typical stationman cars were shoved out by hand, alternating sand and rock with cement.

This system worked splendidly until deep water was encountered. Then it became difficult to move the drivers, the larger of which weighed 31 tons. From then on, the smaller driver drove the bulk of the falsework. When deep water was reached, there were times when

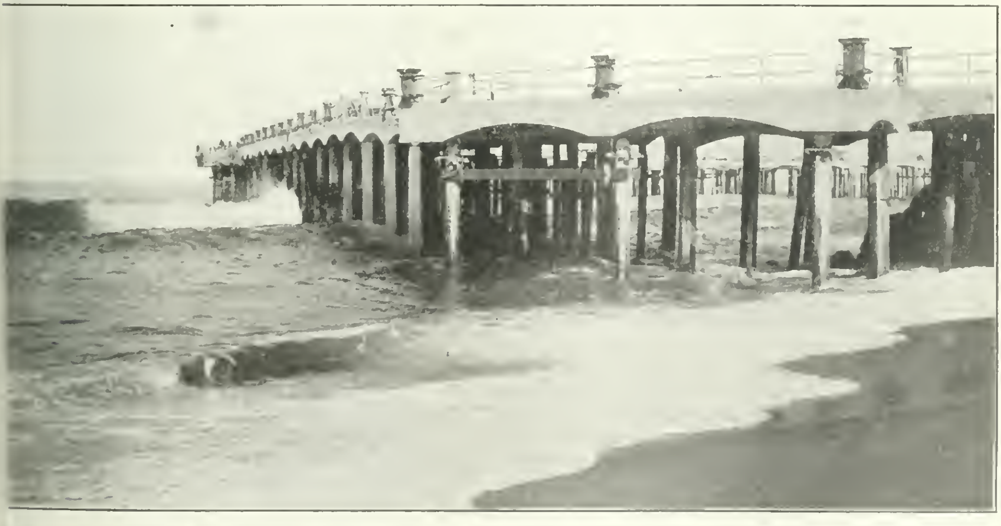


FIG. 3. VIEW OF ONE ALMOST COMPLETED END OF THE REDONDO BEACH PIER

the rigs stood 60 ft. above the floor of the ocean with no means of holding the falsework from pulling out from beneath the drivers. Escapes from a complete launching of the rigs were narrowly averted. On Mar. 22, 1916, one of the heavy northers swept in without any warning. Within two hours of the first blow the entire outer works were scoured and the two drivers lost. Great difficulty was experienced in getting the equipment out.

Toward the end of the pier, owing to the trouble of supporting the piledrivers and excessive lengths of piling, derricks had to be resorted to in driving the piles. These derricks were worked in pairs, the mast being placed on 20-ft. centers. The stiff-legs were lashed to the piles beneath the dock. Concrete piles were rolled to the derricks, and four slings were placed upon the longer lengths. Two derricks would then swing their loads to sea and lower the entire load to the bottom. One derrick having the foot of the pile would let go and swing out to help the derrick having hold of the top; the two would then up-end the pile. Collars were placed upon the concrete piles, and the men steering the jets would ride the pile until it got down to its proper depth.

The work was designed by George W. Harding, of Los Angeles. MacArthur Brothers Co., of New York, Chicago and San Francisco, was the contractor, with the author as superintendent and C. S. Robinson as office manager. J. R. Kirby represented the engineer.

⁂

New Knowledge on Standard Reservoir Mouthpiece

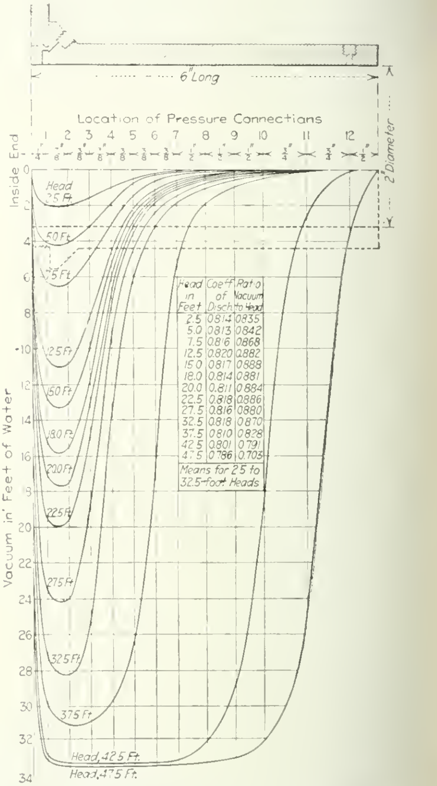
By W. S. Pardoe*

Recent experiments conducted in the hydraulic laboratory of the civil-engineering department of the University of Pennsylvania are of value in explaining the action of the water within a standard short tube and also in correcting many indefinite and erroneous statements contained in standard textbooks on hydraulics.

The tube used in the experiments was 2 in. in diameter, 6 in. long, tapped for ⅛-in. pipe at 12 points spaced in an irregular helix. Each connection was controlled by means of a ⅛-in. cock. A common header was connected to the vacuum gages, water being used for the lower negative pressures and mercury for the higher ones. The general arrangement of apparatus is shown in Figs. 1 and 2.

Thirteen experiments were made with heads varying from 2.5 ft. to 47.5 ft. An examination of the results (Fig. 3) shows that the negative pressure h is about 0.860 of the head H; that it is confined to the inner half of the tube for heads up to 37.5 ft. when the vacuum is 31 ft., or very close to atmospheric pressure. It will also be noticed that up to this head the negative pressure varied, indicating the presence of water at a negative pressure and not a vacuity, as usually represented in works on hydraulics. The curves for heads of 42.5 and 47.5 ft. indicate by their general flatness that a vacuity existed. Furthermore, h is no longer 0.86 H, but approaches 34 ft., or a perfect vacuum. This condition is reflected in the falling off at the coefficient of discharge C_D. At or about 52.5 ft. head the tube ceased to act as a short tube, but discharged a stream similar to that of a standard orifice, this change occurring when the expanding jet ceased to fill the end of the tube. Upon lowering the head the tube did not necessarily again discharge as a short tube, but occasionally did.

The action of the water and consequent losses of head can be explained in a theoretical way by assuming the loss before the *vena contracta* to be similar to that of a standard orifice and the loss after this point to be due to sudden enlargement. The average results of tests on a 2-in. standard orifice gave the following results: Coefficient of discharge, $C_d = 0.5955$; coefficient of contraction, $C_c = 0.602$; coefficient of velocity, $C_v = 0.989$.



Head in Feet	Coeff of Disch	Ratio Vacuum to Head
2.5	0814	0835
5.0	0813	0842
7.5	0.816	0868
12.5	0.820	0.882
15.0	0817	0888
18.0	0.814	0881
20.0	0.811	0.884
22.5	0.818	0.886
27.5	0.816	0880
32.5	0.818	0870
37.5	0810	0828
42.5	0.801	0791
47.5	0786	0.703
Means for 2.5 to 32.5-foot Heads		

FIG. 1. DISTRIBUTION OF NEGATIVE PRESSURES IN 2-IN. STANDARD SHORT TUBE

Let V be the velocity in the full section of the tube and v the velocity in the *vena contracta*. Then

$$H = \left(\frac{1}{C_v^2} - 1\right)\frac{v^2}{2g} + \frac{(v - V)^2}{2g} + \frac{V^2}{2g}$$

$$= \frac{V^2}{2g}\left[\left(\frac{1}{C_v^2} - 1\right)\frac{1}{C_c^2} + \left(\frac{1}{C_c} - 1\right)^2 + 1\right]$$

Substituting the foregoing values,

$$H = 1.498\frac{V^2}{2g}, \text{ or } V = 0.816\sqrt{2gH}, \text{ or } C_D = 0.816$$

which check accurately the average coefficient for head-

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*Assistant Professor of Municipal Engineering, University of Pennsylvania.

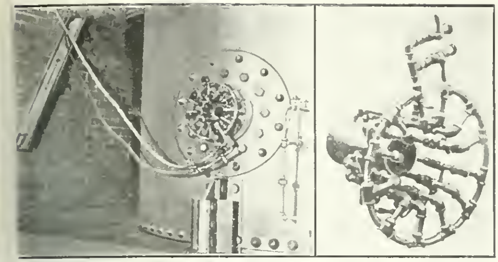


FIG. 2. EXPERIMENTAL SHORT-TUBE MOUTHPIECE

to 37.5 ft. The negative pressure h can be computed follows:

$$h = H - \left(\frac{1}{C_v^2} - 1\right)\frac{v^2}{2g} - \frac{v^2}{2g} = H - \frac{V^2}{C_v^2 C_c^2 2g}$$

$$= H\left[1 - \frac{C_D^2}{C_v^2 C_c^2}\right]$$

bstituting values, the negative pressure $h = -0.875\ H$, ich again checks fairly closely with the experimental sult obtained.

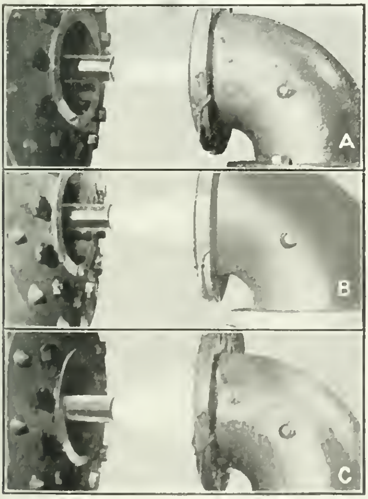
The foregoing theoretical analysis depends entirely on assumption that the jet within the tube contracts ich the same as a jet from a standard orifice and then xpands and fills the end of the tube, the surrounding dium being water in a more or less stationary collar to 37.5 ft. head, and being a vacuity for greater ds. To verify this a glass tube 2 in. in diameter and in. long was substituted for the tapped brass tube, and following observations were made:

1. Up to a head of 18.5 ft. the tube flowed full with appearance of air within it. Hence if contraction does e place, the jet must pass through a surrounding collar water in a more or less stationary or eddying state.

2. At 18.5 ft. head a slight amount of air was seen disengage from the water at the inner end, extending for about ½ in. into the tube. This condition progressed until the head was 28.5 ft., when the inner end of the tube was surrounded by a dense white fog extending about 1 in. into the tube.

3. At 38.5 ft. head the appearance was that of snow or loose foam extending about 6 in. from the inner end of the tube. At 44 ft. head the disturbed condition extended to the outside end of the tube, the inner end appearing as a clear-cut jet showing very distinctly the contraction and reëxpansion on which the foregoing theory depends.

4. At 56 ft. head the jet ceased to reëxpand sufficiently to fill the end of the tube, and it discharged as a standard orifice. The appearance of the glass tube discharging under various heads is shown in Fig. 3. Notice the diverging character of the stream under a head of 42.5 ft.



F . 3. TYPICAL DISCHARGES FROM GLASS SHORT TUBE
Under 2.5 ft. head. B—Under 20 ft C—Under 42.5 ft

The coefficient of discharge for heads greater than 37.5 ft. may be computed by considering the inside end acting as an orifice discharging under a head of $H + 34$ ft., thus:

$$Q = C_D a \sqrt{2g 47.5} = C_d a \sqrt{2g\,[47.5 + 34]}$$

or

$$C_D = C_d \frac{\sqrt{81.5}}{\sqrt{47.5}} = 0.781$$

Which again approximately checks the result obtained for a head of 47.5 ft. This would indicate that although the contraction and reëxpansion are not apparent for heads of less than 37.5 ft., it nevertheless occurs and the theoretical method of analyzing the subject is correct.

*

Rules for Applying Federal-Aid Road-Improvement Act

Under date of Sept. 1, 1916, the United States Department of Agriculture has issued a booklet of rules and regulations to be applied in the expenditure of federal-aid road money.

The act is interpreted to apply to those states where the actual expenditures are made and the work is done wholly by the counties, but supervised in a general way by a state highway department. No federal money will be paid for work which can not be proved to have been economically done. Bids for the work must have been advertised, and the contract must have been awarded to the lowest responsible bidder, unless it be satisfactorily proved that it was advantageous to accept the higher bid; otherwise the federal aid will be prorated to the lowest bid and not the actual cost of the road.

The Office of Public Roads must be notified in advance of a contract letting, so that a representative may attend. No part of the federal money is to be used directly or indirectly for the payment of a premium or royalty on any patented or proprietary material, specification, process or type of construction, unless purchased or obtained by open competitive bidding at the same or less cost than unpatented articles or methods equally suited to the same purpose.

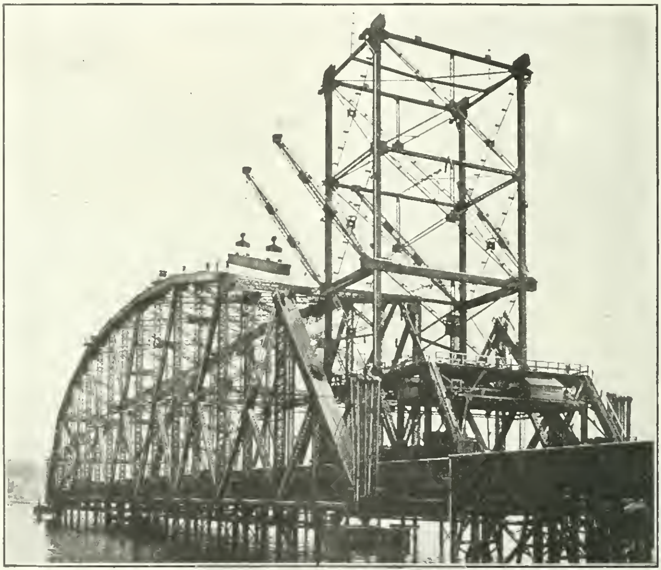
The rules and regulations governing surveys, plans, specifications, estimates, contracts, construction work, costkeeping and payments are so comprehensive that the United States Office of Public Roads and Rural Engineering will have a dominating influence in all work for which application for federal aid is made.

Erection of Quebec Bridge Suspended Span

By A. J. Meyers[*]

The only large step in the construction of the Quebec Bridge that has not been described for the information of the engineering profession is the erection of the 640-ft. suspended span on shore previous to floating to the bridge site and hoisting into place.[1] The importance of the structure warrants completing the record, as is attempted in the accompanying photographs.

The suspended span is 640 ft. long center to center of end supports and 88 ft. wide center to center of trusses. The trusses of the span have the top chords curved to a parabola, the depth at the hip being 70 ft. and at the middle of the span 110 ft. center to center of chords. The web is a subpanel Pratt system with main verticals, compression posts, and main diagonals, tension members. The main panels vary in length from 65 ft. in the end panels to 80 ft. for the panels at the center of the span. For the bottom chords throughout and for the first main tension diagonals of the web, eye-bars were used. All the other truss members were of built-up construction. The top chords were pin-connected at all the main panel points with shop or field splices at the intermediate subpanel points. The web members were connected and riveted together at the main panel points of the top and bottom chords by means of gusset plates which engage the pins of the top and bottom chord members.



Photographed July 21 1916

FIG. 1. COMPLETING ASSEMBLY OF QUEBEC SUSPENDED SPAN AT SILLERY COVE

All truss members were manufactured, shipped and handled in subpanel lengths. Nickel steel was used throughout for all the main truss members and the bottom lateral system, but the top lateral system and the sway bracing were built of carbon steel, as well as the minor web members which carried no moving-load stresses. The greatest area of the top-chord members was 131 sq.in., and in one panel of the bottom-chord eye-bars 311.5 sq.in. The top and bottom lateral systems, as well as the sway bracing, were double intersecting systems, designed to take both tension and compression in each member.

The erection site for the suspended span was located about three miles below the bridge site, in the shallow waters of Sillery Cove, where the bed of the river is exposed at low tide. The excavations for the foundations of the falsework bents supporting the trusses and approach tracks were mostly in rock—red shale and sillery. This excavation work was carried on at every low tide occurring in the daytime. On this account and because of the fact that considerable blasting had to be done, progress was slow, three hours' work once and sometimes twice a day being all that could be accomplished. However, this work and the laying of the concrete for the foundations were all completed during the season of 1915. During the fall and winter of 1915-16 the inside staging that had supported the bridge floor and the traveler tracks during the erection of the south anchor arm was taken down and sent back to the contractor's shops at Rockfield, P. Q., to be remodeled into the falsework bents that supported the suspended-span trusses and the approach tracks during the erection of the span. The traveler that had completed the erection of the north-shore anchor and cantilever arms was also taken down and shipped to the site of the suspended span, where it was reërected with the top trusses and traveling cranes left off, the work of erecting the suspended span being accomplished by means of the four 70-ft. 30-ton booms, placed one at each of the four corners of the traveler.

The traveler and its bracing were figured to resist a 30-lb. wind when standing and a 5-lb. wind when moving. No effect of wind during the lifting operations was considered, as no work could be done during winds of appreciable strength.

The dead-load of the traveler was carried on the front and rear truck springs when moving. Under working onditions these springs were locked, and shims were riven to a snug fit between the front legs of the traveler nd the pedestals resting on floor-beams. Reactions from ifting the top chords, which were the heaviest pieces andled in the span, were on the assumption that the embers for one truss only would be lifted at one time.

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[*] Chief Draftsman, Board of Engineers, Quebec Bridge, Montreal, P. Q.

[1] For notes on the erection of the cantilever arms see "Engineering News," Aug. 17, 1916; for progress in 1915, see Sept. 2, 1916; camps and yards, Mar. 5, 1914, and Oct. 14, 1915; anchor arm, Jan. 7, 1915; erection traveler, Mar. 4, 1915; general design, Apr. 30, 1914; special shopwork, May 14, 1914.

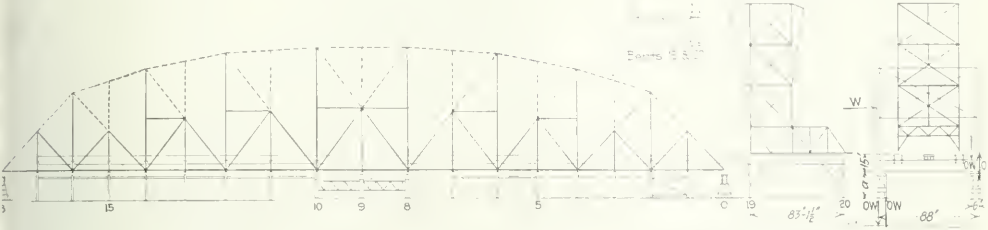


FIG. 2. ERECTION DIAGRAM OF QUEBEC BRIDGE SUSPENDED SPAN AND TRAVELER

similar members for both trusses were lifted at the me time and placed in pairs, the reactions on the front gs of the traveler were equal, but the reaction on ther leg was less than the maximum leg reaction if e pieces were lifted and placed separately. No anchorge, when lifting loads at either the front or the rear the traveler, was required, except when placing the or-beams. It was then necessary to outhaul in all cases hen the floor-beams were placed more than 72 ft. in lvance of the front legs of the traveler; and when acing floor-beams more than 50 ft. in advance of the aveler, the rear derricks had to take a lift on the flooams to the rear of the traveler approximately equal to e load on the front derricks. This procedure was cessary in order to avoid overstraining the longitudinal acing of the traveler.

As shown in Fig. 2, the span was supported during ection on staging bents placed under each panel point. ese staging bents were made up of two columns, spaced ft. apart and tied together by means of batten plates and lacing angles. In designing the columns it was assumed that the total weight of the bridge material, the weight of the traveler, including the member being erected, and the vertical reaction from wind on the traveler and span were carried by the outside columns of the bents. The inside columns were assumed to take care of the overturning effect from transverse wind applied at the top of the bent. Bracing placed in the plane of the outside columns took care of the longitudinal wind load on the trusses and traveler, the staging being braced in two sections. The wind load between panel points 1 and 7 was taken care of by the bracing in panel 1-2, and that between panel points 8 and 17 by bracing in panels 8, 9 and 10. The traveler was erected on bents 19 and 20 immediately adjacent to the staging of the span. While standing at bent 19, the traveler erected staging bents 1 and 2, the longitudinal bracing between bents 1 and 2 and the bridge members in panel 0-1. The traveler then moved forward, erecting staging and longitudinal bracing, floor-beams, bottom chords, bottom laterals and web members, except the upper half of the main diagonals and the vertical substruts, as it advanced, until it reached bent 17. The traveler then moved backward and completed the erection of the trusses by placing the top chords and upper web members as well as the top laterals and sway bracing. In Fig. 2 the members erected as the traveler advanced are shown in full lines. Dotted lines indicate the members placed on the return trip.

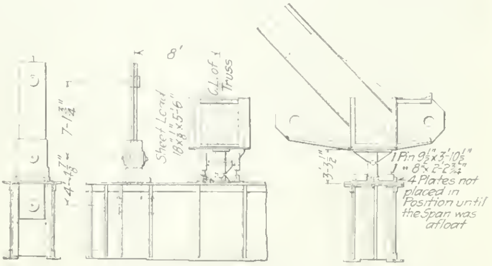
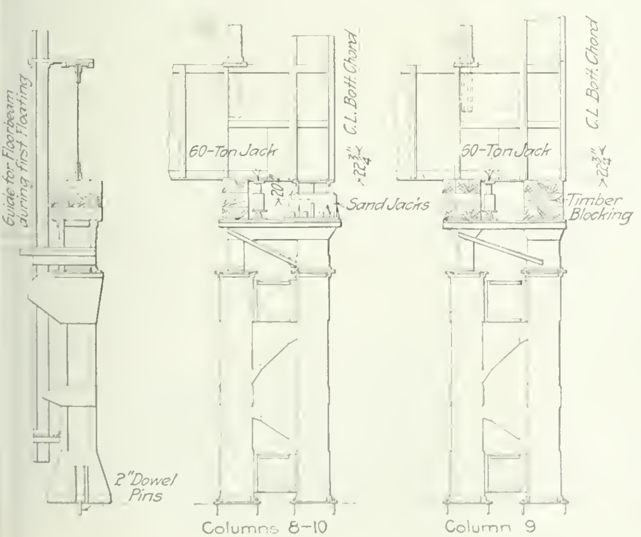


FIG. 4. END SUPPORTS AND LIFTING GIRDER, QUEBEC SUSPENDED SPAN



IG. 3. STAGING BENTS AND JACKS FOR SUSPENDED-SPAN ERECTION

As illustrated in Fig. 3, sand jacks were used at the even panel points, directly under and with tops bolted to the vertical posts of the trusses, to transfer the load to the outer columns of the staging. Timber blocking was used for the same purpose at the subpanel points and also between the floor-beams and inside columns of the staging at all panel points. The vertical posts and vertical hangers into which the floor-beams framed had their inside webs slotted to allow the end web plates of the floor-beams to pass through. In order to make this connection the floor-beams were placed on timber blocking over the inside staging columns, about 3 in. above their camber position; and after placing the vertical posts or hangers and bolting the floor-beam connection, the floor-beams and verticals were together lowered to their correct camber positions to a bearing on the sand jacks or timber blocking over the outside staging columns by means of hydraulic jacks.

In the shop the truss members were made of such a length center to center of panel points that after the span was erected and carrying its full live- and dead-load the trusses would have their geometrical shape; that is, the truss members would be straight between main-panel points. On this account the faced ends of the top chords, where these members were spliced in the field, would not come to a square bearing during erection. In order to obtain a square bearing at these points before riveting on the splice material the camber elevations of the lower-chord panel points, during the erection of the span, were calculated so that the top-chord bearing surfaces for the pins at the main top-chord panel points and the bearing faces of the top-chord members at the intermediate panel-point splices would come together just sufficiently to allow the splice material to be temporarily bolted in place with 50% of the field holes filled with bolts.

The span being completely assembled, the timber blocking at the intermediate staging supports and under the floor-beams was taken out, and the sand jacks were lowered until the span rested on its end supports at L0 and L18. The top-chord members then came to a bearing on the pins in the half-pin holes at the main panel points; and the bearing surfaces at the field splices came together, the nuts on the bolts attaching the splice material having previously been loosened. The field rivets in these splices were then driven. All the vertical subposts supporting the top chord members at the subpanel points were made of such a length that these chord members would be straight between main-panel points under the dead weight of the span as it rested on its end supports.

In designing the trusses the main diagonals in the center panels L8-L10, where the web system is double intersecting and statically indeterminate, were calculated to carry only live-load stresses in the lower halves of these members. The upper portions then took the panel dead-load concentrated at panel point 9. In order to insure this condition after the span was erected, the holes in the gusset plates connecting these members at the bottom-chord panel points L8 and L10 had been drilled in the shop to $\frac{15}{16}$ in. in diameter and the holes in the member to $\frac{11}{16}$ in. in diameter. When the members were first erected, these connections were fully bolted with $\frac{5}{8}$-in. bolts; and when the span was swung on its end supports at the panel points L0 and L18, if the panel points L8 and L10 were not at the same distance from a line joining L0 and L18, the lower of the two points was lifted by means of hydraulic jacks, the $\frac{5}{8}$-in. bolts being loosened in both connections. The shims under the higher point were removed as the load was applied to the lower point; and when the panel points L8 and L10 were brought into their correct position with relation to the line joining L0 and L18, they were firmly shimmed against the staging bents. All $\frac{5}{8}$-in. bolts being removed, the $\frac{11}{16}$-in. holes in the members were reamed to $\frac{15}{16}$ in. in diameter through the holes in the gusset plates and the connection fully riveted up before removing the shims.

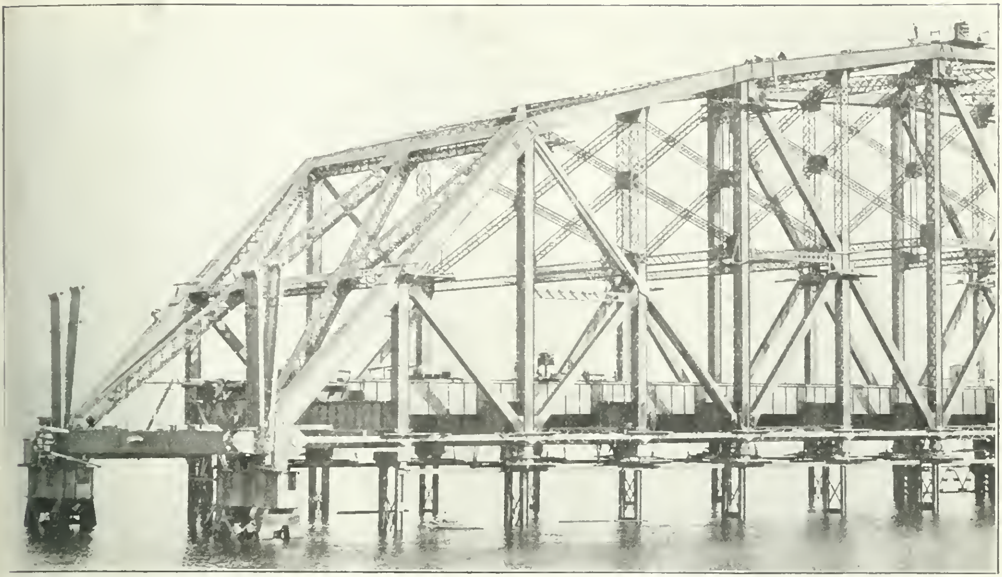
At the end supporting points L0 and L18 provision had to be made to take care of expansion and contraction due to changes of temperature and the stretch of the bottom chord under dead-load stress after the points of intermediate support were removed. As illustrated in Fig. 4, the span was supported at these points by a series of castings and pins. The arrangement of castings and pins shown was demanded by the conditions of hoisting to place in the bridge. However, to take care of this expansion and contraction, the lower longitudinal pin and its bearing castings were polished and lubricated to insure that the friction would not exceed 10% of the vertical end reaction of the trusses as the surfaces slipped under the end thrusts of the span; and the end bents at L0 and L18 in addition to taking care of the longitudinal wind on the span were designed to resist this horizontal friction force, which was estimated at 300,000 lb.

* * *

Quebec Bridge Suspended Span Falls Into River in Hoisting

(Telegram from Harry Barker, Associate Editor, "Engineering News.")

Quebec, Sept. 12, 1916.—The great center span of the Quebec Bridge fell into the St. Lawrence River at 10:50 a.m. Monday, Sept. 11, after it had been hung to the cantilever arms by the erection hanger chains and had been hoisted successfully 10 or 15 ft. From the best information now available, it is believed that six lives were lost in the disaster and six men were injured. I had closely watched the operations of floating the suspended span into position, mooring it to the guide trusses and beginning the work of hoisting, and I saw it collapse. There was no lack of expert eye-witnesses. In fact it is doubtful whether there was ever brought together on this continent a larger assemblage of eminent structural engineers than had gathered at Quebec to witness the final task in the completion of the greatest bridge in the world. The Canadian Society of Civil Engineers had arranged a special excursion of its members to witness the event. No one had any thought of danger in connection with the erection work, but the engineers of the St. Lawrence Bridge Co. decided that it was better for



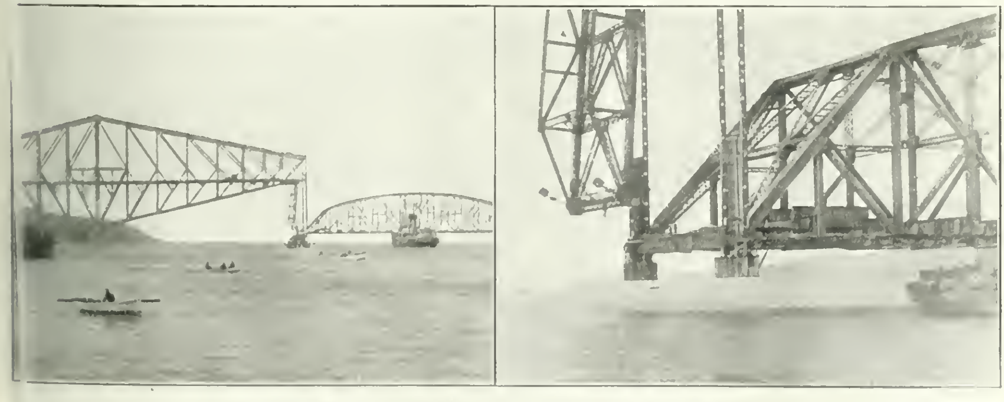
THE SUSPENDED SPAN ON FALSEWORK AT SILLERY COVE
Permanent hanger eye-bars projecting up from end pins; hoisting links projecting up from lifting girders

iose in charge of the operating machinery not to be istracted by the presence of any number of guests on ie moving span. The visitors, therefore, observed the ork from the shore or from vessels in the river or from e cantilever arms above.

The delicate work of transferring the suspended span om the falsework on which it was erected at Sillery ove, to the scows on which it was to be floated to the idge site was done during the night. The valves in e bottom of the scows under the span were closed about a.m. As the tide rose, the load was gradually transrred from the falsework supports to the scows and at 10 the span was afloat. Further work was then postned until daylight.

At 4:40 a.m. tugs began moving the span out. At 15 the span had been swung across the stream and the shore lines were cast loose. At 5:20 the three-mile trip upstream began, two tugs ahead pulling and five tugs downstream dragging backward to keep the floating mass under control, with an eighth tug, a large seagoing boat, standing by. Aided by the flowing tide, the trip was made in 1 hr. 10 min. At 6:35 the span was in position under the cantilever arms; 7 min. later the auxiliary mooring lines from the steam hoist on the floating span had been run out to the south cantilever mooring truss. Then one after another the four main mooring lines from the electric hoists on the south cantilever were attached. The same procedure was completed at the north end a few minutes later. The whole process of mooring required 1 hr. 5 min.

At 7:25 the downstream tugs eased off and nosed in close to the scows. About the same time the upstream



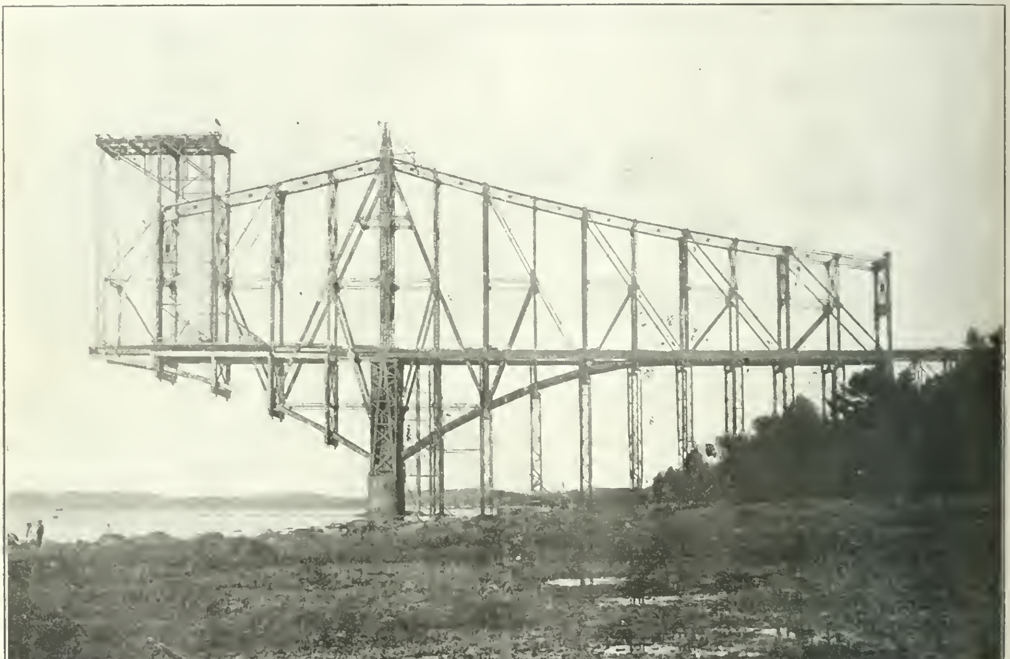
THE SUSPENDED SPAN HANGING FROM THE HOISTING CHAINS
n the detail view, note the short transverse girder, the "lifting girder," under the span corner; the hoisting chain are connected to the short links seen in the view at top of page

tugs also eased off to stand by. Twenty minutes later all lines had been made fast at the north and south ends of the truss and all the tugs had cast off.

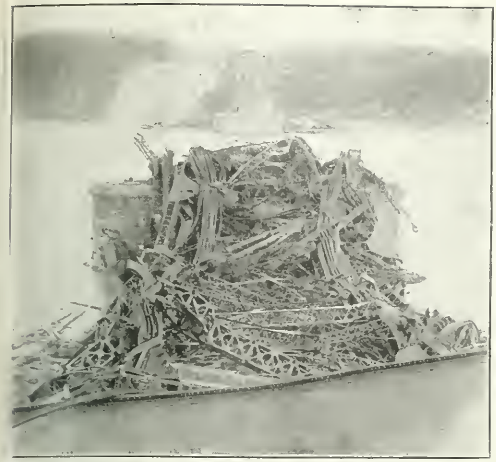
At 7:18 the north hanger chains swung forward from back of the mooring truss. Three or four minutes later the chains on the south side were swung down. All four pairs of hangers were connected to the span simultaneously, within a few seconds.

At 8:23 a.m. the erection link pins were seen to be at the bottom of the slot on both north and south hanger chains. As the tide fell, the weight of the span began to be transferred to these chains. At 8:50 the jacks at the north end of the span began working, and practically at the same time the jacks at the south end. At 9:22 a.m. the span cleared the scows, the south end lifting apparently a few seconds first. At 9:25 a.m. the scows on the north side were cut loose from the span. The south group followed in a few minutes.

The scows then drew to one side revealing the spectacle of the great 640-ft. span hanging suspended from



A COMPARISON OF OUTLINES—THE OLD QUEBEC BRIDGE CANTILEVER AND THE NEW, IN PROCESS OF ERECTION—1907 AND 1916



SOUTH HALF OF THE OLD QUEBEC BRIDGE
When completed nearly to center of suspended span as a cantilever structure, the entire half bridge fell

e lifting chains and tumultuous chorus of cheers re- unded from the crowds aboard the vessels which rowded the river downstream, and among the many ousands of spectators on both banks of the river. verybody believed, of course, that the crucial and dif- ult stage of the work was past and the rest was merely routine operation. Four lifts of 2 ft. were taken with e north jacks and five lifts with the south jacks. Work as then suspended for a short time to relieve the men fore starting on the long and taxing routine of hoisting.

Hoisting Is Resumed After Recess

The lunch interval lasted an hour; then all hands went ck to the bridge, and jacking was resumed. The opera- ns worked perfectly as before. The span rose steadily. At 10:46 a.m. one additional lift had been taken each cantilever since the lunch recess, making five lifts the north end and six at the south. At this time on ch side of the river the top jacking pins were out; the ttom jacking pins were in, and the top girder was scending for another cycle. The weight of the sus- nded span was hanging from the lower or fixed jacking rders and everything apparently was stable and secure. At this moment, something, somewhere, gave way on about the suspended span, far below the level of most the observers. What that initial failure was, every gineer in every branch of the profession will earnestly sire to learn, for concededly this bridge represents the ght of constructional effort. It is possible here to e only an account of the fall of the suspended span seen by the editor of *Engineering News* and as re- unted by other eye witnesses afterward. These de- iptions permit an answer to the puzzle—in fact sev- l answers, wherein lies doubt and confusion for the sent. Several combinations of circumstances can be mulated to agree more or less closely with all the evi- nce at hand.

The Great Span Falls Into the River

At 10:50 a.m. the attention of the closest observers s attracted by sounds that seemed to tell of serious uctural failure. To some there was a noise like the charge of a cannon, almost immediately followed by the lighter cracking of accessory failures, and then slipping and roaring noises, as the span went into the water. It is hard to separate the subjective from what was actually observed in the few seconds while the amazed observers watched the span disappear.

Observers who were clear of the bridge downstream, off the south cantilever, seem to agree that the south upstream corner of the span first slipped off the lifting girder. They think also that at this stage that corner of the span dropped almost to the water, thirty feet below, before the south downstream corner left its lifting girder. To southerly observers, the overturning motion started by the falling of the upstream end continued as an upstream overturning, and simultaneously the end of the upstream truss appeared to fall down as the structure corkscrewed into the water. It appeared further that a considerable part of the span—possibly a third of its length—was submerged before the north ends appeared to slip off their lifting girders. It was not possible to tell from this distance whether one corner at the north end lifted off in the fall.

An important difference is noted in the observation made by a prominent engineer who watched the span from the very tip end of the north cantilever. He declares that the upstream truss at the north as well as the south corner slipped off before either of the downstream truss ends left its seat.

It seemed to observers on the south cantilever as though the great north cantilever must be pulled down by the violence of the shock. Some small disturbance of the cantilever end was apparent from across the river, but the gigantic frame stood the test nobly, and in a few seconds came the realization that it was safe. In the meantime the hanger chains, with the lifting girders on their ends still intact and in place, swung about violently, crushing the wooden inside operating platforms.

On the jacks and platforms of each arm were about twenty men. Only one of these was lost and three hurt, though all the rest had narrow escapes. The chief inspector of the Board of Engineers, Herbert McMillan, posted on the downstream platform, north cantilever, had a leg broken. One man on the upstream platform, north cantilever, dropped overboard and was lost. On the south cantilever one man on the downstream pin platform jumped and with three others was rescued.

Many prominent engineers from the United States and Canada were on the suspended span when the lifting operations began. At the intermission in the jacking operations they came ashore. That saved their lives. The total death roll is still uncertain, but probably only 11 were lost and 6 injured in the great accident.

Both cantilever arms of the structure were thronged with many prominent engineers who had come to see the crowning achievement of the Quebec bridge's history. Besides these visitors, there were engineers and inspectors of the company, and of the Board of Engineers, and many government officials. These men find their sensations, as they were thrown down and about by the oscillations of the cantilever ends set up by the shock of the load release, difficult indeed to describe. Out of the chaos of stories, however, there comes some indication that the downstream cantilever end first went up and returned, while the upstream cantilever end was pulled down and outward. This first motion might have been followed by a series of oscillations of 15 to 18 in.

maximum. It appears clear that each of the K-trusses acted independently, thanks to the flexibility of the lateral connections. Yet there appears to have been no damage to the lateral system for observation indicates no permanent distress of the lateral members. Through the interior of the bridge the longitudinal edges appear still perfectly parallel.

The Condition of the Four Pairs of Hanger Chains

The hanger chains, as previously stated, are still there and substantially intact, with the lifting girders hanging at their lower end. *But they are not uninjured or unmarked*, and this of course is significant. Careful note has been taken of their condition in a joint examination by the Board of Engineers and the St. Lawrence Bridge Co.

South Side Hangers—The downstream hangers show the lifting girder at the bottom, the jacking girders at bridge floor, and the top supporting girder, inclined downward in the upstream direction at an angle of 10° or so; the hangers and girders rocked on the top pin. The lower end of the inner hanger, i.e., the one nearer the center line of the bridge, is bent upstream. The lifting girder hung to the chain is battered, the lower or longitudinal bearing pin has disappeared, and the upper or transverse pin has turned and dropped into the place of the lower pin.

The upstream hanger chain shows all girders substantially level transversely. The hangers themselves are not damaged, except that the inner one is scored where it sheared through the end bottom strut of the span. There is evidence of rotation of the lifting girder from the appearance of the connection to the chain.

North Side Hangers—The upstream and downstream hanger chains are unbent, and are in better condition than those of the south end. However, the inner hanger of each chain is dented and scored where it sheared through the bottom strut.

The preceding lacks detail. It truthfully indicates the general conditions, however.

Cause of the Accident—The Most Likely Theory

Reference to the drawing on p. 523 of this issue or to the slightly less complete drawing p. 423, Aug. 31 issue, shows a cruciform rocker casting between suspended span and lifting girder, by way of which the end of the suspended span rested on the lifting girder. This casting formed a sort of universal joint to support the span; it had a longitudinal pin below and a transverse pin above. Sliding movement along the longitudinal pin was helped by extra lubrication while the span was on falsework, but was blocked by bolting on four retainer plates when the span was floated off on scows.

Study of the sketch of the method of support of the span on the lifting girder here will show that there was a measure of instability in the arrangement, the weight being on top, with a universal joint under it, and the support—the point where the girder was hung to the chains—being practically at the same level as the universal joint. To explain how the truss span comes to be in the river and the lifting girders are still there we must look for some action that would unseat the span. The span might slip off, or the girders might kick out, or the rocker casting between girder and truss might break.

No actions are known to have occurred in the hoisting that would favor either a sliding off of the span or a kicking out of the lifting girder. The most probable explanation at the moment is that the cruciform rocker casting between lifting girder and end of the suspended span broke.

The rocker whose break caused the disaster is believed to be the one at the south upstream corner whose fall was first observed. Fracture of the casting probably occurred on the side facing the center line of the span. At any rate the break must have been so located as to let the truss corner fall on the lifting girder off center and near the midspan edge. Then the girder rotated, kicked back, and let the corner of the span slide off with nothing but the strength and support of the portals and sway bracing to hold it from falling into the water. Clearly the portals and laterals of a 640-ft. span were not equal to such duty.

As soon as the span lost its support at the south upstream corner by breaking of the rocker, the diagonally opposite corner or the north downstream corner probably lifted slightly so that the line of support then was diagonally across the span from south downstream to north upstream corner. Failure of the portals and lateral system and possible rotation of the trusses and failure of the whole structure both downward and sideward was inevitable in this condition.

All this took only four or five seconds, of course and observation of the individual actions is uncertain However, it appears that the upstream truss began to crumple as the span tilted, the ends of the truss going down and its center up.

I send you my account after most favorable opportunities to observe the facts and conditions of the hoisting operation, seeing the collapse from an excellent vantage point, and after interviewing a large number of eyewitnesses to check my observation of the facts of the collapse and engineers of the bridge company as well as independent engineers to check the facts as to the behavior of the individual parts.

No one knows at present whether more will be learned concerning this failure in the sequel, as the physica evidence is deep under water. It is only fair, however, to impress on all engineers that the case is so extraordinary that, especially in view of the wonderfully scrupulous work of the Commission and the bridge company, judgment should be formed only tentatively, and final conclusion held in abeyance. One thing only is clear just now, tha an awful accident has happened.

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What Caused the Quebec Bridge Disaster?

By no means the least remarkable circumstance in connection with the disaster to the great bridge at Quebec is the fact that although the disaster was witnessed by over a hundred of the most eminent structural engineers in both Canada and the United States, including the expert staff engaged in the erection of the bridge it was not certainly known for 24 hours after the disaster occurred, exactly where was the initial point o failure.

When the first unsatisfactory press dispatches came over the wire, telling practically nothing, save that the span had collapsed and gone to the bottom of the river the most probable conjecture seemed to be that some thing had gone wrong during the ticklish process of mooring the span into exact position and transferring it from the scows which brought it to the bridge site to the hanger chains. As this was apparently the most delicate part of the work, the possibilities of trouble from wind or tidal currents or other unforeseen interference with making the connections to the cantilever arms loomed large in the imagination. These first speculations were of course swept one side when the news came that the span had been actually hung from the lifting chains and hoisted some distance when the collapse occurred.

Many engineers, doubtless, then turned their thoughts to a consideration of a possible failure of the lateral bracing of the span. While every precaution had been taken apparently to make sure that the bridge should be kept level while the lifting process was going on, it was of course possible that one corner might be lifted more rapidly than the others, producing a torsional effect on the truss. It was conceivable, at least, that such uneven hoisting might have gone far enough to throw such stresses into the lateral bracing as to cripple some of the members and cause the collapse of the entire structure. It will be evident that the truss would not have to be cant over very far before its enormous weight would overload the wind bracing.

More circumstantial reports from Quebec disposed also of this hypothesis. Had the failure occurred in such a manner, the great number of expert bridge engineers who watched the failure would have promptly identified and reported its evident cause. The same is true of any failure within the suspended span, from whatever source; and more than this, the span was a piece of bridgework of ordinary type, and internal failure was no more likely than in any other large truss bridge.

The huge lifting chains by which the truss hung suspended did not fail. They are intact, with the lifting girders still attached to their lower ends. The suspended span alone is gone. That is the basal fact. The swinging chairs on which the span was seated are intact—barely scratched—but their burden has slipped off into the river.

The place of initial failure, then, is narrowed down to the place where the truss rested on the girders which hung from the bottom of the lifting chains. Study of the drawings of this connection, on page 523 of this issue, shows that the rocker bearing on which the truss rested was over 4 ft. higher than the pin-bearing through the girder by which the load was transferred to the chains. To hold the girder from rotation, there were plate-and-angle connections between the top chord of the girder and the short built-hanger link which formed the means of attaching the girder to the chains.

Of course, so long as the span remained absolutely level, and absolutely central on the lifting girder, there was no tendency to tip or rotate the girder, and no strain against the plate-and-angle connection just mentioned. At the moment of the accident something happened which upset this condition of perfect central loading. If the steel casting which supported the south upstream corner of the span broke under its load of some 1,300 tons, its fracture would have produced the loud report with which the disaster began. As the truss shoe settled down through the broken fragments of the casting, it was bound to destroy irrecoverably the delicate condition of central loading. It may have kicked the supporting girder out from beneath it; it may have shoved it far enough to one side so that the unbalanced load on the girder would rotate it on its pin and let this corner of the truss slide off. In either case the wreck of the suspended span would occur as the eyewitness account describes it. One corner unsupported and only the unsteady swinging chairs under the other three, the ponderous span was bound to go to the bottom.

*

Temporary Trestle to Complete Kansas City Bridge

Pending the construction of the new 23rd Street Trafficway in Kansas City, Mo., a temporary trestle is to be built to connect the Allen Ave. viaduct in that city with the east end of the new Kansas Ave. bridge over the Kaw River in Kansas City, Kan.

The Wyandotte County (Kansas) Commissioners, about two years ago, let a contract for the new Kansas Ave. bridge to replace the old structure which was not only inadequate but also did not conform to the Government and Kaw Valley Drainage Board's requirements of a two-pier structure in the 734 ft. established channel. The new bridge was located to meet the proposed 23rd Street Trafficway Viaduct on the Missouri side and is practically completed at a cost of $480,000. It has two 317-ft. spans in the channel and the total width of 64 ft. provides for one 6-ft. sidewalk on the south side, a 36-ft. roadway and a double street-car track on the north side.

Although an item of $300,000 for the construction of the 23rd Street Trafficway was included in a recent bond issue, voted in Kansas City, Mo., the city has been unable to come to any agreement with the four railroad companies where tracks are crossed by the proposed viaduct as to their share of the expense of construction. Plans and specifications are being prepared by Harrington, Howard & Ash, Consulting Engineers. The structure will be reinforced concrete and will cost approximately $560,000, including a long approach on Liberty St., which will replace the present Allen Ave. viaduct. The city proposes to pay one third of the cost, the street railways company has agreed to pay one-third and it is expected that the steam railroads will agree to contribute the other third. Court proceedings have already been instituted for the widening and regrading of 23rd St. east of Brooks St. where the new viaduct will terminate, the balance of the city bond issue being used to help pay this cost, and it is possible that the other points in controversy will be settled in the next few months.

In the meantime, the temporary timber structure will be built and the new Kansas Ave. bridge thrown open to traffic, so that the old bridge across the Kaw may be removed before it becomes a menace again in the spring high water. The temporary trestle will be 1,056 ft. long and average about 30 ft. high. It will carry a double-track car line, included in a 36-ft. planked roadway, but no sidewalks. The contract price is $19,150. This sum was obtained by "passing the hat" among the industries in the West Bottoms who will be served by its construction, forty of them contributing $5,090 and by the Kansas City Railways Co. who paid $12,500; the balance will be paid by the railroads and the city.

News of the Engineering World

Sewage Disposal at Lynn

An investigation of methods of disposal of the sewage of Lynn, Mass., conducted by the State Department of Health and the Municipal Council of the city, has resulted in the recommendation that the ocean be utilized, the method of dilution being the most efficient of all systems of disposal now in use.

The dry-weather flow in the sewers amounts to about 12,000,000 gal. per day, while the sewerage system is capable of delivering about 81,000,000 gal. per day, including storm water, at the outlet. The wide variation in rates of flow would make it difficult to provide treatment, but consideration was given to methods of chemical precipitation, filtration, activated sludge, screening and disinfection, as well as the recommended method of disposal by dilution. The success of the latter method at Boston is cited by the joint board as an example of the value of that method to coast cities.

*

Pennsylvania R. R. to Detroit

The plans of the Pennsylvania Railroad Co. to expend $40,000,000 to enter Detroit, Mich., are officially announced. The entire traffic of the city has heretofore been handled by the Michigan Central, Grand Trunk and New York Central lines.

From Toledo, Ohio, the present northern terminus of the Pennsylvania lines, the tracks will be extended a few miles to connect with the Pere Marquette R.R., for the joint use of which the Pennsylvania R.R. has already perfected arrangements. This will give the Pennsylvania an entrance to Detroit, where it is proposed to spend a large sum in paralleling the belt-line railway of the Detroit Terminal R.R., owned jointly by the New York Central and Grand Trunk lines. A part of the project is a large terminal passenger station at Detroit.

The new belt line will connect with practically all the large automobile factories and will give the Pennsylvania a share in an immense traffic.

The Detroit terminal work will be in direct charge of B. V. Sommerville, former Principal Assistant Engineer, Southwest System, Pennsylvania lines west of Pittsburgh. He has offices in Detroit under the title of Resident Engineer.

*

A Steel Stack Section fell nine stories when one leg of the A-frame of the derrick, with which it was being hoisted, broke. The stack is being erected on the Pittock Block, Portland, Ore., by Clay S. Morse & Co. The last section was being hoisted when the accident occurred. The section is $10\frac{1}{2}$ ft. in diameter by 15 ft. long, and weighs 4,500 lb. The fir boom—109 ft. long by 18 in. in diameter—dropped across the parapet and snapped in two. According to press dispatches the stack section and the wreckage from the derrick struck a roof 100 ft. below, but did not go through. The rivets will be taken out and the section straightened.

Expanding the Corps of Engineers, U. S. A.—The largest number of commissions in the Corps of Engineers, U. S. A., to be awarded to a single class of West Point graduates is the 24 given to the members of this year's class. Of these 24 graduates, 21 are first lieutenants, their commissions dating from July 1. The other three are second lieutenants—the only ones now in that lowest rank. The law effective July 1 provides for 79 second lieutenants. The basic salary of a first lieutenant is $2,000 per annum and of a second lieutenant $1,700.

The Bronx Valley Sewage, of Westchester County, N. Y., has been ordered purified by the Secretary of War. Notice was served on the manager of the Bronx Valley Trunk Sewer Commission, Sept. 11, that the government would bring suit to force the removal of the sewer outfalls in the Hudson River at Yonkers unless the county builds a treatment plant. In 1912 the Federal Government brought a suit against the Bronx Valley Sewer Commissioners, but the action was dismissed upon the signing of a stipulation that the commission would treat the sewage before it reaches the Hudson River. John J. Brown is manager of the Bronx Valley Sewer Commission.

Flood Prevention in Kansas has been investigated by an engineering committee appointed by the Kansas Flood Congress which convened a year ago. The committee states that conservative estimates fix the net losses in Kansas during the past thirteen years at approximately $52,000,000, or an average of $4,000,000 annually. In addition to the direct monetary losses, there has been a large amount of indirect property loss and more than 100 lives have been sacrificed. The committee believes the cost of flood protection must be paid, to a large extent, at least, by taxation upon the citizens of Kansas. Coöperation of the Federal Government is necessary, however, for the complete solution of the problem, as many of the streams which cause damage in Kansas have part of their drainage area beyond the state boundaries. The committee says that the first thing to be done in the study of flood prevention is to establish stream-flow records and it recommends the establishment of a number of river gaging stations. The committee was composed of T. J. Strickler, Chairman, Engineer of the Kansas Public Utilities Commission; H. A. Rice, of the State University Engineering School; H. B. Walker, State Drainage Engineer; A. A. Robinson, formerly of the Santa Fe, and Charles Wenzer, consulting engineer of the Union Pacific. Under a recent act of Congress, a survey is to be made by the U. S. Engineers of the Kansas, Neosho and Cottonwood rivers and their tributaries, with a view to the development of some system of flood control.

PERSONALS

L. P. Matthews, a structural engineer of Lima, Ohio, has joined the staff of A. M. Frink, Architect and Engineer, Cleveland, Ohio.

C. R. Chevalier, formerly Division Engineer of the Boston & Maine R.R., St. Johnsbury, Vt., has been appointed Roadmaster of the Portland Terminal Co., Portland, Me.

Joseph K. Gannett, Assistant Chief Engineer of the Samuel Austin & Son Co., Cleveland, Ohio, has been appointed Chief Engineer of the Philadelphia branch of the company.

C. S. Izant, formerly of Izant & Frink, Architects and Engineers, Cleveland, Ohio, is now in charge of factory output and production methods for the Corning Glass Co., Corning, N. Y.

J. W. Beardsley, M. Am. Soc. C. E., Chief Engineer of the Porto Rican Irrigation Service since 1910, has resigned. He was formerly Director of Public Works of the Philippine Islands.

Robert Lenox Stewart has resigned from his position as Engineer in charge of the New York City office of the Casper Ranger Co., of Holyoke, Mass., to accept a position with the Bridgeport office of the Austin Co.

George J. Percival has resigned his position with Day & Zimmerman, Consulting Engineers, Philadelphia, Penn., to become Engineer of the Philadelphia office of the F. W. Mark Construction Co., of Cleveland, Ohio.

William Ferguson, formerly Supervising Engineer at Detroit, Mich., of the Travelers Insurance Co. and the Travelers Indemnity Co., of Hartford, Conn., has been promoted to be

Traveling Supervising Engineer with headquarters at Hartford.

Robert E. Bell has been appointed Assistant Chief Engineer of the Samuel Austin & Son Co., Cleveland, Ohio, to succeed Joseph K. Gannett, promoted, as noted elsewhere. Mr. Bell was formerly in the office of the Building Commissioner of Cleveland.

J. Albert Holmes, M. Am. Soc. C. E., of Somerville, Mass., has been appointed Resident Engineer for the J. G. White Engineering Corporation on three large earth dams for the Southern Power Co., near Bridgewater, N. C. He was formerly Division Engineer in charge of the construction of the Charles River dam at Boston and Resident Engineer of the Somerset dam at Somerset, Vt.

Lincoln Bush, M. Am. Soc. C. E., Consulting Engineer, New York City, has been selected as the third arbitrator to settle the Galveston (Tex.) causeway controversy. As noted on p. 333, of "Engineering News," Aug. 17, the other members of the board of three outside engineers to investigate designs and report upon the project are Prof. A. N. Talbot, of the University of Illinois, and Prof. George F. Swain, of Harvard University. Professor Talbot represents the steam-railway interests and Professor Swain the county and electric-railway interests. These two selected the third member of the board.

John L. Thompson, M. Am. Soc. M. E., formerly Supervising Engineer of the Travelers Insurance Co. and the Travelers Indemnity Co., of Hartford, Conn., has been made Superintendent in general charge of the engineering and inspection division of the company. He was born in Bridgeport, Conn., and was graduated from Sheffield Scientific School, Yale University, class of 1904. After four years with the New York Telephone Co. as an assistant engineer in the department of building construction, he entered the service of the Travelers Insurance Co. as an inspector. He has served three years in the underwriting department. **William P. Eales,** formerly Supervising Inspector at Philadelphia, Penn., has been made Assistant Superintendent.

Dr. Allan D. Risteen, M. Am. Soc. M. E., recently Engineer f the Travelers Insurance Co. and the Travelers Indemnity Co., of Hartford, Conn., has been appointed Director of Technical Research and Safety Publication Work of the company. le was born in Amesbury, Mass., and was graduated from he Worcester Polytechnic Institute in civil engineering in 885. Later he took graduate courses at Dartmouth College nd Yale University, where he was awarded the degree of octor of Philosophy in 1903. For two years after graduating rom Worcester Polytechnic Institute he was with the United tates Coast and Geodetic Survey. Later he was Editor of Power." The change has been made in Dr. Risteen's position to enable him to devote more time to technical research nd the direction of the publications on safety.

The Corps of Engineers, U. S. A., has been increased by 21 raduates of the 1916 class at West Point. Of these 21 are irst Lieutenants at $2,000 per annum, plus allowances, dating om July 1. The 21 most fortunate ones are: John H. Wills, ynchburg, Va.; Raymond G. Moses, Denver, Colo.; Wilhelm D. yer, Trenton, N. J.; John W. Fraser, Suffern, N. Y.; Charles . Cunningham, Lawrenceville, Ill.; Dwight F. Johns, Rockrd, Ill.; William A. Snow, Washington, D. C.; Thomas D. nley, Washington, D. C.; William H. Britton, Cedar Rapids. wa. Elroy S. Irvine, Phœnix, Ariz.; Notley Y. Du Hamel, ooklyn, N. Y.; William H. Henderson, Georgetown, Tex.; obert G. Guyer, Fort Sill, Okla.; Edward C. Smith, Maon, S. C.; Robert A. Sharrer, Westminster, Md.; Ludn D. Worsham, Evansville, Ind.; Edward G. Bliss, Washgton, D. C.; Ralph G. Barrows, Rochester, N. Y.; Holland Robb, La Crosse, Wis.; Frederick W. Bonfils, Fort Contution, N. H., and Robert R. Neyland, Jr., Greenville, Tex. e three commissioned Second Lieutenants are William M. ge, Jr., Lexington, Mo.; Stanley L. Scott, Louisville, Ky.; d Tattnall D. Simkins, Albany, Ga.

F. B. H. Paine, William McClellan, F.'s Am. Inst. E. E., d **Horace T. Campion,** M. Am. Soc. C. E., announce the formon of the firm of Paine, McClellan & Campion, of 25 Church New York City, and 1420 Chestnut St., Philadelphia, Penn. Paine is the son of Charles Paine, prominent a few years as a railroad engineer and executive. In 1886 he entered Westinghouse laboratories at Pittsburgh as a student. 1889 he went into the Southwest as salesman and eneer for the purpose of establishing electric lighting comies in municipalities. From 1891 to 1893 he was in the ploy of the Edison General Electric Co., Siemens & Halske In 1893 he returned to the Westinghouse Co. spending st of his time at the New England office, finally becoming manager. In 1905 he became General Manager of the conıction work of the Ontario Power Co. In 1911, he opened an office in New York as a Consulting Engineer. Mr. Campion was born in Philadelphia and has spent the larger part of his engineering life there. After a short time spent in architectural offices he entered the electric railway field through the old Philadelphia companies, finally becoming assistant to the Chief Engineer, William S. Twining. About 1905 he left the Philadelphia Rapid Transit Co. to take charge of the Philadelphia office of the Re-Enforced Cement Construction Co. During this time he had charge of the very heavy reinforced concrete forebay work of the Ontario Power Co. at Niagara Falls. He has made a special study of the design and construction of car-barns and substations. In 1907 he associated himself with William McClellan, another member of the present partnership, in order to carry on a constructing and consulting engineering business. A biographical sketch of Dr. McClellan was published in these columns on Aug. 31, at the time of his appointment as Director of the Wharton School of Finance.

OBITUARY

Emil Herter, M. Am. Soc., M. E., Chief Mechanical Engineer of the Edison Storage Battery Co., West Orange, N. J., died Aug. 24 aged 59 years.

Douglas Boyd Carpenter, formerly a member of the engineering staff of the Southern Ry., has been killed in action in France, where has was serving as Second-Lieutenant of the Royal Engineers of Great Britain.

Henry Horne, for many years an erecting engineer with the Allis-Chalmers Co. of Milwaukee, Wis., died recently at the home of his daughter, in Anniston, Ala. He had charge of the installation of many water-works plants throughout the country.

Walter Chur, President and General Manager of the American Railway Supply Co., of New York City, died Aug. 29, at his home in East Orange, N. J. He was horn in Philadelphia 71 years ago. He had been General Manager of the company for 33 years.

Charles W. Kouns, General Manager of the Eastern lines of the Atchison, Topeka & Santa Fe Ry., died at his home in Topeka, Sept. 3. He was born in New Holland, Ohio, Oct. 22, 1854, and began railway work as a brakeman in 1871. He was promoted through the train-dispatching and transportation departments to be General Manager of the Western lines in 1909. He was transferred to the Eastern lines in 1910.

ENGINEERING SOCIETIES

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

AMERICAN CHEMICAL SOCIETY.
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickly, Penn.

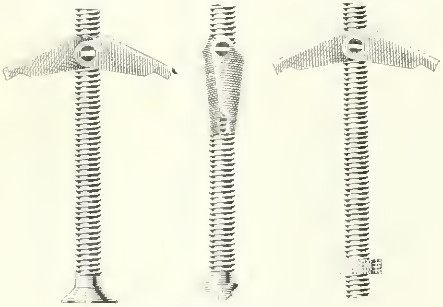
The Association of Port Authorities will hold its fifth annual convention in Montreal, Canada, Sept. 13 to 15.

The Washington State Association of County Commissioners and the Washington State Association of County Engineers will hold a joint convention at Tacoma, Wash., Sept. 14 to 16. A number of technical papers will be presented, as will also a number of addresses on subjects of general interest to highway officials.

Appliances and Materials

An "Automatic" Toggle Bolt

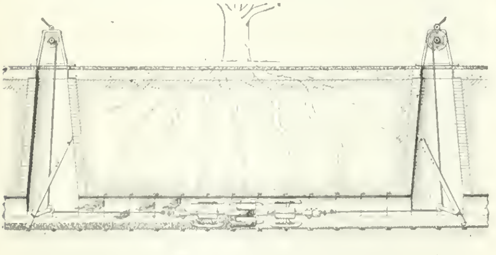
A new design of toggle-bolt head, called the "Arrow," has just been put on the market by the U. S. Expansion Bolt Co., Duane St., New York City. The head is formed by two 1-in. hinged wings and a trunnion nut engaging the bolt threads. A spring inside the wings keeps them opened out except when passing through the bolt hole. When the bolt is in place and the wings have been freed the inner edges bear directly on the bolt threads, giving a holding power equal to the strength of the bolt itself and locking the bolt against turning. It is claimed that these hold in corners with a single wing open. Samples are furnished on application.


"ARROW" TOGGLE BOLT

* * *

Two-Way Sewer-Cleaning Machine

A rotary-blade sewer-cleaning machine and root cutter, which can be pulled in either direction with equal facility, has been introduced by the Buffalo Municipal Equipment Co., Buffalo, N. Y. The device is made to clean pipe sewers from 8-in. diameter up. Sets of equipment may be rented, as well as purchased. It is claimed that roots or any kind of obstruction can be removed with this device, which is designed with strength of parts particularly in mind. The manufacturer guarantees to replace any part broken in actual use within five years.


TWO-WAY SEWER-CLEANING MACHINE AND ROOT CUTTER

New Noiseless Non-Metallic Gears

A new material for gears, having all the noiseless qualities of older non-metallic products, greater strength and better mechanical characteristics, has been developed by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh. It bears the trade name "Bakelite Micarta—D", and consists of layers of heavy duck bonded together under pressure with "Bakelite"—the synthetic phenol-formaldehyde resin. This gear material can be made in plates of up to 2 in. thickness. It has a tensile strength, parallel to laminations of 10,000 lb. per sq.in.; a compression strength of 30,000 lb. per sq.in. perpendicular to laminations, and of 17,000 lb. per sq.in. parallel to laminations; a traverse strength of 17,000 lb.; a coefficient of expansion per inch per degree Centigrade, of 0.00002 in. in the direction parallel to laminations and of 0.000085 in. in the direction perpendicular to laminations. It has a specific gravity of 1.4, weighs 0.05 lb. per cu.in., and has a water absorption of 0.25 to 2% by weight, depending upon the relative amount of edge surface exposed. Shrinkage and oil absorption is practically zero.

End plates are needed only where the face width of gears is to be more than 2 in. so that two plates have to be riveted together, where the service is extremely severe, or where the diameter is several times the face width. It is claimed that the new gears can in general be substituted for steel, cast-iron or bronze gears and with the same dimensions as those of the old gears.

* * *

Hand Pressure-Sprinkler

The accompanying view shows a new type of pressure-sprinkler recently placed on the market by the Buffalo Municipal Equipment Co., of Buffalo, N. Y. The water-tank capacity is 45 gal. A small horizontal compressed-air tank behind the water tank furnishes sufficient pressure to throw the water 35 ft. laterally, it is claimed. The needle showe is controlled by a lever within reach of the operator. Although this device is designed for street sprinkling in advance of sweepers, it is claimed to be particularly wel adapted for sprinkling public halls, playgrounds, tenni courts, lawns, railway-station waiting-rooms, etc.

HAND SPRINKLER FOR STREETS OR LAWNS

Engineering News

VOLUME 76 SEPTEMBER 21, 1916 NUMBER 12

Steel Sheetpile Coffer-Dams for Troy Lock and Dam

By D. A. Watt*

SYNOPSIS—Several types of coffer-dam were used to lay dry Hudson River preparatory to construction of lock and dam at Troy, N. Y. Article in "Engineering News," Sept. 14, 1916, described timber and gravel dams. This article describes sheetpile cylinder coffers and earth-fills with sheetpile center line.

In the construction of the lock and dam at Troy, N. Y., the west end of the dam was built behind timber coffer-lams, as described in the previous article. Before and fter their completion, construction proceeded on the ock itself and the east section of the dam. The lock and lower guide wall were built inside coffer-dams, but the foundations of the upper guide wall were built in the water, as the amount of masonry was too small and the water too deep to warrant the expense of a coffer-dam for them. The lock coffer was made in two sections, partly to save time in construction and partly to save piling, for by completing the head walls and the river wall first, the masonry could be used to replace some of the coffer and the piling be removed for use in the second coffer. The first, or upper, coffer-dam (No. 2) was located in the main channel of the river. As it had to remain in place for not less than two winters with attendant exposure to floods and ice, besides having to carry an unusual head of water, its construction had to be reliable in all respects. It would block up more than a third of the river's area of discharge, and during and after the construction of the west arm of

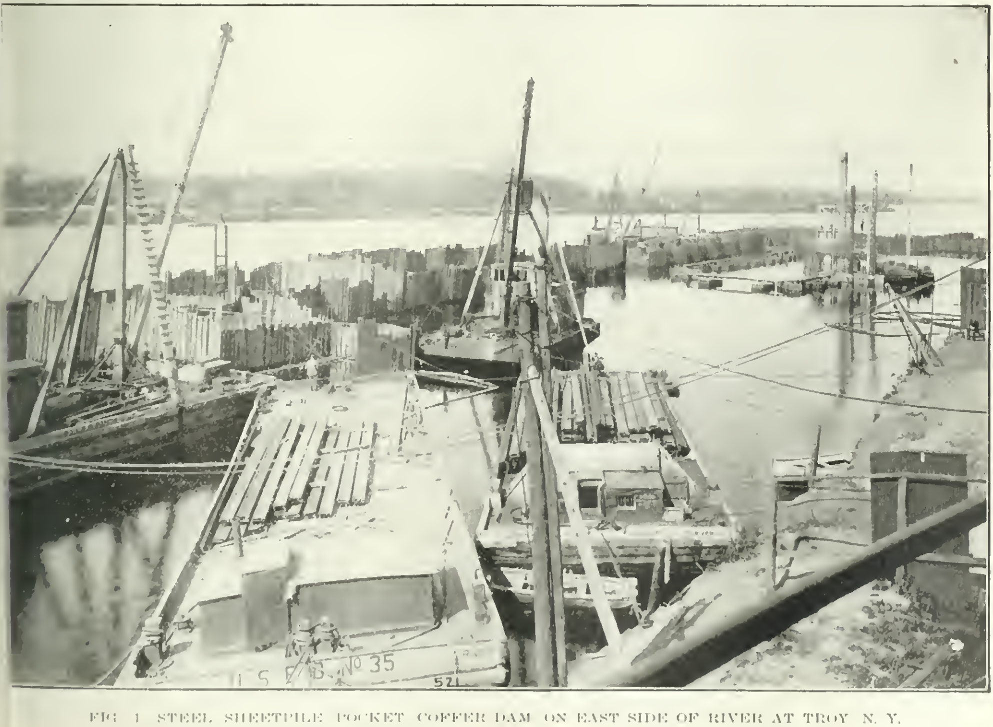


FIG. 1. STEEL SHEETPILE POCKET COFFER-DAM ON EAST SIDE OF RIVER AT TROY, N. Y.
This is a view of coffer-dam No. 2 looking north

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*Principal Assistant Engineer, United States Engineer ffice, Albany, N. Y.

the dam about another third would be closed. The flood velocities past the coffer would therefore be very high, tending to scour away any outside banking, which in turn would result in leaks through the coffer-dam unless the latter were water-tight in itself.[1] In addition to this the water about 50 ft. out from the banks reached a depth of 20 ft., which gradually increased to a maximum of about 27 ft. With 7 ft. added for the working range of floods, all but a small portion of the coffer-dam would have to support a maximum head of 27 to 34 ft. Any kind of timber framing for such a load would need to be very heavy and would be difficult to place reliably in the depths at the site and difficult to hold in the current until the filling could be put in. Moreover, wooden sheeting could not be driven into the gravel bed for any distance without splitting; and if it were not driven and reliance placed instead upon outside banking, the latter would be liable to be washed away by the strong flood currents, with resultant breaks of the river underneath the coffer-dam. Lastly, a timber coffer of large size would not be easy to clear away and in the process most of the pieces would be destroyed, while those that might be saved would have no market value.

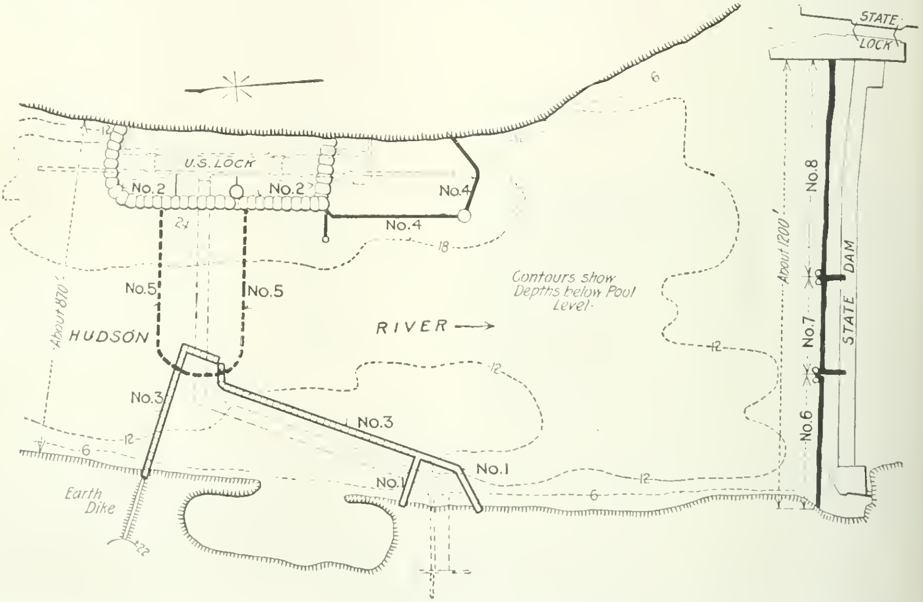

FIG. 2. GENERAL LOCATION OF COFFER-DAMS IN CONSTRUCTION OF LOCK AND DAMS AT TROY, N. Y.

These considerations led to the adoption of steel piling placed as a series of pockets, since the latter could be made of any size necessary to be stable in themselves. The piles could also be driven to or nearly to rock, thus removing the dangers of undermining; they could be pulled without undue injury and would then be available for use in later coffer-dams; and when finally done with, should be available for sale as scrap for nearly a third of their first cost. Comparative estimates showed that the wooden type would be about as expensive as the steel type, after allowing only a 33% salvage value for the piling of the latter, and it had in addition the serious disadvantages just enumerated. Now that all construction has been completed, it has become apparent that the adoption of the steel was decidedly economical. Three coffer-dams were built with the original bill of piling (which included only enough for the first coffer plus about 10%); enough surplus piles were available for sheathing for deep excavation and for protecting the coffers in front of the old dam; and a large salvage value was obtained.

Designing the Sheetpile Cellular Coffer

In proportioning the sizes of parts the pockets were assumed as having no back pressure from inside the coffer and as being subjected on the outside to a head of water measured from the rock to the top of the pockets, which were run up to about 7 ft. above pool level. This gave pressures of water varying from about 21 ft. to 41 ft. (see profile, Fig. 4). To this was added the comparativel slight pressure from the material overlying the rock These loads were to be counterbalanced solely by th weight of the fill taken as 110 lb. per cu.ft. for the uppe half and as 65 lb. for the lower half. It may be note that in closed pockets of this type much of the fill i still immersed after the coffer has been unwatered and s loses part of its weight, since the leakage from the outsid cannot readily escape. Thus in the 50-ft. diameter cylinders of the coffer-dam for raising the battleship "Maine." filled chiefly with a sandy clay, the line of saturation wa very high, following an inclination from near the outsid water line of about 1 vertical to 5 horizontal, and all efforts to remove or intercept the seepage by means of numerous perforated pipes and box wells sunk 20 to 30 ft deep in the fill proved unavailing. This seepage wa infinitesimal in amount, but it sufficed to keep the fill i a fluid state to within a few feet of the top.

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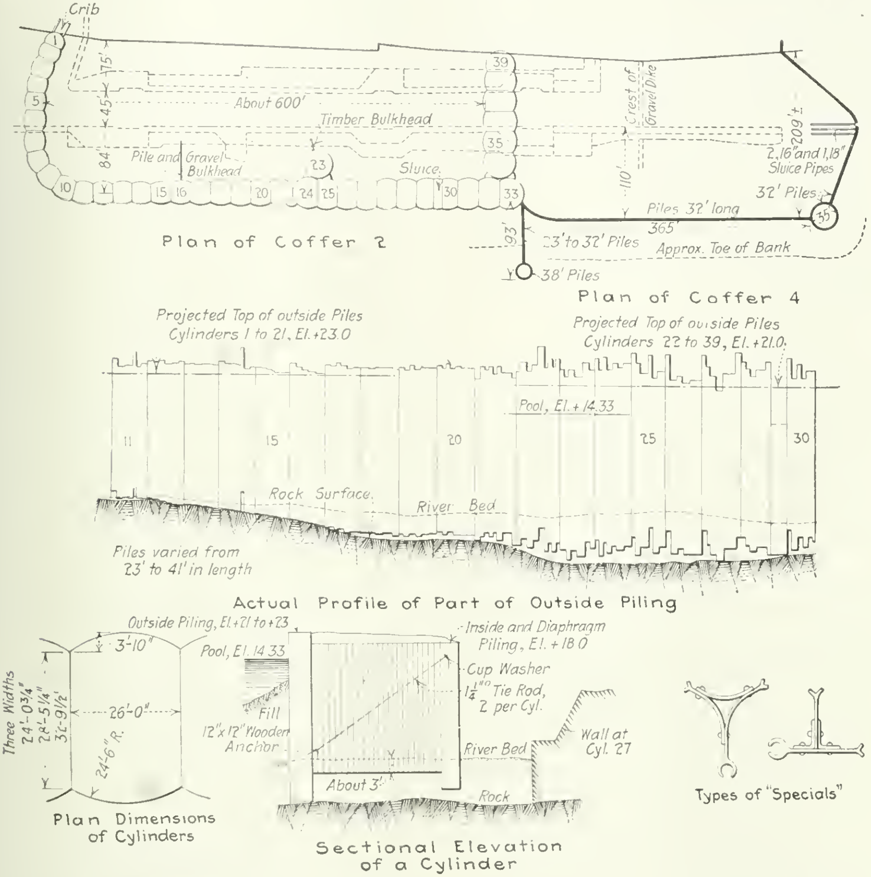
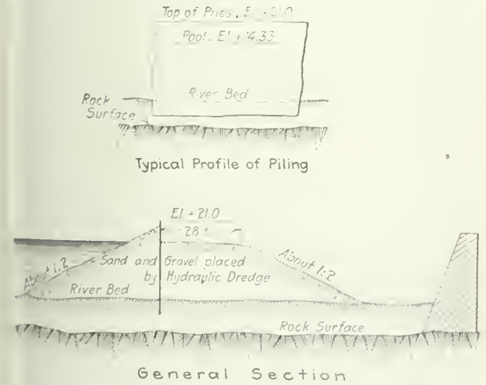
[1] Measurements taken at the height of subsequent floods showed a fall ranging from 1 to 2 ft. between the upper and lower ends of this coffer-dam, causing velocities which at times resulted in the suspension of navigation.

The angle of repose of the fill was taken as 1 vertical to 2 horizontal, and no support from the diaphragms against sliding was assured, as it was evident that their piles would tend to slide along their joints under any stress.

As proportioned by the foregoing assumptions, the theoretical resultant of vertical and horizontal pressures came a little within the middle third. This, however, was merely a theoretical safety, as the weakness of coffer-dams of the gravity type usually consists in excessive pressures at the toe or in an overload of horizontal shear. The latter is the more common source of danger, and in point of fact most of such structures will be found on analysis to be balanced near or beyond the edge of a theoretical safety against this stress. In the present case the water pressure and the sliding resistance of the fill (assumed as having a coefficient of 0.5) were nearly balanced, and to add a factor of safety two 1¼-in. rods were placed in each cylinder, as shown in Fig. 4.

Trials proved that the most economical size of pocket to meet the foregoing assumptions would be one with a width of 26 ft., having its outer and inner faces curved to a radius of 24½ ft. and joined by straight diaphragms, and of a horizontal depth varying to suit the depth of water (see Fig. 4). The outer and the inner face piling were made long enough to reach to rock except where the rock was low, when the inner piling was made 3 ft. shorter and driven that much less, while the diaphragm piles were made in general only long enough to drive 2 or 3 ft. into the river bed, below which point it was assumed that the





FIGS 3 TO 5. PLANS AND DETAILS OF COFFER-DAMS NOS 2 AND 4

Fig. 3—Enlarged plan of coffers Nos. 2 and 4. Fig 4—Details of coffer No. 3. Fig. 5—Details of coffer No. 1

tendency of the filling to rip the pockets apart would be resisted safely by the bearing against the gravel. The piles were specified to be made with an ultimate tensile strength of interlock of 8,000 lb. per lin.in., and the possible angle of inclination to each other was to be 15°.

About 1,900 tons of piling of 38-lb. section (equivalent to about 3,400 separate pieces) were purchased from the Carnegie Steel Co., the lowest bidder, at $35.20 per ton for plain piling and $45.20 per ton for junctions or "specials" (Fig. 4). A salvage value was agreed on, f.o.b. cars at Troy, of $10.71 per ton for specials and for piling 30 ft. long or under, and the same price for damaged longer piling. Long piling which had 30 ft. in a condition suitable for redriving was to be paid for at $26 per ton for the undamaged portions. The lengths varied from 23 to 41 ft., about 40% of the total number being 32 ft. The hole in the end of each pile, usually made about 1 in., was specified to be 2½ in. in diameter, and this was found much preferable to a small one when handling.

Method of Driving the Pockets

Driving was begun at the north end, the piles being set around a templet of 2-in. plank, some of which can be seen in Fig. 1. At the south end the water-tight connection with the bank, or "cutoff," was made by a line of single piles joined to the bank pocket, and at the north end a dirt-filled box was used. At first a full templet was employed, but later a half one gave better results, as it allowed more freedom of movement for the driving boats and was more easily picked out of the finished pocket. The best progress was made by setting up several piles along the templet before driving, as this took the least shifting of tackle, and the piles, being interlocked with the preceding pocket, could not fall over. A considerable number of pockets was set before any filling was done, the first one (No. 1 in Fig. 3) serving as an anchor for the rest, as its piles were driven several feet into the bottom. The adjacent pockets, although resting on practically bare rock, showed little tendency to lean. If this occurred, they were pushed back by a tugboat and then guyed until they could be filled. One or two of the pockets farther down the line, where the piles were driven to a penetration of several feet, got out of plumb considerably in driving and could not be straightened; they were therefore filled as they stood.

The maximum penetration was not over 8 or 9 ft. and in most cases was considerably less, as the gravel was compact. Thus, although the piles had been ordered long enough to extend to rock, few of them reached it except where the gravel was shallow. The profile of some is shown in Fig. 1.

For the handling and driving, derrick boats were employed almost entirely, on account of their wide reach. Three steam hammers of a standard make did the driving, and one or another and often two of them would be out of commission most of the time on account of breakdowns. This gave permanent and expensive employment to several machinists and caused a steady loss of efficiency in the driving crews. An experiment with a view to avoiding this expense was made with a hammer devised by the mechanical engineer, E. C. Quinlivan. It was a home-made affair of heavy bar iron which straddled the pile and was worked by a single line, the knuckles of the pile itself serving as guides. This hammer seemed to possess many possibilities; and if the driving had not been nearing a conclusion, it would have been experimented with further.

When closing a pocket, eight or ten piles were set up on each side of the gap, interlocked with the last piles driven, but themselves resting on the river bed. This was necessary to give flexibility enough to let the closing pile be set. As soon as several pockets had been completed, filling was begun by a hydraulic dredge using sand and gravel from the site of the new channel. The fill was made in about 6-ft. layers, moving from pocket to pocket as each layer was finished, so as to avoid distorting unduly the straight sides.

One point had been overlooked, however—that of providing a low-level outlet for the water from the discharge, which had to rise in consequence some 5 or 6 ft. above the river level before it could escape over the tops of the piles. As a result the pockets were forced temporarily into a cylindrical shape; but by regulating the placing of the gravel in the adjacent pockets the sides drew back to nearly their original straightness, and even where they retained a considerable bow, no harmful results occurred. The outward movement of the sides from the water pressure was fan-shaped, as the bottoms of the piles were held fast in the river bed. This distortion could be prevented by having one or two low piles over which the water could escape, the opening being closed by plank as the filling climbed up. Such an opening should preferably be placed on the river side if a hydraulic dredge is used; otherwise the silt in the overflow would spread over the coffer inclosure and make an overlay of some inches of mud. A small amount of filling was also placed against the inner and outer faces of the cylinders, to assist in checking leaks. Most of that placed outside at the upper corner was washed away by the flood currents before the coffer-dam was abandoned.

The first pile of this coffer-dam was set about the middle of July, 1913, and the filling was completed and unwatering begun about the end of the following November. The structure was nearly water-tight; practically no seepage took place through the pockets and not much underneath them, and except in floods one 12-in. centrifugal pump, lifting about 45 ft., was sufficient during the greater portion of the work to keep down the water. No repairs of any kind were needed, nor were any difficulties caused by leakage, although the coffer was exposed to two winters and to many floods and was kept unwatered during part of the first and all of the second winter. It was flooded several times, once because of the failure of the river and harbor bill, once through the suspension of work for the season, and the other times because of floods that began to overtop it. No deformation of pockets was at any time visible to the eye, and observations taken to ascertain if any were beginning to lean inward at the top showed a maximum movement of 2½ in., near pocket 23. With the majority of the pockets there was no movement at all, and after the first few weeks all movements ceased. The portion last used was finally abandoned on Aug. 1, 1915, when the lock was complete and ready for navigation. The removal of the piling will be made the subject of a separate article.

Cost of Cellular Coffer-Dam No. 2

In giving figures for the cost of the steel coffer-dams it is believed that the figures most useful would be those based on the cost of each one assumed as a separate unit. The data given below are therefore based on the supposition that the first-lock coffer-dam was built with piling used for that structure only and that the piling was then sold; and that the filling and banking were disposed of directly into the spoil banks and not used again for other coffer-dams. The actual cost, however, was much less than under this supposition. The other two steel coffer-dams were built with the piling from the first coffer, so that no additional piles had to be purchased for them; and most of the filling and banking of one coffer was used over again for the next one, the final removal to the spoil banks being made only when the last cotter-dam was done with.

	Short Tons			
3,079 piles (2,000.05 short tons) @ $35.20 per ton				$70,402
90 specials (119.33 tons) @ $45.20 per ton				5,394
Tie-rods, 7 tons @ $45.20				316
Washers, 1.7 tons @ $65				111
Total metal				$76,223
Salvage value:				
Piles, etc., under 30 ft.	266.0			
4% estimated waste on longer piles	74.4			
Total scrap	340.4	@ $10.71	$3,646	
Merchantable	1,785.6	@ 26.00	46,426	
Total salvage				50,072
Net cost of metal				$26,151
Unloading, yard work and transporting piles, 3,169 pieces @ $1				3,169
Templets, making and handling				1,200
Setting and driving piles @ $2.60*				8,250
Setting tie-rods, 70 pieces @ $5				350
Filling and banking, 65,000 cu.yd. @ 20c. for placing and 20c. for removing				26,000
Jacking and pulling piles, at about $3.50*				11,092
Transporting, sorting and loading, at 50c.				1,585
Miscellaneous work				10,660
Total cost				$88,457
Cost per linear foot (1,000 ft.)				$88.46

*Of these amounts labor was about 74%, repairs 6%, and supplies 20%.

The foregoing are field costs of construction and removal and include ordinary running repairs. They do not include depreciation or district-office costs, or supervision above the grade of foreman.

SINGLE-LINE SHEETPILE COFFER-DAM

The second coffer-dam (No. 4), to inclose the remainder f the lock, was attached to the first one and consisted of single line of steel piling, about 650 ft. in length, with a rotecting spur at its upper end and an anchor cylinder t the lower corner. Relying on the experience obtained vith the first coffer, the piles were driven only 5 or 6 ft. nto the river bed, and no attempt was made to reach the ock (Figs. 4 and 5). The banking was relied on to rovide resistance to seepage and stability, the width of he inner bank being made sufficient to resist sliding. ost of the piles used were taken from the first coffer. s by September, 1914, the lock had been completed far nough to allow its river wall and head walls to replace uch of the coffer-dam, assisted by the bulkhead from ylinder 16, shown in Fig. 7, of the plan Dam No. 5. The line of piling was located far enough from the proposed masonry to avoid trouble from too steep excavation slopes, and all the banking below water level was placed by the hydraulic dredge and taken from the site for the new channel or from the first-lock coffer-dam. The inner bank was never built up above the water line, but the outer one was raised a few feet by using derrick boats and orange-peel buckets. As the style of construction provided no tension in the interlocks and any water percolating to the piles would therefore tend to escape through the joints, the latter were filled with river sand poured in from the top, with the view of stanching them. Before this was done, however, and before the outer banking had been raised, a flood came that rose several feet upon the unprotected faces of the piles, and at many points there was a copious leakage that washed down a good deal of the bank. By the time the next flood came, however, the joints had been filled and the banking finished. The latter in many places was several feet below the flood level, which rose until the water began to run over the low piles; but the joints now proved entirely water-tight except for a little seepage, and the steel wall, unsupported or cantilevered above the top of the inner banking, held without difficulty the pressure of the water, amounting to a head of about 6 ft.

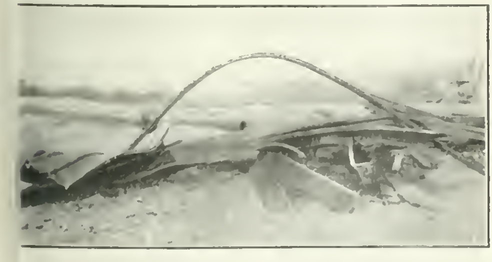
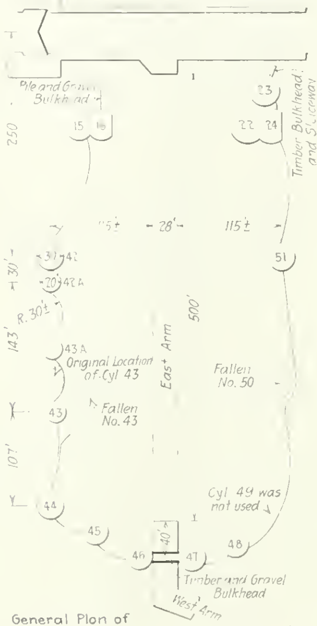
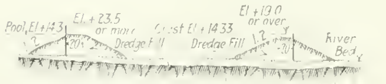


FIG. 6. PILES DISTORTED BY FLOOD



General Plan of Coffer for East Arm of Dam (No.5)



Typical Section of Coffer No. 5

FIG. 7. PLAN AND DETAILS OF COFFER FOR DAM NO. 5

Pumping out was begun on Jan. 9, 1915, and was carried on slowly until Jan. 16, on which date the bottom was reached. One 12-in. centrifugal pump, running about one-third of the time thereafter, kept the inclosure empty. About four weeks later the division between the two coffer-dams was cut through, and the leakage was then run north to the main sump. During its existence the coffer-dam was partly flooded once, and once entirely, due to high water. The latter flood tested severely the breakwater before described, and the current around its end ran 6 or 7 mi. an hour; but fortunately no harm resulted, and the protection it afforded saved from erosion the adjacent coffer banking.

By April, construction had advanced far enough to allow removing some of the piling for use in the coffer-dam for the east arm of the dam, and a cutoff dike of excavated material was therefore built just below the main lock walls, as shown in Fig. 3, and pile pulling was begun. The dike and the remains of both coffer-dams were kept in service until Aug. 1, 1915, when the dredge began the removal of the former and opened the entrance for navigation.

COST OF SINGLE-LINE COFFER

The cost given below is based on the assumptions described for the cost of the first-lock coffer-dam—namely, that each coffer was a separately paid for structure. Field costs only, as specified for the other coffer, are given.

797 piles (470.2 short tons) @ $35.20 per ton				$16,551
8 specials (9.6 tons) @ $45.20 per ton				434
Total				$16,985
Salvage value:	Short Tons			
Piles under 30 ft. and specials	91.3			
4% estimated waste on longer piles	15.5			
Total scrap	106.8	@ $10.71	$1,145	
Merchantable	373.0	@ 26.00	9,698	
Total salvage				$10,843
Net cost of metal				$6,142
Unloading, yard work and transportation, 805 pieces @ $1				805
Templets for 2 cylinders				100
Setting and driving piles @ $2.10				1,690
Banking, 40,000 cu.yd. @ 20c. for placing and 20c. for removing				16,000
Pulling piles, at about 75c.				604
Transporting, sorting and loading, at 75c.				604
Miscellaneous work, 10%				2,590
Total cost				$28,535
Cost per linear foot (main coffer, 650 ft.; breakwater, 90 ft.; total, 740 ft.)				$38.55

COMBINATION CYLINDER AND SINGLE-LINE COFFER

The third and last steel-pile coffer-dam was used to complete the unfinished portion, 500 ft. in length, of the east arm of the dam (No. 5), Fig. 7. Its design was an evolution of the second-lock coffer and the general conditions to be fulfilled were that the masonry of the dam had to be completed in one season or the expense would have to be incurred of a coffer-dam that would successfully outlive the winter floods and act as a substitute in 1916 for the old dam downstream, which by that time would have been removed from the new navigation channel. It was therefore decided to endeavor to complete the masonry in a single season.

Having the steel piles on hand, the adoption of a wooden coffer-dam was not considered, as it would have involved buying additional material and the type would be more vulnerable to floods. The plan chosen comprised a single wall of steel piles supported by banking, generally similar to the second-lock coffer-dam. Four principal changes were made, however: No driving was done (except for parts of the cylinders specially exposed to undermining), but the piles were merely rested on the bottom of the river; anchor cylinders were used about 100 ft. apart, so that if high water pushed over any of the line piling while being set up, the damage would be checked at the nearest cylinder; the width of the inside fill was made 20 ft. at the water line instead of 28 ft.; and the fill on the outside was not raised above the low-water line.

The last-named feature saved a good deal of banking and was adopted from the experience with pouring sand in the interlocks of the second-lock coffer in order to make the joints water-tight. The method proved equally successful in the present case. No special lengths of piles were used, but random lengths were set up as they came delivered on the barges. The ends of the coffer-dam at the lock were joined to portions of the lock coffer-dam which had been left in place for that purpose. The width between north and south lines was made ample, so as to accommodate the trackage and leave a large margin for spoil, etc. (see Fig. 7).

The program was to begin setting up cylinders 41 to 48 inclusive with their connecting diaphragms (Fig. 7) as soon as the spring floods had passed; to complete the remaining cylinders next; and finally to link them together with the line piling. The flow was to be shut off when ready by the line between cylinders 42 and 43, and the final closure made between 50 and 51. A diameter of 30 ft. was chosen for the cylinders, to give ample stability, and the line piling was bowed downstream so that if a flood came before the banking was in place there might be less chance of distortion than with a straight line. It was not anticipated that the attached cylinders could give much support under such conditions, as their diameter was too small.

Pile setting was begun the last week in April, 1915, and was continued leisurely, as it was inadvisable to have much of the work in place before the June rise. The west cylinders were placed and filled, and the isolated cylinders in the river were then begun. Some of these gave trouble, as the rock had been swept bare in places by the concentration of the currents, and guys had to be used to hold the piling up. More than once the guys slipped, sometimes owing to boats fouling them, sometimes to other causes, and the piling fell over. No harm seemed to be done, however, to the pieces, and in one case where the cylinder had been closed just before falling it was fished up and set on its feet again with two or three days' work, apparently little the worse. Finally it was judged advisable to pump a small bank of gravel onto the bare rock where these troubles were liable to occur. The piling was then set up and driven into this holding ground and lashed with guys until it could be filled. This method proved successful in avoiding future trouble. Where the bed was naturally of gravel, occasional members of the piling were driven into it for 3 or 4 ft., holding up the cylinder.

TROUBLES DUE TO HIGH WATER

By the end of June all the cylinders had been placed, as well as the line piling of the upstream arm, except for the center bay, and much of the downstream line running east from cylinder 48. Thereupon began one of the wettest seasons on record, which continued without a break until the spring of 1916. The first flood undermined cylinder 51 until it sank under the water, while three other cylinders (42, 43 and 50) were somewhat flattened from loss of filling, but otherwise held their own. The end of the downstream line piling was also pushed over. At the height of the flood the slope over the site of the coffer was 13 in. As soon as the water receded, the three flattened cylinders were restored satisfactorily by pumping in more filling, and work was begun on hoisting the fallen one and the downstream line.

Just a week after this flood, however, another and much worse one came, causing a head of 2 ft. at the coffer site. Cylinder 42 was again flattened, and 43 and 50 disappeared under the surface. About 50 ft of the line piling attached to 43 went down also. It was found later that this cylinder had been revolved by the current and had been torn loose and thrown down under the line piling, which settled down on top of it. The general effect of these floods on some of the piling is shown by Fig. 6.

A week after the height of the flood, boats were able to get out into the current and start repairs. Six hoisting boats, extemporized and otherwise, were employed thereon. The flattened cylinders were restored satisfactorily by pumping in filling, and all but two of the fallen ones were set up and similarly refilled. Although their appearance when restored was decidedly disreputable, they were able to perform their duties satisfactorily. Cylinders 43 and 50 were found to be half buried in banks of gravel. After several attempts to pull them up, they were abandoned and still lie on the bottom of the river.

This flood and the apprehension of others to follow made necessary a revision of the plan for closing the cofferdam. Had the season been normal, there would have been ow water by the end of July, and the two navigation pools immediately upstream in the Mohawk and Hudson Rivers could then have been drawn down several feet and been allowed, when all was ready, to fill up again, tempoarily cutting off all discharge and current in the Troy pool. n the still water thus secured the closure could have been made in less than eight hours. No low water could now e relied on, apparently, and it was evident that the closure must be made with the still abundant flow. To do this, two new cylinders 43 and 42a were set up as shown in Fig. , one near the abandoned 43 and the other adjoining 42, hich was leaning too much to provide any interlock. The ne piling between 43 and 44 was then completed, the ew piles merely overlapping the end of the line, which was adly twisted. A third new cylinder, 43a, was next set up n the middle of the opening, leaving about 15 ft clear on ach side to be closed by line piling. These three new ylinders rested on bare rock, except part of 43, which erlapped the remains of the banking.

Experience with the fallen and the flattened cylinders ad shown that even where the rock was bare, the feet the piles of a cylinder might not all reach it, especially those driven in closing, and that where there was an pening of only a foot or so under a single pile a strong urrent would gradually suck out the filling and perhaps use a collapse. To prevent such trouble, riprap was rown inside the three new cylinders, chiefly against the ling, to a depth of about 5 ft., and the filling was then umped upon it. It may be noted also that the diameter the cylinders was reduced from 30 to 20 ft.

Were the writer designing other structures of this type would use cylinders of the smaller diameter, as with side layers of riprap as described they would weather y ordinary flood as safely as the larger ones. Although e riprap makes porous spots in the coffer-dam, no trouble ults, as was proved in this case, where the outside and e inside banking formed a blanket of sufficient thickness to care for such local weaknesses. Another point to be mentioned is that the closure should be made on the side least exposed to the current, so that if the closing pile does not reach the bottom, there will be less force of water to play into the opening.

This work was interfered with by two small rises, but was made ready for the final closure on Aug. 12. When placing the new cylinders the side connection piles had been fitted with eye-bolts carrying two ⅞-in. steel cables, intended to make horizontal loops for supporting the closure piling while being placed in the current. One cable was about 3 ft. from the bottom and the other about 3 ft. below the water surface, and they were designed to support a 3-ft. head on the piles. One end of each cable was brought to the top of the cylinders, so that the loop could be tightened or slackened if found necessary. These loops acted in reality only as guard cables, as when setting the closure piling the pieces were driven until their feet bit into the shale rock, and occasional piles were guyed to the derrick boats, holding the line until final closure could be made. Two derrick boats, working continuously for nearly two days, closed the two gaps successfully by Aug. 14. The depth of water in which the piling was set varied from 21 ft. at cylinder 43 to 29 ft. at cylinder 42a, and the head as the closure progressed rose from 0.2 to 0.7 ft., as much as possible of the discharge being passed through the lock and the power bulkhead openings.

Less than a week after the north arm had been closed the fringes of the Galveston hurricane of 1915 passed over the watershed, and on the night of Aug. 22 the river began to rise sharply. By next day the water was flowing over the crest of the masonry dam at cylinder 46 with a depth of 7 ft. and with the cross-current from the oblique arm began to erode the incomplete protection and to suck the filling out of cylinders 47 and 48. Much material was pumped back into them by the dredge, and where practicable the piles were driven farther down; but the filling still escaped, and by the second day the cylinders were creaking and swaying ominously. In one of the cylinders a single pile was found to be causing the trouble, as it had jammed about 1 ft. above the rock, leaving a gap through which the filling was sucked out. Just inside the river faces of both cylinders, therefore, and inside the line piling, riprap was thrown until all gaps appeared to be blocked up, and new filling was then pumped upon it. This stopped all trouble. The same currents had pulled loose the timber closure between cylinder 47 and the masonry dam, and this had to be replaced in water 18 ft. deep and in a river current running over 6 mi. an hour, requiring much patience and care to accomplish.

All restorations were completed after two days' work, and the closure of the south arm was proceeded with and completed on Sept. 3. The dredge completed the banking on Sept. 10, pumping out having been begun three days before with two 12-in. electric pumps. A third 12-in. and two 6-in. pumps were added a few days later; and a 10-in. centrifugal steam pump followed, as it was imperative to have an ample breakdown service owing to the long perimeter of the coffer-dam (about 1,300 ft.) and to the depth of water upon the banking (from 16 to 28 ft. at low water). By September 13 the water had been lowered about 18 ft., the pumping being proceeded with leisurely so as to drain the inner banking slowly and allow the coffer-dam to adjust itself to the pressure. Excavation was begun the same day, but another rise stopped operations for a few days, and the closure had to be partly flooded. When pumping was resumed, the water was lowered to about 23 ft. below the river level and could be held there without difficulty by two 12-in. and the one 10-in. pumps, lifting about 35 ft. Thereafter, as the banking seasoned, the leakage steadily decreased until one 12-in. pump and about one-quarter of the capacity of another 12-in. pump could take care of it.

Excavation was resumed on Sept. 18, and the first concrete was laid on the twenty-third. The full length required, 500 ft., was completed five weeks later, on Oct. 29. Although several rises occurred during this time, the coffer-dam was kept unwatered, though once or twice it was a toss-up whether or not the water should be let in. Counting from July 1, eleven rises, large and small, passed down the river before the coffer-dam was done with. The pumps were stopped for the last time on Nov. 3, and the river was practically free of obstructing piling three weeks later. The piles were removed very rapidly, as few pieces had been driven, and the only difficult work was with the distorted cylinders and the torn north line. One clump of piling was removed from the latter consisting of about 25 pieces twisted and locked together. They had to be cut apart on the bank with an oxyacetylene torch.

The coffer-dam proved quite satisfactory. Its speed of construction, aside from delays by floods, was limited only by the capacity of the hydraulic dredge to supply filling and banking, and the use of line piling with isolated cylinders allowed the construction to proceed step by step with a minimum of risk of losing previous work. The damaging floods of July and August would probably have caused a total loss with a wooden coffer-dam, whereas very little of the displaced steel piling could not be pulled up and reset. The structure proved almost entirely water-tight, and when done with, its removal was very rapid, being limited practically by the capacity of the dredge to dispose of the banking.

On account of the changes and repairs resulting from the abnormally wet season, it would be difficult to give costs comparable with those of a normal year. As compared with the second-lock coffer-dam, however, the difference in cost per linear foot would not be great, for while the cylinders increased the proportion of piling, the reduced width of the banking and the lessened cost of placing and removing the piles, due to eliminating most of the driving, effected a considerable saving.

Engineers in Charge of Work

The work was performed under the supervision of General (then Colonel) William M. Black, now Chief of Engineers, United States Army, with Captain R. D. Black as local engineer officer, succeeded in 1914 by Major M. J. McDonough. The fieldwork was commenced by Assistant Engineer A. C. Harper and continued by Junior Engineer J. J. McCabe. The mechanical work was under Wm. O. Quinlivan and the office work under Junior Engineer F. P. Fifer. The writer supervised the work locally.

* * *

Municipal Dock Construction is to be undertaken by the City of Albany, N. Y., in order to carry out its scheme of river front improvement. The city made an agreement with the Hudson Navigation Co. to build a pier on the river front with buildings for the handling of passengers and freight, but the company has failed to carry out the work. An ordinance has therefore been introduced under which the city will issue bonds to cover the cost of the work and will lease the buildings when completed to the Navigation Co.

Development of Government Railways in China[*]

By C. C. Wang[†]

Since the introduction of railways in 1876, China's railway policy has undergone a number of changes. At first it was a general policy of opposition, as shown by the fate of the Shanghai-Woosung Railway.[1] The ignorance regarding the new scheme of transportation, the general prejudice against foreign innovations, the fear of foreign influences and the deep-rooted superstitions together with the untactful behavior and irregular methods used by some of the foreign promoters—all these combined to prevent the introduction of the new means of transportation. Moreover, the apathy against railways was not limited to any one class but extended to all classes of the nation. The railway policy of China then, if any policy existed, was that of exclusion.

Beginning about 1879 a number of the enlightened officials began to realize the usefulness of railways. Efforts were made even at considerable personal risk, to introduce railways into the country; but the Court above and the people below were as obstinate as before. In spite of apparently insurmountable difficulties, however, the ingenious and persistent efforts of these enlightened officials gradually removed the barriers.

After the Boxer uprising, the Court became too busily occupied with other questions to maintain its opposition against railways. So for about eight years, the Government adopted what may be called a *laissez faire* policy.

By 1907, the Peking-Mukden, the Peking-Hankow, the Peking-Kalgan, the Tientsin-Pukow, the Shanghai-Nanking, the Kirin-Changchun and the Chengtai Lines had been opened to traffic. The enormous returns made by a number of these lines at once made a deep impression upon the people. They began to realize the possibilities of railways as investments. So superstition, formidable as it was, gradually gave way in the face of the increasing usefulness and earning power of railways, and in its place a railway fever set in.

The "localization" movement was started, with the slogan that each Province should race against all the rest in building all the railways within its boundaries. Many railway companies were organized. Several Provincial Governments also jumped into the whirlpool. Numerous schemes were embarked upon. Liberal rights were obtained from the Government. A considerable amount of money was raised, and a number of lines put under construction. From all appearances, there was a general enthusiasm for railway building. But the lack of practical experience in this new enterprise more than counterbalanced the force of enthusiasm, and actual railroading did not go very far.

In order to prevent these schemes from becoming complete failures and to extend the then favorite policy of centralization, which had been adopted by the young Manchu princes a few years before, the program of railway nationalization was embarked upon. This measure met with immediate and wide-spread opposition, which led to the Revolution of 1911 and resulted in the overthrow of the Manchu Dynasty.

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[*] From a paper in the "Far Eastern Review."

[†] Chairman of the Government Commission on the Unification of Railway Accounts.

[1] After overcoming all sorts of obstacles, the first rail of this narrow-gage line was laid in 1876, exactly 50 years after the "Rocket" made its debut in England. But later opposition became so strong that the railway had to be repurchased by the Government and the rails, etc., torn up and conveyed from the mainland to Formosa to rust.

As if heavenly sent for the special purpose of overthrowing the Manchus, the "localization" movement immediately subsided with the dissolution of the Dynasty. The spark which started the conflagration, the nationalization policy, however, outlived all the turmoils. This policy has since been quietly carried out until now practically all the provincial concessions are taken back.

Side by side with the nationalization program, the policy of making a system of State railways has been definitely adopted. A system of trunk lines which should be constructed and operated by the Government has been carefully mapped out. Thus the policy of creating a system of national railways began with the downfall of the Manchu Dynasty and consolidated itself during the Republic.

By the end of 1915, there were in all 8,342 kilometers of railway under operation in the country. Of these the most important is the system of Government railways, which comprises 15 different lines with a total of 5,702 kilometers, thus equalling 68.1% of the total kilometrage in the country. The second class embraces 2,399 kilometers of "concessioned" lines such as the Chinese Eastern, the South-Manchuria and the Chiaochou-Tsinan Lines: while the last class consists of 242 kilometers of private lines which are owned and operated by private Chinese companies.

This system of government railways has cost the Chinese Government $398,221,176, being about $73,783 per kilometer of line.

There are 627 locomotives of all classes which were bought from more than five different countries. A total of 823 passenger cars and 10,118 goods wagons were used in carrying the 26,036,152 passengers and 14,580,-'64 tons of freight in 1915. A gross revenue of 56.1 million dollars was earned, while 48 millions were spent for doing the business and paying interest on the capital, leaving $8,100,000 to the Government as a net profit during the same period. In addition to the lines under operation, there are now about 10,000 kilometers of line which are either under construction or definitely projected.

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Hydraulic Principles of Flume Intakes and Outlets

By A. C. Norton*

When the velocity of water in a flume exceeds that in ie canal above, there must be a sufficient drop in the take to provide for the loss of head due to the change cross-section of the conduit and to give the necessary celeration to the water. The entry-head loss will de-nd on the shape of the transition section between the nal and the flume, which, if properly designed to make ie change gradually, will reduce the entry-head loss to actically nothing. The increased velocity head is the fference between the velocity in the flume and the nal above.

The entry head and increased velocity head may be termined by the following formula:

$$h = \frac{V_1^2 - V_2^2}{2cg} \qquad (1)$$

here h equals velocity and entry head in feet; V_1 equals velocity in the flume; V_2 equals velocity in the canal; g (32.2) equals acceleration due to gravity in feet per second; c is an experimental factor depending on percentage loss due to entry and will vary from 0.6 for abrupt entry, as when a straight head wall is used, to 0.9 where the transition is made gradually, as shown in the accompanying plans.

At the outlet where the velocity is reduced from that in the flume to that in the canal, there is a slight loss in head due to the change in section, but unless the velocity in the flume is but slightly greater than in the canal, it is not enough to take up all the difference in velocity head, and theoretically it should be possible to regain this head. Practically, however, it is possible to regain only part of this velocity head, and that only under certain conditions.

The conditions necessary for part of this velocity head to be used in regaining the lost grade are:

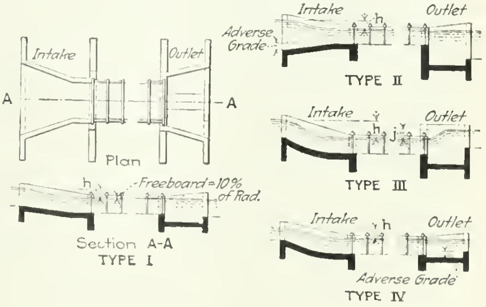
$$v > \sqrt{gd} \qquad (2)$$

and

$$s > g/e^2 \qquad (3)$$

Where d is depth in feet of water in the flume.

For smooth interior flumes, e may be taken as 100, hence the slope must be equal to or greater than 0.0032 and v, 11 to 12 ft. per sec. or over, depending on the size of the flume. To determine the height the water will rise in the canal above that in the flume at the outlet, or what is known as jump:



FOUR TYPES OF CANAL-FLUME TRANSITIONS

$$J = -d + 2\sqrt{d\frac{v^2}{2g}} \qquad (4)$$

Where J equals the jump in feet; v equals velocity of water in the flume in feet per second; d equals depth of water in the flume in feet; g equals 32.2; s equals slope of flume per unit of length; e equals 100.

In order to be entirely safe, however, it is better to use only about half the value of J in practice.

General Plans for Transitions

These plans show the manner in which the transition between the canal and the flume may be made, also how the entrance and velocity head is provided for to gain the required velocity in the intake, formula (1).

Type I. At the outlet the water surface is the same in the canal as in the flume, except where the velocity is high enough to jump, formulas (2), (3) and (4). The main problem at the outlet is to check the velocity of the water from the flume down to that in the canal in such a manner as to prevent cutting and scouring the canal below the outlet of the flume. Where the velocity in the flume is high, it becomes necessary to construct some manner of check or to riprap the canal for a short distance below the flume.

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*Chief Engineer, R. Hardesty Manufacturing Co., Denver, lo.

Type II. This shows conditions where the depth of water in the canal is much greater than that in the flume. The maximum economy of grade is obtained by allowing only sufficient drop in the water surface in the intake to allow for h, formula (1), the bottom of the flume being higher than the top of the canal and the bottom of the intake on an inverse grade. Theoretically, this is a very satisfactory solution, but practically it is not recommended if it can be avoided, unless used in modified form.

This type of intake may work satisfactorily when clear water is used or a full head kept running, which may give enough velocity to the water to prevent the canal from silting in front of the intake. The principal objections are that as soon as the head is reduced, the velocity decreases to such an extent that it is practically impossible to prevent silting of the canal up to a level with the bottom of the flume. This may be partly overcome by placing a gate in the bottom of the canal above the intake, which will serve as a sluice and drain gate.

At the outlet, the bottom of the canal must be enough below the bottom of the flume to allow the water surface in the canal and the flume to be the same elevation, unless conditions are such that Type III outlet may be used; formulas (2), (3) and (4).

Type III. This shows conditions where the flume is carrying water under high velocity. At the intake the head h will be very large, formula (1). At the outlet, the jump may be taken advantage of providing the velocity in the flume is great enough to produce a jump; formulas (2), (3) and (4).

Type IV. Here the canal is shallower than the flume; the head h is allowed in the water surface at the intake. The outlet may be constructed on an adverse grade if the velocity in the flume is great enough to prevent silting. A gate may be provided, as shown, to drain the flume. The water surface in the flume at the outlet being the same as that in the canal unless the velocity be great enough to use Type III outlet.

CONCLUSIONS

1. The grades must be computed from the water surface owing to the differences in the depth that may exist.

2. The losses of grade consist of four quantities: (a) The loss of head at the intake due to the change in section; (b) the required velocity head at the intake; (c) the grade of the flume itself; (d) the loss of head at the outlet due to the change of section.

3. On short flumes, h will be much greater than the grade of the flume itself and must be allowed for two reasons: (a) in order to prevent piling up in the canal above the intake of the flume, and (b) in order to obtain the full carrying capacity of the flume.

One of the most common errors in flume construction consists in allowing all the available grade to be taken up in the flume itself, making no allowance for velocity head, consequently, the free board in the canal above the flume will be reduced until the velocity head is attained or the flume will carry only part capacity. In cases of short flumes, where a certain small amount of grade is available and a large velocity head cannot be allowed, the only alternative is to increase the size of the flume and cut down the velocity even though there may be sufficient grade by allowing it all in the flume to give it a much higher carrying capacity. The grade lost *must* consist of both velocity head h and the grade of the flume.

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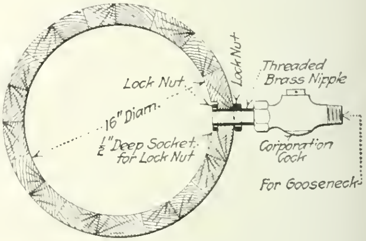
Madison-Anson Water-Supply

A project, now in the course of construction, to supply two Maine water districts, Madison and Anson, probably has the distinction of being the only new water-supply development in New England at the present time. The villages of Anson, Madison and North Anson, about 80 mi. north of Portland, are to have a gravity water-supply from Hancock Pond through a pipe line 13 mi. long.

The intake is to be 16-in. universal-joint cast-iron pipe laid by a diver to a point 250 ft. from the shore line, where the depth of water is about 18 ft. The first 6½ mi. of the pipe line is 16-in. wood-stave pipe, and the other 6½ mi. is 14-in. cast-iron pipe. On account of the length of the main, three relief valves are provided to reduce water-hammer. There are a few service connections on the wood-stave main, a detail of which is shown in the accompanying illustration.



DETAIL OF SERVICE CONNECTION, WOOD MAIN

The contract cost of the main and appurtenances is $140,000 and of the distributing systems of two of the villages, $20,000. One village already has a local water-supply and distribution system. The combined population of the three villages does not exceed 5,000.

The water-supply system is designed to deliver 1,000 gal. per min. at 60 lb. pressure in the fire district of Madison, which is near the end of the line. The maximum pressure on the wood-stave part of the line is about 80 lb. All three villages have manufacturing interests, for the fire protection of which the water-supply was urgent.

In trenching for the pipe line the contractor, the Hanscom Construction Co., Boston, Mass., is using a Parsons trenching machine, probably one of the first of these machines to be used in Maine. The minimum depth of the pipe line in the woods is 4 ft. and in roadways or beaten paths 6 ft. Walter H. Sawyer, Consulting Engineer, Lewiston, Maine, who designed this water-supply, states that a covering of 2 ft. has been found sufficient for water mains in undisturbed wooded country in Maine, that the snow cover furnishes ample protection from freezing at this depth.

San Francisco Shore Protection Near Completion

The design of the Esplanade, now being constructed
long the shore of the Pacific Ocean at San Francisco,
ras briefly described in *Engineering News* of Sept. 16,
915, p. 571.

The structure is planned primarily for beach protec-
ion, having a front wall formed by driving interlocking
oncrete piling to a depth of 13 ft. below extreme low
ide. These piles were precast, are 10 in. thick, 4 ft.
wide and 20 ft. long. When in position they will form
a reinforced-concrete curtain wall 10 in. thick, extending
north and south. Inside of this outer line of sheetpiles
are located pedestal piles 18 in. square, with 3-ft. square

db. and 21½ ft. in length, spaced at 10-ft. centers.
tween these two rows of piles are placed heavy rein-
rced beams 20x13 in. by 27½ ft., weighing 13 tons,
ich form the main tie and by means of keyways sup-
rt the intermediate slabs of concrete. These beams are
aced on 20-ft. centers, except at stair sections, where
ey are at 10-ft. centers. The space between beams is
ncreted to form a heavy reinforcing slab, five bleacher
its and three stringers for additional support. The
ingers have a cross-section 16x18 in. The entire sec-
n between the beams has a solid bearing on sand and
in. of packed clay. The minimum thickness of this
acher section is 12 in. The last bleacher riser develops
o a rollway, and this rollway ends at the top of and
ms part of a 3½-ft. parapet wall, with returns at
her side of each stairway section. Behind the para-

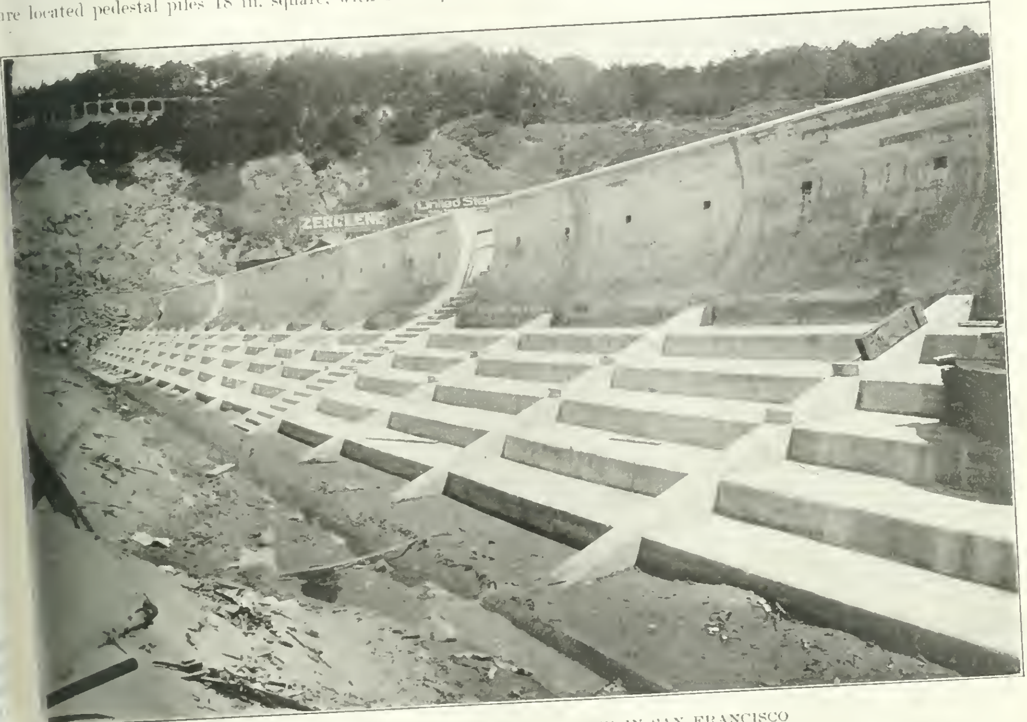
pet is a 20-ft. sidewalk with scupper holes to release wave water and a 6-in. concrete curb and gutter.

Over the front row of sheetpiles is a heavy reinforced-concrete slab 4 ft. thick and 6 ft. wide, which caps the piles and forms a main support for lower ends of beams and intermediate slabs. At the upper end of the beams, bearing on the pedestal piles, is a similar cap that ties the upper portion of the slab and structure together. Expansion joints are provided, likewise drinking fountains and electric-light connections.

All sheetpiles, H-beams and pedestal piles were precast, allowed to season for 40 days and then put into position. Most of the precast work was done on the bank above the beach and hauled to position on cars over a construction track. Some were cast on the beach and handled directly by derrick. All piles were driven by four water jets and steam hammer.

Two jets of 2-in. pipe reduced to ¾ in. at the discharge end were used on each side of the sheetpiles and one at each corner of the bulb piles. In both cases they were so located that they discharged about 1½ ft. below the bottom of the pile.

Water for jetting was supplied by the Olympic Salt Water Co., under static pressure of 130 and nozzle pressure of 10 lb. per jet. Consumption of water by jetting process was approximately 100 cu.ft. per min. The steam hammer was made useful by the fact that the summer beach level is 8 ft. above the required grade on sheetpiles and if placed to required grade by jets it would be impossible to interlock the next pile. There fore, 10 or 11 sheetpiles were placed to sand grade and



SHORE PROTECTION AT OCEAN BEACH IN SAN FRANCISCO then with hammer and jets were driven to the required grade, one sheetpile always remaining at sand level to start the next pile. The bulb piles were jetted to required grade without the use of the hammer. All jetting was accomplished without very great difficulty. Floating boulders, especially at the north end of the contract, gave some trouble, making it necessary to excavate 8 ft. to winter beach level and then remove boulders. All H-beams were placed by the heavy derrick without any difficulty.

Contract for the second unit of the Esplanade was awarded in July, 1916, to J. D. Hannah for $23,148.90. This provides for an addition of 170 lin.ft. of structure, identical with that described above, so that by Nov. 1, 1916, there will be completed 670 ft. of structure. It is to be hoped that in the forthcoming budget enough money will be appropriated to finish this deserving project as far south as the chalet pile structure, built some years ago.

Design and construction of the Esplanade are under the direction of M. M. O'Shaughnessy, City Engineer.

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Solving Louisiana Highway Improvement Problems

By M. C. Huckaby*

Among the first of the Louisiana communities to take up systematic road improvement was St. Tammany Parish, which is situated in the southeast corner of the state and borders on Lake Pontchartrain. The parish entered the field in the spring of 1914, by voting a bond issue of $180,000. A good roads' committee of ten members was appointed and organized, which in turn employed the writer as highway engineer to take charge of the project.

In St. Tammany Parish, as in many other sections of the state, unfortunately, the laymen had decided before obtaining the services of an engineer just how many miles of road they would build with the bond issue and, as is commonly the case, the mileage was set plenty high enough. With the $180,000-bond issue they proposed to improve 220 mi. of roads in alignment, grade and drainage.

The country being on the Gulf border, the rivers and streams through this section have to accommodate all the water that comes from the interior. Therefore the bridge item was necessarily large, and had to be made up by taking either from the width or the length of the roads to be improved.

Unusually Narrow Cross-Section Adopted

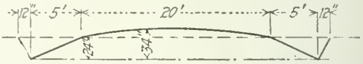
A meeting of the committee was held, and after a thorough discussion of the problem it was decided to begin the improvements on the main arteries first and to make the width between the centers of side ditches 30 ft., with a minimum distance of 20 ft. between the shoulders and a crown of 1 on 12. This being settled, the cross-section shown herewith was designed and adopted.

Throughout St. Tammany Parish the topography is uniform. In the southern portion the country is very flat, while in the northern part it is somewhat rolling. As a rule the grade line can be made parallel to the ground line everywhere except across river and stream bottoms. Therefore a cross-section was designed such that the cut from the side ditches, by means of blade graders, would balance with the necessary fill for the crown.

The writer is aware that there are those who do not approve of side ditches of the shape and depth shown; it is believed by some that such a ditch is dangerous, but as yet the writer has never known of a serious accident caused by the steep slopes. On the other hand, by cutting the ditches deep a quality of material was taken from the bottom which was much better for mixing with the top soil than could have been obtained otherwise without going to much greater expense. Again, by cutting the ditches down to the depth shown, better drainage was assured. A minimum distance of 38 in. was maintained between the bottom of the ditch and the crown of the road. To date, the ditches have proved very satisfactory in keeping the roadbed drained.

For this section of the country large ditches are indispensable, owing to the fact that such large rainfalls have to be taken care of. The cross-section illustrated was used on about 100 mi. of road; a cross-section that was only 20 ft. between centers of ditches was used on about 25 mi., and out of this same bond issue about 40 mi. of state-aid road was built, which was constructed with a similar cross-section, the principal difference being that a state-aid road is 24 ft. between shoulders.

However, it will be seen that only about 165 mi. of road was constructed out of the 220 mi. proposed; but the roads were made wider, the alignment was improved more, and the grade lines were much better than the committee had originally planned for. Also several of the roads were provided with reinforced-concrete bridges and culverts.



CROSS-SECTION ADOPTED FOR ST. TAMMANY PARISH ROADS, LOUISIANA

Results Prove Economy of Design

There is excellent material for building roads at a moderate cost. The natural soil in this section of the country can hardly be surpassed for road building anywhere. In many places there is a clay foundation covered with a sandy soil of from 3 to 6 in. in depth; when taken from the side ditches and mixed and shaped in the road, this gives a good wearing surface, and that too without any extra or unusual cost for mixing other than that accomplished by the regular process of moving and placing material.

The uniformity of this natural mixture is not such that the road will run for great distances without some weak places, but by careful maintenance and adding more sand or clay, as the case may require, it will be possible to correct the weak places at a moderate cost and have the wearing surface everywhere uniform.

The traffic in this parish is not unusually dense, but the tonnage is fairly heavy. It is a lumber section, and the highways are used for logging purposes. The traffic regulations with reference to loading are practically the same as everywhere else in the South. The limitations are based on the size of the wagon and team instead of the width of tire—that is, the law allows all the load that will stay on and that can be drawn by the team.

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*Chief Highway Engineer, Parish of St. Tammany, Louisiana.

All the work done on the roads referred to was by contract, and the contract prices varied between the following limits on the principal items: Earth and embankment, 16 to 20c. per cu.yd.; reinforced concrete in place, $13 per cu.yd.; creosoted pine timber in place, $45 to $50 per M ft. b.m.; clearing and grubbing, $35 to $60 an acre.

There is a splendid opportunity in St. Tammany Parish to study sand-clay roads under service, and it is the intention of the writer to make such a study.

HIGHWAY-BRIDGE PROBLEMS

Bridge building on the highways of St. Tammany Parish is complicated by the condition of minimum fills and maximum waterways. That is, the valleys are usually wide and flat, allowing the water to spread over a large area. In several instances it is somewhat difficult to design a bridge that will have sufficient waterway without building an unusually long one or making the embankment unusually high to serve as a dam to hold the water back until it can run through the bridge opening. This latter is possible, as the current is almost negligible in every case and a rise of a few inches on the embankment would spread the overflow over a large area without material injury to property.

For the condition just described a design was made such that the depth of floor would be a minimum, thereby increasing the height of the waterway for the same grade line. The principle was used both in the concrete- and in the wooden-bridge plans. Concrete bridges were designed on a through-girder type, thus eliminating projecting beams on the bottom by using a reinforced-concrete slab (reinforcement laid both ways). A further decrease in the depth of the floor slab was made possible by using intermediate supports or short panels. For wooden bridges the panel length was reduced, the depth of the stringers was made a minimum, and the deficiency n strength was made up for by closer spacing. A minimum depth of 6 in. was used for the stringers in this design.

The foregoing conditions were common, but there were places where beam-and-girder concrete type and the onger-span types of wooden bridges could be used to dvantage.

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Shallow Railway Floor on Canal Bascule Bridge

By ARTHUR G. HAYDEN*

A remarkably shallow floor for heavy railway traffic makes the Franklin St. bascule bridge on the Erie Canal n Syracuse, N. Y., structurally notable. The bridge is ss than two years old; it has performed successfully in l respects.

The depth of floor was limited by the maximum navi-ible water surface in the canal and the allowable elevation of rail. The bridge, spanning 10 ft. in the clear, car-es a roadway of 31½ ft. total width between curbs and two sidewalks each 6 ft. clear width. There are four nes of main girders. The New York Central R.R. track cupies the middle roadway, 11 ft. 10 in. wide curb to rb, between the middle girders. The two roadways be-een middle and outer girders are 9 ft. 10 in. wide tween curbs.

The two outer girders are supported on the trunnion pins and carry the bridge structure and the balancing counterweight. The two middle girders are supported on the trunnion-end floor-beam and outer-end floor-beam, but come to a bearing on the abutments at each end when the bridge is closed, so that their live-load reactions go directly to the abutments.

The floor-beams of the middle roadway are 17 ft. 3 in. in span and only 18 in. deep. They consist of a web plate 18x3/8 in. and four angles 5x3½x7/16 in. The problem of construction was to obtain a floor of the required depth giving the necessary rigidity for railroad traffic without using a ballasted trough floor, which would increase the dead weight of the bridge and add to the cost of operating machinery. The difficulty was overcome by making the railroad-track stringers continuous from end to end of the bridge by means of top flange plates passing through the floor-beam web and bottom flange plates passing below the floor-beams, thus distributing over several the loads that would otherwise come on one floor-beam. This simple expedient is shown quite clearly in Fig. 3.

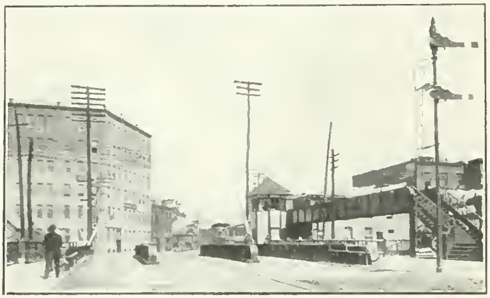

FIG. 1 COMBINED RAILWAY AND STREET ROADWAY OF FRANKLIN ST. BASCULE BRIDGE, SYRACUSE, N. Y.

The bridge was designed for Coopers E 60 loading, or four concentrations of 36,000 lb. each on the railroad track of the middle roadway, with impact allowance of 70%, an 18-ton road roller on any part of the roadway with impact allowance of 70%; 100 lb. per sq.ft. roadway and sidewalks not occupied by the concentrated loads, with impact allowance of 70%.

The roadway floor over the counterweight pit is stationary (Fig. 2), thus obviating the need of a heel lock and its operating mechanism and avoiding the precipitation of dirt into the pit when the bridge is raised. The outer main girders back of the trunnion pin descend through slots in the pit floor when the bridge is raised.

OPERATION OF THE BRIDGE

The machinery for operating the bridge (except motors and the rack) is located on the moving structure. The two 12-hp. electric motors, set in a machinery pit at one side of the bridge, gear to a shaft *CD* concentric with the trunnion pins. The racks *A*, which the rack pinions *C* engage, are on the curved back wall of the counterweight pit. All other machinery is placed on the moving structure, shaft *BC* with gear *C* and pinion *B* being supported by brackets from the main outer girders, and shaft *AA* with gear *B* and rack pinions *A* being supported on the girders and the concrete counterweight. This arrangement is different from that usually adopted for New York

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*Bridge Designer, Barge Canal Office, Albany, N. Y.

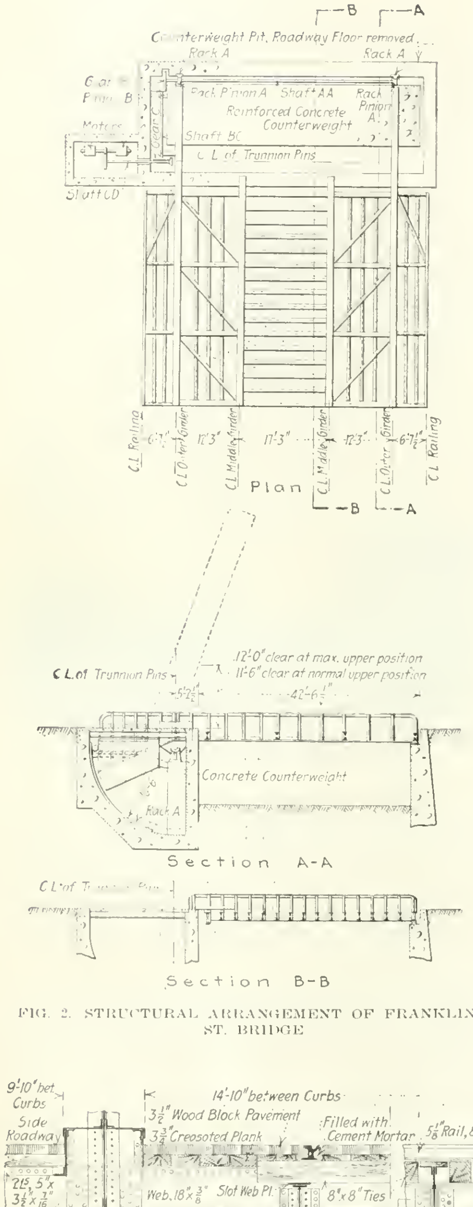

FIG. 2. STRUCTURAL ARRANGEMENT OF FRANKLIN ST. BRIDGE

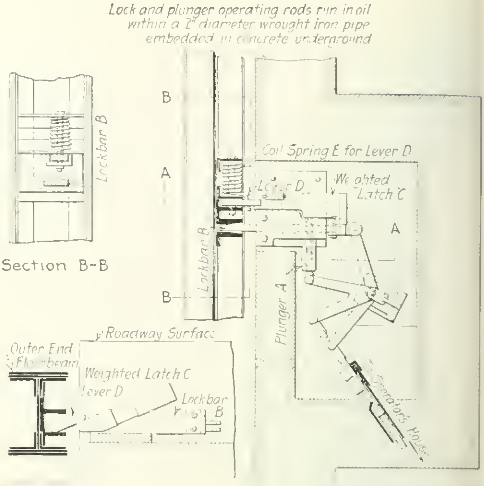

FIG. 4. TOE-LOCK MECHANISM

State lift bridges, which is to put the motors and machinery all on the concrete counterweight.

The motors are controlled by a controller of the drum type located in the operator's house near the bridge, and switches are provided so that either motor may be cut out if disabled and the bridge operated with the other motor. Each motor is furnished with a solenoid brake, mounted on the extended motor shaft, which is released with the controller on the first point. A mechanical foot brake to give the operator more complete control of the bridge comprises a band brake on the main shaft of the motors, connected with a foot treadle in the operator's house by means of rods running underground. There is provided an adjustable limit switch to stop the bridge automatically at the maximum upper position if the operator fails to arrest it in time. Wooden buffers are placed on the inside face of the first wall of the counterweight pit, which in crushing against the tail end of the moving girders will absorb the impact of the blow if the operator fails to stop the bridge in time and the limit switch and the mechanical brake all fail to act properly.

When closed, the bridge is locked at the outer end with a toe lock. The operating levers of the lock mechanism are interlocked with the railroad signal levers in a machine in the operator's house, so that they can be operated only in the following order in opening the bridge and in reverse order for closing: Two levers set the railroad signals at either end of the bridge to show danger. The setting of the signals releases the lever for operating the plunger *A*, Fig. 4, which passes through the lock bar *B*. The drawing of the plunger *A* releases in turn the lever for drawing the lock bar *B*. The opening of the lock automatically closes the main circuit for operating the bridge motors, by means of a circuit controller. The bridge can now

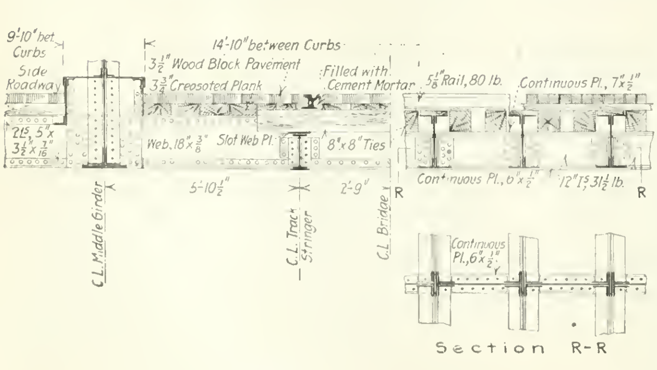

FIG. 3. SHALLOW RAILWAY-FLOOR CONSTRUCTION

be raised by the motor controller. When the bridge rises a few inches the weighted latch C of the toe lock falls into place so as to prevent the lock bar from being thrown into place until the bridge again descends and automatically raises the latch by means of the lever D, the impact of which is broken by means of the spring E.

A circuit controller, located on the inside face of the front wall of the counterweight pit, is operated by a lever connected with the girder at the trunnion, so that as soon as the bridge starts to rise the electric current operating the railroad signals is automatically broken. This serves as a precaution (in addition to the interlocking of the signal levers with the lock-operating levers) against the operation of the railroad signals when the bridge is open.

The plunger A (Fig. 4) of the bridge lock is a safeguard against the operation of the signals until the lock bar is actually in place after the closing of the bridge. Without it, in case the lock bar became detached from its crank, the lock-bar lever could be thrown and the signals cleared with the bridge unlocked. But the plunger is obstructed by the lock bar. Its lever cannot be thrown, and the other operations cannot be performed.

The rods operating the bridge lock run underground in wrought-iron pipe ducts filled with oil to prevent water from seeping in and freezing. At the outer end of the bridge is attached an air buffer, fitted with adjustable exhaust and relief valves, which prevents the bridge from pounding on the abutment if the bridge in closing gets beyond control.

The bridge was designed in the New York State Barge 'anal Office and constructed by the Steel Storage and Elevator Construction Co., Contractor, of Buffalo, N. Y.

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Electrolytic Sewage-Treatment Tests at Durant, Okla.

One of the few plants that are treating sewage by the lectrolytic process is owned and operated by the City of Durant, Okla. The promoters requested the Engineering Department of the Kansas State Board of Health to make a test of the Durant plant. A two-weeks' test as accordingly made by J. E. Welker, assistant engineer, extending from Sept. 26 to Oct. 5, 1914. An bstract of Mr. Welker's report to C. A. Haskins, engineer of the board follows, with a plan of the works.

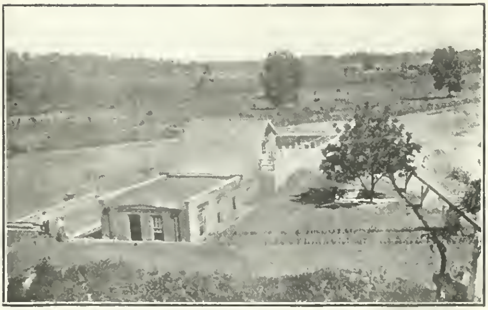

FIG. 2. GENERAL VIEW OF DURANT SEWAGE WORKS

At the time of the test, Durant had an estimated population of 7,500, but only 475 house connections. The sewage is wholly domestic, and reaches the works in a fairly fresh condition.

Preliminary to the electrolytic treatment the sewage is screened and settled. (See Fig. 1 for layout and details of plant and Fig. 2 for a general view.) The final effluent is discharged into a small brook, 100 ft. distant.

The two successive bar screens have 1- and ½-in. clear spaces and are set at angles of 45 and 30°.

The Imhoff settling tank is unusually shallow. It has a holding capacity of 100,000 gal., of which 25,000 gal. is in the digesting chamber. Sewage is admitted from a distributing trough to the digesting chamber at five points and the tank effluent is discharged over five weirs into a collecting trough.

Each of the three electrolytic troughs (Fig. 1) contains 10 sets of electrodes, consisting of 19 iron plates, 12x24x$\frac{3}{16}$ in., spaced ¾ in. apart. The troughs are baffled at the top, bottom and sides. For each trough there is a 2½-hp. generator, supplied with 3-phase alternating current at 2,200 volts, stepped down to 220 volts. The power line was not metered at the time of the test.

The amount of sewage being treated at the time of the tests, as determined by measurements on the trough weirs, was about 225,000 gal. for the 24 hr., with a night rate of 100,000 gal. The corresponding tank-retention period was 8 to 11 hr. From 5 p.m. to 7 a.m., the troughs were not used; the sewage had tank treatment only.

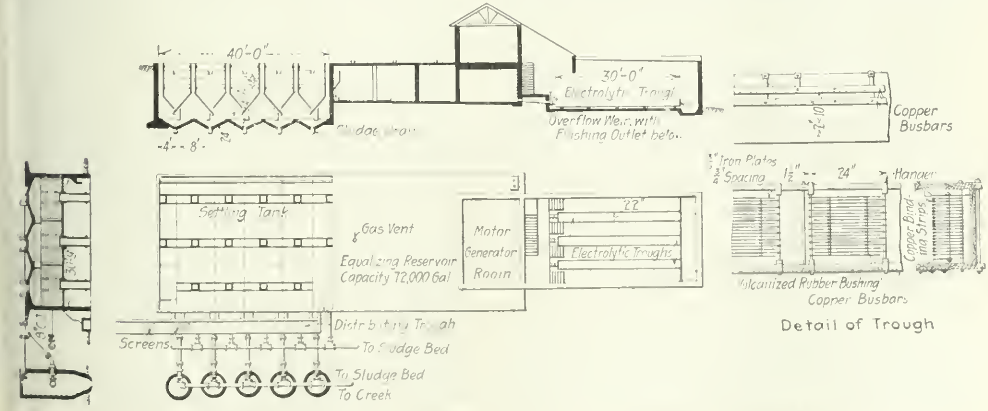

FIG. 1. LAYOUT AND DETAILS OF IMHOFF TANKS AND ELECTROLYTIC SEWAGE WORKS, DURANT, OKLA.

BACTERIAL RESULTS AT DURANT SEWAGE WORKS

Date	Time	Source of Sample*	Flow in Gal. per Day	Bacteria per C.C.† Total Count	Per Cent. Reduction‡	Volts	Amperes
Sept. 27	12 noon	Manhole		900,000			
		Reservoir		800,000			
		Trough 3	152,000	25,000	96.9	5.8	300
		Trough 2	53,500	340,000	57.5	4.9	200
		Trough 1	152,000	220,000	72.5	5.0	200
	6 p.m.	Manhole		2,500,000			
		Reservoir		1,700,000			
		Trough 3	152,000	570,000	66.5	5.6	300
		Trough 1	152,000	638,000	62.5	4.5	200
Sept. 29	11 a.m.	Manhole		1,900,000			
		Reservoir		2,500,000			
		Trough 1	97,200	720,000	71.2	6.0	300
	5 p.m.	Manhole		1,400,000			
		Reservoir		1,700,000			
		Trough 1	81,500	1,160,000	31.7	5.8	300
Sept. 30	10 a.m.	Manhole		4,000,000			
		Reservoir		1,600,000			
		Trough 1	81,500	67,000	96.0	5.9	250
		Trough 3	114,800	48,000	97.1	5.7	300
	4 p.m.	Manhole		3,200,000			
		Reservoir		2,100,000			
		Trough 1	67,000	120,000	94.3	6.0	300
		Trough 3	114,800	126,000	94.0	6.0	300
Oct. 1	9 a.m.	Manhole		1,100,000			
		Reservoir		1,000,000			
		Trough 1	114,800	53,000	94.7	6.0	250
		Trough 3	114,800	29,000	97.1	6.0	300
	3 p.m.	Manhole		1,500,000			
		Reservoir		1,200,000			
		Trough 1	152,000	392,000	67.3	6.0	240
		Trough 3	152,000	300,000	75.0	6.0	300
		Outfall		670,000	44.1		
	4:45 p.m.	Trough 2		496,000	58.5	4.0	200
Oct. 2	8 a.m.	Manhole		1,500,000			
		Reservoir		3,700,000			
		Trough 1		130,000	96.5	6.0	250
		Trough 1	114,800	40,000	99.0		
	2 p.m.	Manhole		1,500,000			
		Reservoir		900,000			
		Trough 1	81,500	209,000	76.8	6.0	250
		Trough 2	114,800	510,000	43.4	6.0	100
		Outfall (35 yd.)		700,000	22.2		
		Outfall (Approx. 375 yd.)		424,000	53.0		
Oct. 3	7 a.m.	Manhole		140,000			
		Reservoir		1,530,000			
		Trough 1		185,000	88.0	6.0	250
		Trough 2		582,000	62.0	6.2	200
		Trough 3		257,000	83.3	6.0	290
	1 p.m.	Manhole		860,000			
		Reservoir		980,000			
		Trough 1		127,000	87.0	5.2	300
		Trough 3		250,000	73.6	5.2	300
		Outfall		690,000	29.6		
Oct. 4	12 m.	Manhole		800,000			
		Reservoir		950,000			
		Trough 3	81,500	750,000	21.0	6.0	250
		Trough 1	53,500	600,000	36.8	6.0	220
		Outfall		520,000	45.3		
Oct. 5	11 a.m.	Manhole		460,000			
		Reservoir		280,000			
		0.4 Distance					
		Trough 1		56,000			
		Trough 3	53,500	76,000	73.0	6.0	260
	2 p.m.	Manhole		800,000			
		Reservoir		500,000			
		Trough 1	114,800	300,000	40.0	5.8	275
		Outfall		235,000	53.0		
	3 p.m.	Manhole		450,000			
		Reservoir		500,000			
		Trough 3	114,800	142,000	71.6	6.0	290
	5 p.m.	Reservoir		440,000			
		Trough 1	97,200	174,000	60.5	5.6	280
		Trough 3	97,200	296,000	32.7	5.8	300

* Manhole samples were raw sewage; reservoir samples were Imhoff tank effluent; trough samples were taken at the overflow end of the trough except in the one case otherwise stated; outfall samples were composite trough samples. One of the troughs [No. 2—Editor] lacked the copper binding strips on the electrode plates, so its results were not comparable with the others and affected the outfall samples.

† On agar after 36 hr. at 40 deg. C. [Red colony counts were also made, but have been omitted here—Editor.]

‡ Figured from reservoir (tank effluent) samples. Summarizing: 95% of the tests gave a reduction of less than 97.5; 70%, less than 94; 50%, less than 78; 20%, less than 59; 10%, less than 36; 5% less than 30.

The chlorine in the raw sewage ran from 29 to 190 p.p.m., but more generally from 50 to 75. Putrescibility tests (standard methods of the American Public Health Association) showed 21% relative stability for the raw sewage on three different days; 30% and 68% for the Imhoff tank effluent on two different days; 55% and 97% after electrolytic treatment in Trough 1 on one day, 99% for Troughs 1 and 3 on one day, and 99% for Trough 3 on a third day; 99% for the outfall effluent one day but only 37% another day, when some raw sewage entered the outfall.

The bacterial log is given in the table. No satisfactory tests of the character of the effluent in the joint outfall could be made because the current was off and the troughs bypassed from 5 p.m. until 7 a.m.

In operating the troughs, the current was reversed each day to clean off the electrode plates and the troughs and electrodes were frequently cleaned by emptying the troughs and turning in a stream of water from a garden hose.

Gas formed in the troughs at all times during the test, probably due, in part, to electrolysis of the sewage. This gas would ignite with considerable force.

According to figures supplied by W. P. Danford, City Engineer of Durant, the original cost of the plant was as follows: Construction, $9,100; electrolytic equipment, $5,200; engineering and general expenses, $1.200; total, $15,500. On the basis of treating 100,000,000 gal. of sewage a year Mr. Danford estimated (in 1914) the operating costs per 1,000,000 gal. as follows: Purchase of current (including lighting) $6.40; attendant, $7.20; incidentals, 20c.; renewal (once a year) of copper strips, 60c.; total, $14.40.

Mr. Welker summarized his study of the plant as follows:

> Samples of final effluent were practically odorless after being bottled and allowed to stand at room temperature for a period of several days. After a longer period, some putrefaction did take place in the bottled samples. It was impossible to make a satisfactory study of the conditions existing in the outlet brook below the plant, due to the entrance of raw sewage for a part of the time. However, no nuisance was created for a considerable distance below the plant, which the writer inspected.
>
> The final effluent showed a high relative stability, as indicated by methylene blue putrescibility tests.
>
> No relation could be found between the bacterial reduction and the energy used, or between the reduction and flushing reversing current or hosing out of troughs. In general, the lower the bacterial content of the effluent from the settling chamber, the lower the percentage reduction of bacteria in the troughs.

Municipal Shops at San Diego

By Francis M. Lockwood*

The assembling of San Diego's machine shop followe closely the establishment, in May, 1915, of the City Manager scheme of government and the appointment of Manager.

With the placing of the different departments of publi works under one head, the plan of consolidating the shop and yards of the Street, Water and Sewer Department was conceived and put into effect. Some 2½ acres o ground that had been used by the Street Department wa utilized for this purpose, and with the addition of th meter-repair shop, which was moved from the Water De partment yards, and the alteration and remodeling of th buildings already located on this plat a very adequate municipal shop and yards was fitted up. Fig. 1 is a view of portion of the yards, and Fig. 2 is an interior view o the machine shop.

The machine shop occupies a position about a bloc back from the entrance to the yard, in the rear of whic is an acre of ground used for corrals for the stock. Thi building is 50x100 ft. in plan and is used as a machin shop, automobile-repair shop and blacksmith shop. I is equipped with two lathes, a 6- and a 10-ft., with swing of 16 in. It has also two drill presses, two trip hammers, two emery wheels, shears and punch and a tir bender. On the second floor is the carriage and carpente shop, with its rip and cutoff saw and planer. A pain shop adjoins the machine shop in the rear at one end and horseshoeing shop at the other.

All machine work that can be handled with a 16-in lathe, all automobile repairing, blacksmithing and horse shoeing for the city are done at this shop. Pump repairs, repairs to dredges and other machinery used at the harbor, as well as carpenter work, are also handled here, the work all being under the supervision of a Master Mechanic.

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*Secretary Operating Department, San Diego, Calif

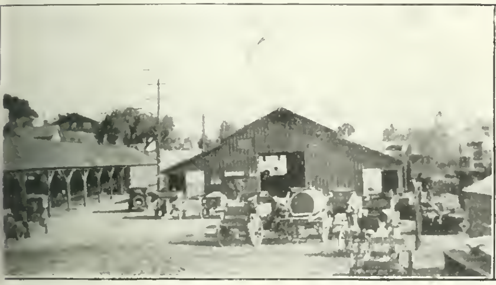
This shop is self-sustaining, charging the different bureaus for work done, but only at the actual cost of material and labor furnished. In addition to the money saving accomplished on the machine work, which is estimated at 35%, a greater saving is made in the department's being enabled at all time to secure the services of a first-class mechanic for emergency repairs without experiencing the delays so often encountered when outside machine shops have to be depended upon.

Eleven Ford runabouts used in the department have een standardized, each being fitted with a bed for carry- g tools and materials and all painted a uniform color ith the city's label attached. A saving of 50% is made automobile repairs, and the painting is done at a saving 33⅓%.

Opposite the entrance and extending down the middle of e yard is a long shed with a 50-ft. driveway on either le, which is used for storage of street sprinklers and eepers and for a pipe rack. Each end is inclosed, one ing used as a storeroom for the purchasing bureau and rying a stock of approximately $70,000, the other ng fitted up as an office, having desks for the Master chanic and the superintendents and clerks of the street d water bureaus.

At the right of the entrance a two-story house is occu- d by the emergency crews. Extending from this to the chine shop is a shed utilized for oil and gas tanks, for brooms for the water and sewer bureaus and for a ter shop. All meter repairs are attended to here, and a ent meter box is also being made which replaces the wooden meter boxes as fast as they become useless. is concrete meter box is built for 15c., a saving of 100% r the wooden box with iron cover, and its life is ctically endless.

At the left of the entrance is the Street Department n, with stall room for 65 head of stock and storage m for 300 tons of hay. Adjacent is space for storage lump wagons, etc., and beyond is the broom shop, where om cores for the rotary sweepers are filled and push oms for the "white wings" are made. These brooms, ddition to being of a quality superior to any the mar- affords, are made 50% cheaper than they can be ob- ed. The Street Department toolroom is also situated e and a building for storage of heavy machinery.



IG. 1. PART OF MUNICIPAL YARD, SAN DIEGO. STREET EPARTMENT BARN ON RIGHT; STORAGE SHED ON LEFT

FIG. 2. MUNICIPAL MACHINE SHOP, SAN DIEGO, WHERE A SAVING OF 35% IS EFFECTED

Steel Sheetpile Coffer-Dam for Lock on Cape Fear River

A steel coffer-dam of the pocket type was used in the construction of Lock No. 2, Cape Fear River, North Carolina. This work is described in the September-October issue of the *Professional Memoirs* of the Corps of Engineers, U. S. A., and the Engineer Department at Large; the work was similar to that described in the first article of this week's issue, at Troy, N. Y.

For the Cape Fear River lock double rows of Lackawanna sheetpiling, connected at intervals by transverse rows, were driven around the lock site. The pockets thus formed were of such dimensions that when filled with earth they could resist the unbalanced pressure on the coffer-dam without support. As the steel on the land side was driven well back into the river bank, where the ground was level with the tops of the pockets, no filling was necessary on that side; the river pockets were filled with material dredged in the coffer-dam inclosure.

The pockets were of two types. Those at the upper end had parallel inside and outside walls tied together by walings and steel cables and rods. The other pockets were without ties, the inside wall being curved to reduce distortions in the steel piling caused by the filling.

Driving requirements and limited space for plant made necessary two single-wall panels in the upper and lower wings. These panels were held by cables to wooden pile anchorages.

Arched-web piling, on account of its greater transverse strength, was used in the walls held by walings and on the outside of the river pockets; straight web piling was used in the interior curved walls, the cross walls, and on the outside of the land pockets. The total length of the coffering was 878 ft.

The elevation of the top of the steel above mean low water was 23.1 ft. This elevation corresponded to an average height above the river bottom of 28 ft. The lock floor was laid before pumping out so that the coffered inclosure, after pumping out, had a depth of 31 ft.

The controlling conditions were: A narrow river, requiring a coffer-dam which would obstruct the river as little as possible; a poor foundation, which made it desirable to seal the bottom before pumping out, and a considerable head of water to take care of. The river is subject to rapid rises, which completely submerged the coffer-dam. A 24-in. pipe through one of the pockets, 12 ft. below the top, provided for flooding the coffer.

Engineering Literature

Reviews of Technical Books

By R. Fleming*

The question, "Did you ever hear of anyone except the author, the reviewer, the author's wife and the publisher's advertising man who had really read a book review?" asked a few months ago by a "reformed book reviewer," does not apply to technical books. Purchasers of technical books for libraries are guided largely by book reviews. Engineers isolated from their fellows are obliged to decide from reviews what books they shall purchase. The Technology division of the New York Public Library publishes lists of technical books that have been added to the library. Following the titles and descriptions there are references to the papers in which the books have been reviewed. Extracts from one or more reviews are often given. The demands of public and technical libraries may require no small part of the first edition of a book if it is favorably reviewed. The importance of the review is thus readily seen.

A good book review should be clear, concise, fair and accurate. The scope of the book, its value as a whole, any special features that are brought out, and to what class of readers it is valuable should be stated. That no injustice may be done to the author the reviewer should have an adequate knowledge of the subject reviewed. It is often difficult to be fair to seller and buyer, the publisher and the reading public. If true to his convictions, the reviewer must sometimes say disagreeable things.

The story is an old one of the critic who always wrote his reviews before reading the books, "because reading prejudiced him so." Are technical books reviewed without being read? Sometimes. What can be done with the preface, the table of contents and the publisher's announcement is surprising. Generalities thus take the place of definite statement. An abstruse book on mathematics was once handed to a nontechnical man for review. After floundering around he concluded with, "They that like this sort of thing will find in this book something that they like." Two or three years ago a book treating of a subject upon which little had been written went the rounds of the technical papers for review. It had grievous faults, but was not condemned because reviewers were unfamiliar with its subject. They passed upon it in language similar to that quoted, but not so frank.

Unworthy books are sometimes foisted on the public by extensive advertising and extracts from reviews in the so-called "popular" science and technical periodicals. These reviews are often by men who write glibly on subjects of which they know but little. Again, the indorsements of college professors of standing are obtained in some way and widely flaunted. How Prof. —— of —— and Prof. —— of —— can recommend —— in the terms they do is beyond the writer's comprehension.

The signed book review is the great promoter of efficiency in book reviewing as well as a corrective of evils. A man writing over his own name gives more thought to his statements and is chary of writing about things with which he is not acquainted. The fact that there is a name attached gives greater weight to the opinions expressed and locates responsibility. The practice of having book reviews signed is followed by the leading technical periodicals, and the practice is increasing.

* * *

Making Engineering Libraries of Greatest Benefit

Librarians are beginning to appreciate that the engineering profession constitutes no small part of their clientele, and they are discussing ways and means for satisfying the demands of those who seek specialized technical information. This is the express object of the Special Libraries Association.

To be of the greatest use to engineers the existence of the association must be known to them, and it must have their active coöperation, or at least the coöperation of such of them as are qualified to offer suggestions and support. The following extract from a paper by Kenneth C. Walker, of the Department of Technology of the New Haven Public Library, makes a plea for coöperation, not only of engineers, but of libraries:

> The first step is not new to the library field and is very much in the air. It is the assignment of libraries already strong in one subject, the sponsorship of that subject. This subject of sponsorship needs no enlargement.
>
> Having our roster of sponsored libraries, the next step is to publish this list and distribute it widely and to the most effective places. Perhaps I should say here that, with these sponsored libraries, suitable subsponsored libraries, or agencies distributed regionally, should be made effective in order that the maximum convenience and accessibility be accomplished.
>
> The next problem is to educate the clientele in the use of library service. W. P. Cutter, in his paper on "The Technical Library's Field of Service," read at the October meeting of this Association says: "This is the most difficult step; for unless you can find out very specifically what a man wants you will not only waste your time in looking up information which is not wanted by the client, but you make him skeptical of your ability to help him. . . . Be sure therefore that you know what is wanted."
>
> A problem connected with smooth and efficient operation of the sponsored libraries is that of standardization. This would include the standardization of interoperation; further the standardizing of operations of frequent occurrence. Standardization would not only promote unification, which is most desirable, but would permit of detail work being done by assistants, thereby leaving for the work of the librarian th work of the executive—creating and directing.
>
> Little or nothing has been said of the person in charge of these sponsored collections. By virtue of the fact that certain collections have been assigned a given sponsorship, it is to be supposed that the executive of such a collection is an able person. These executives to my mind must be more than catalogers, classifiers and reference workers; they must be what C. B. Fairchild, Jr., has aptly called the future special librarian—the consulting analyst.
>
> Any undertaking cannot be successful without making itself known to all it is intended to benefit. In other words, whatever the outcome of this paper may be, publicity must play an important part.

The engineering societies of the country, as well as wide-awake individual engineers, can aid in the needed publicity work, and take advantage of the services which the public libraries are offering to help them.

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*American Bridge Co., 30 Church St., New York City.

REVIEWS AND NOTES

Water-Works Engineering

Reviewed by Caleb Mills Saville[*]

WATER-WORKS HANDBOOK—Compiled by Alfred Douglas Flinn, M. Am. Soc. C. E., Deputy Chief Engineer, Board of Water-Supply, New York; Robert Spurr Weston, M. Am. Soc. C. E., Assistant Professor of Public Health Engineering, Massachusetts Institute of Technology, Consulting Sanitary Engineer; and Clinton Lathrop Bogert, Assoc. M. Am. Soc. C. E., Assistant Engineer, Board of Water-Supply, New York. New York: McGraw-Hill Book Co. Leather; 6x9 in.; pp. ix + 824; 411 illustrations. $6 net.

Recently two very notable publications on sanitary subjects have been presented to the engineering profession. The first of these was the three-volume work by Metcalf and Eddy, "American Sewerage Practice," and the second is the "Water-Works Handbook" just out under the authorship of Messrs. Flinn, Weston and Bogert. To those who knew of the forthcoming of this book its appearance was awaited with an eagerness that was found not to have been misplaced when the book was at length received.

To those water-works men who know of the book only rom press notices that have appeared since its publica- ion it may be said safely that it is a working tool which ills a long-felt need in its particular province. This ook is unique in its presentation of water-works facts, nd many of the data contained, especially in the first and niddle parts of the book, are from original sources and ow available for the first time.

It is a practical book for practical men, compiled with are by able practicing engineers. It is not a textbook n any sense of the word, and yet no college technical ourse in sanitary science can now be complete without equent reference to the facts and data which have been ken so generously from the personal notebooks of the thors.

As a general proposition the word "handbook" means collection of heterogeneous data which often are thrown gether with little attempt at classification and slight planatory matter to aid in their application to special oblems. This phase is noticeably absent from the pres- nt book, and he who reads carefully will find something re to aid in almost any difficulty.

The book is divided essentially into three principal ctions—First, "The Supply of Water"; second, "Its istribution to Consumers"; and third, "Its Treatment Provide a Safe and Clean Water."

In the first section there are three parts—Part I. Sources," comprising chapters on "Rainfall," "Evapora- on," "Runoff and Ground Water"; Part II. "Collec- on," with chapters on "Intakes," "Watershed Develop- nt," "Reservoirs," "Dams of Masonry," "Earth and ck Fill," "Wells" and "Infiltration Galleries" and Notes of Equipment for Treating Water"; Part III. ransportation and Delivery," containing chapters on pen Channels," "Aqueducts," "Metal, Wood and Con- te Pipes."

In the second section there are twelve chapters devoted "Cast-Iron Pipes," "Distribution Systems," "Valves, tes and Hydrants," "Service Meters," "Pumps and mping Stations," "Distributing Reservoirs," "Stand- es and Tanks," "Water Consumption," "Hydraulic mputations," "Masonry and Puddle," "Nonferrous Metals," "Corrosion of Iron and Steel," "Conversion Tables" and a "Miscellany" of unclassified general data.

The third section, which is given over to the "Character and Treatment of Water," contains nine chapters "Character of Water," "Inspection of Sources of Supply," "Storage of Water and Improvement of Reservoirs," "Sedimentation," "Aëration and Chemical Treatment," "Water Softening," "Preliminary Filtration and Deferrization," "Filtration" and a final chapter on "Examination of Water."

In general, the first section, comprising 378 pages, contains data of remarkable value; the second section of 265 pages includes much useful information very well arranged; the third section of 160 pages in comparison with the others is rather disappointing in that the chapters are brief and either omit or only mention some of the newest thought in water-works treatment.

As a whole, the subjects of the chapters are well selected and logically arranged. The book is thoroughly and carefully indexed in 21 pages, references to more extended treatment of subjects are freely given, the diagrams generally are well chosen and drawn, and the tables are excellently compiled. The book appears in attractive semi-flexible covers; the printing and paper have been chosen with care to avoid fatigue to the eye.

Many of the data undoubtedly could be found elsewhere in special treatises, technical publications and in reports after more or less patient search. So far as the reviewer is aware, however, there is no other book that so logically gathers together this matter and presents it in such great detail, stripped of nonessentials, ready for use by the busy water-works practitioner.

With a book so varied in its subject matter it is possible to give only the briefest survey of its contents. Beginning with the subject of rainfall, statements are made of general applicability, followed by tables of selected long-term rainfall and temperature records covering the entire country. These are amplified by diagrams showing typical relations between intensity and duration of rainfall under maximum rates.

The subject of evaporation is well treated, giving usable data based on results from various parts of the United States, and includes much new matter from recent Weather Bureau research.

In the chapter on runoff great stress is laid on the necessity for proper data, and the principal requirements are shown. The rather long description of current-meter mechanism could well have been replaced by a very brief statement and a sentence or two added concerning the several types of meters and their special applicability. The subject of watershed development is exceedingly well treated and contains a vast fund of very useful information.

The chapter on masonry-dam construction is particularly valuable on account of the data drawn from the exhaustive studies made for the work of the New York water-supply. Especial mention may be made of the information presented on the effect of upward pressure and ice and temperature effect. Dams and weirs on porous foundations are treated in some detail, much of the matter being drawn from the admirable monographs of W. G. Bligh on this same subject. The chapters on earth and rock-fill dams seem hardly to have received as much attention as could be desired, in view of the importance of such structures in ordinary water-supply development.

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[*] Chief Engineer, Hartford Water-Works, Hartford, Conn.

The chapter on wells is particularly full and brings into convenient form much very useful information that might be easily overlooked in a casual search. The chapter on infiltration galleries is rather brief, but the references are particularly complete and undoubtedly give adequate details.

The chapters on the transportation and delivery of water are very well written and crammed full of data and information. The investigation work along the lines of this subject by the New York Additional Supply Board was especially complete, and the results here given will be highly appreciated by water-works designers.

The chapter on plate-metal pipes might with advantage have included more data on durability and conditions under which such pipes can be used to best advantage. The chapter on pumps, pumping stations and equipment is excellent, and the data given are quite complete.

The chapter on hydraulic computations is especially rich in ready-to-use diagrams and tables for solving ordinary water-supply problems, as well as giving exceptional data for advanced investigations. Much valuable information is brought together in the chapter on nonferrous metals, and the paragraph on the cracking of brass or bronze especially is of timely interest.

The third section of the book, on "Character and Treatment of Water," brings together in usable form much information hitherto scattered in many places. The data in the chapters on character of water, storage of water and improvement of reservoirs are of particular value in their references to American water-supply.

The chapter on aëration and chemical treatment is quite complete, as is also that on water softening. The chapter on filtration is rather brief, the most useful data being the cost of various plants and methods of operation.

To sum up, the "Water-Works Handbook" meets the needs of the designer of water-works systems and also contains most valuable information and suggestions for the water-works operator. The facts are stripped of technical detail and set down in plain language. It is not a treatise on water-supply, but is exactly what it purports to be, "a usable compilation of information, old and new, for the water-works engineer and superintendent, the designer, constructor, operator and inspector."

In its sphere it is undoubtedly one of the most valuable books on water-supply subjects which have appeared, and there is every reason to believe that it will be one of the "best sellers" from the technical press.

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Laws To Regulate Competition

TRUST LAWS AND UNFAIR COMPETITION—By Joseph E. Davies, Commissioner of Corporations, Department of Commerce. Paper; 6x9 in.; pp. 832. 40c.; sold by Superintendent of Documents, Government Printing Office, Washington, D. C.

Hon. Joseph E. Davies, the author of this book, was formerly a prominent attorney of Madison, Wis., but four years ago was appointed Commissioner of the Bureau of Corporations and later was made Chairman of the Federal Trade Commission, which succeeded to the work of the Bureau. His book reviews the present Federal and state antitrust laws and laws covering various methods of unfair competition, with judicial decisions thereon. It has been said with truth that the laws which have been made to prohibit the organization of trusts have not prevented the further consolidation of industrial enterprises. On the other hand, examination of Mr. Davies' book shows that these laws have had a material effect in limiting improper business practices and combinations tending to monopoly. Mr. Davies' review includes not only American legislation and court decisions, but laws of foreign countries dealing with the same subject.

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Three Books on City Planning

THE PLANNING OF THE MODERN CITY: A Review of the Principles Governing City Planning—By Nelson P. Lewis, M. Am. Soc. C. E., Chief Engineer of the Board of Estimate and Apportionment of New York City. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xv + 423; 62 text illustrations and 87 plates. $3.50 net.

CITY PLANNING, With Special Reference to the Planning of Streets and Lots—By Charles Mulford Robinson, author of "Modern Civic Art," "The Improvement of Towns and Cities," etc. A reissue, revised, with much additional material, of the work originally published under the title of "The Width and Arrangement of Streets." New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xiv + 344; 58 illustrations. $2.50 net.

CITY PLANNING: A Series of Papers Presenting the Essential Elements of a City Plan—Edited by John Nolen, Fellow, American Society of Landscape Architects. New York: D. Appleton & Co. [National Municipal League Series.] Cloth; 5x8 in.; pp. xxvi + 447; illustrated. $2 net.

Three books on city planning, each from a different viewpoint—one of them, in fact, from many viewpoints—coming off the press as nearly together as these three certainly attest a lively interest in the subject. Each volume is good, in its own proper way, and only to a minor degree are the books competitive.

In the volume on "The Planning of the Modern City," by Nelson P. Lewis, we have the first really American book on city planning written by an engineer for engineers. This does not mean that the volume will not be eminently useful to the architects and landscape architects from whose ranks most of the other books on city planning have come. It will be decidedly useful to them. It will also appeal to laymen who, though deeply interested in city planning, feel that most of the architects and landscape architects are carried away by their devotion to the æsthetic side of the subject. As Mr. Lewis well says in his introduction, "the fundamental problems of city planning are, and from their very nature must be, engineering problems."

The author describes the aim and method of his book as an attempt "to show by a few concrete examples what has already been accomplished, rather than to indicate just how the several problems should be attacked or solved." These examples are too modestly characterized as "few."

After introducing his subject, Mr. Lewis outlines the elements of the city plan, which are (1) transportation (2) the street system, (3) parks and recreation facilities and (4) the location of public buildings. All four of these he considers as engineering problems, devoting a chapter to each. The need and economic value of a city plan and the industrial plan or district are next considered. A return is then made to streets and transportation, with special relation to street traffic and details, and to the railroad in its relation to the street system. Building restrictions, city environs, garden cities, legislation methods and progress, financing, land policies and, finally "The Opportunities and Responsibilities of the Municipa Engineer" are taken up in succession.

In the chapter whose title has just been quoted Mr Lewis truthfully says:

> The engineer as the first man on the ground has a rare opportunity and a grave responsibility. The task calls for vision and imagination, and these are qualities the exercise of which on the part of the engineer has often been thought

rather dangerous; and yet the engineer lays the foundations upon which our cities are built. He has been too prone to regard his preliminary work as a mere matter of surveying; more or less precise surveying, it may be, but he has been more intent upon the accuracy of his measurements of lines and angles and of his computation of areas than upon the larger problem of providing for the orderly and sightly development of the city.

This broader vision Mr. Lewis' book is well designed to give. The well-chosen and admirably presented illustrations will aid in making the vision clear.

The name of Charles Mulford Robinson is well known in America and England to all who have given much attention to city planning, both through his books and his many city-planning reports. The book now before us, in smaller compass and in a more modest but very useful form, appeared a few years ago as "The Width and Arrangements of Streets" (reviewed in these columns Dec. 14, 1911). The material there given has been rearranged and extended under these three main heads: (1) "Standardization in Street Platting," which is broad enough to nclude both the economic and social defects of standardzation; (2) "Functional Street Platting," which comrises the body and fulfills the main object of the book, nd (3) "City-Planning Legislation," a fifty-page review f attempts at control, excess condemnation, methods of treet widening and the zoning or districting system.

Under (2) many phases of street planning are considred, taking into account the various classes of streets relation to traffic and use, as well as lot platting and ublic reservations of land other than for use as streets.

Mr. Robinson's book is unique in that he has chosen an ement—a large and fundamental one—in city planning d treated it systematically and in considerable detail. e shows more restraint than in his "Modern Civic Art" d many of his city-planning reports, which were too onouncedly æsthetic in aim and expression for the avere prosaic and rather suspicious American citizen and xpayer who must pay the city-planning bills.

The volume is fittingly illustrated and well made nerally.

Under the leadership of John Nolen, himself a past ster in city planning and landscape work, fifteen ecialists in city planning and related subjects have laborated in producing a handbook entitled "City Planng." The book is designed for "the more serious and ponsible part of the general public" that wishes infortion on the subject "in compact and readable form," l also for students and practitioners of the art who h "a convenient summary of American experience and a embodiment of good methods and practice."

A partial but fairly good idea of the wide scope of the ume and the competency of the list of contributors y be given by the following selection from the conts: "Introduction," F. L. Olmsted; "Subdivision of L id," John Nolen; "Public Buildings," Edward H. B nnett; "Park Systems," John Nolen; "Water Supply," C eb M. Saville; "Navigable Waters," E. P. Goodrich; ilroads," George R. Wadsworth; "Transportation," B jamin A. Haldeman; "Rapid Transit," John V. D ies; "Fundamental Data," George B. Ford; "Finan," Flavel Shurtleff; "Legislation," Charles M. Robn. At the end of the each chapter there is a special iography and at the end of the book a general iography.

The book deserves a wide general circulation among students of city planning—whether in school or in civic life—and will be valued by specialists for bringing together so much material from the pens of so many city-planning workers. It is a pity that so many of the line drawings and lettered wash drawings were reproduced without first being properly relettered to size and style suitable for photographic reduction. As a result, much of the lettering is illegible.

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Revised Edition of Harbord and Hall's Metallurgy

Reviewed by William Campbell*

THE METALLURGY OF STEEL—By F. W. Harbord, Assoc. R. S. M., F. I. C., formerly Consulting Metallurgical and Analytical Chemist to the Indian Government, Royal Indian Engineering College, Coopers Hill; and J. W. Hall, Assoc. M. Inst. C. E., Consulting Engineer, Birmingham. (In two parts.) Vol. I, Metallurgy. By F. W. Harbord Vol. II, Mechanical Treatment. By J. W. Hall. Fifth edition, enlarged and revised. Philadelphia: J. B. Lippincott Co. [Griffin's Metallurgical Series.] Cloth; 6x9 in., pp. xvi + 522 and xviii + 411; 54 folding plates, comprising 115 figures, over 500 illustrations in text and nearly 80 photomicrographs of steel sections. $12.50.

The fourth edition of this work appeared in 1911. The main changes occur in the chapters on the Theory of Hardening Steel and on Alloy Steels, which have been brought up to date. The second volume on the Mechanical Treatment of Steel, by J. W. Hall, remains the same. As a textbook on the Metallurgy of Steel, these two volumes retain their place in the first rank and deservedly so.

Discussing the various theories of hardening, we have now the Stress Theories (p. 362). According to Carpenter and Edwards, on quenching steel severe stresses are set up which cause very pronounced crystal twinning. At all surfaces of slip on which twinning occurs, amorphous layers are found. *"We consider that the ultimate cause of hardening by quenching steels is the presence of these amorphous layers."* It follows that the final cause of hardening by quenching is exactly the same as by cold work—the interval deformation of crystals. According to M'Cance's interstrain theory of hardness (p. 365), in a quenched and uniformly hardened steel the carbon is in the state of solution, and it retains a portion of the iron in the gamma condition—the proportion increases very rapidly with the carbon content. The majority of the iron is, however, in the alpha condition, but owing to the restricted mobility during the period of quenching, the crystalline units are not homogeneously oriented, and the hardness of steel is due to this condition, which is similar to that of interstrain. According to Humfrey hardening is due to the presence of a hard amorphous solution of alpha iron and iron carbide, which solution can be compared with Beilby's amorphous phase due to overstrain.

To the chapter on alloy steels, Guillet's diagrams showing the constitution of chrome, manganese and nickel steels have been added. Alloy steels are now industrially so important that 33 pages is all too short to devote to them. Reference might be made to the works of Marz and Becker, and a well-chosen bibliography would be of great value.

It is stated that the way in which carbon diffuses in cementation is still a matter of discussion (p. 216). Yet after reading Giolitti's book on "Cementation of Iron and Steel" there seems little room for much discussion.

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*Professor of Metallurgy, School of Mines, Columbia University, New York City.

Similarly in Chapter XV (p. 341) the various researches showing the relation of carbon and iron, which are mentioned, have been admirably dealt with by Giolitti. The omission of reference to Wittorf's diagram with Fe_4C and FeC_2, also Upton's diagram with Fe_6C and Fe_2C, is noticeable.

Two or three minor criticisms occur. As an illustration of a modern openhearth plant, the 1898 plant at Homestead is given. Gary or the new Edgar Thomson would be better. Again, Chapter XII on armor plate could be improved. Plate for the United States Navy is stated to contain 3.25% Ni and good Krupp plate Ni 3.5 : Cr 1.5 : Mn 0.7 : C 0.3%. Yet it is generally understood that the Navy uses nickel-chrome-vanadium.

Under the heading of the Duplex Process (p. 201), "Various attempts . . . have not been attended with great success" hardly applies to this country; for several of our large plants are duplexing most successfully.

In conclusion we may say that Harbord and Hall's Steel holds the place in advanced textbooks that Stoughton's iron and steel holds in elementary texts and is well worth the reading.

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A Tribute to Colonel Gaillard

DAVID DuBOSE GAILLARD: A Memorial—Compiled and published by the Third United States Volunteer Engineers. St. Louis, Mo. (1718 Pierce Building): Luther Ely Smith, Secretary, Third United States Volunteer Engineers Association. Paper; 6x9 in.; pp. 188; illustrated.

The Third Regiment of United States Volunteer Engineers served during the Spanish War under the late Col. David DuB. Gaillard as commander. Following Colonel Gaillard's death in December, 1913, members of the regiment at their annual meeting held in St. Louis in the following May decided to compile and publish a memorial volume in honor of their former commander. In this volume have been brought together many tributes to Colonel Gaillard's work as an engineer and as a man which appeared at the time of his death, and accounts of his life and professional achievements. The paper on "Gaillard as an Engineer" was prepared by Col. Edgar Jadwin, who served with Gaillard on the Isthmus.

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Petroleum on Public Lands

PETROLEUM WITHDRAWALS AND RESTORATIONS AFFECTING THE PUBLIC DOMAIN—By Max W. Ball. Compilation by Lucetta W. Stockbridge. Washington D. C.: United States Geological Survey. Bulletin 623. Paper; 6x9 in.; pp. 427; 9 folding plates in separate cover.

This bulletin contains an elaborate record with maps and published correspondence, concerning the withdrawal from entry of oil lands in the public-land states. There is a prevalent idea that the principal motive of the Government in withdrawing the lands from entry was to prevent the giving away of natural resources of great value and to save the underground stores of oil for use by future generations. This bulletin explains that the Government stepped in to save the oil industry from impending ruin, as well as to check the vast waste that was going on. The placer law, under which all oil development on the public lands is carried on, practically forces the owner of oil-bearing land to drill for oil or run the risk of losing his land. Further, after he has drilled and found oil, the law practically forces him to exhaust the deposit at the quickest possible rate lest his adjoining neighbor put down a well and take the oil away from him. The present law thus practically compels over-production of oil. This over-production and the methods by which the drilling is carried on result in an enormous waste of this valuable fuel, and it was deemed best therefore to withdraw from entry all the oil-bearing public lands until Congress shall pass a new law to supersede the present statute and remedy conditions which are universally agreed to be bad.

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Industrial Chemical Processes

OUTLINES OF INDUSTRIAL CHEMISTRY: A Textbook for Students—By Frank Hall Thorp, Ph.D., with Assistance in Revision from Warren K. Lewis, Ph.D., Professor of Chemical Engineering in the Massachusetts Institute of Technology. Third revised and enlarged edition. New York: The Macmillan Co. Cloth; 6x9 in.; pp. xxv + 665; 137 illustrations. $3.25 net.

Professor Thorp's teaching text on chemical processes in industrial services has been favorably known for years, but of late has necessarily been inadequate owing to the great strides of industrial chemistry since the 1905 edition. The new book follows the general scheme of the old one, but differs in detailed presentation and is more extended in scope. Great technical detail is not presented, the author relying on his selected bibliography to guide the student and casual seeker to more extended discussions. The wide range for such a moderate-sized volume precludes the possibility of mathematical treatment of phenomena involved.

The book begins with the more general and fundamental processes, evaporation, distillation, filtration, calcination and refrigeration. Then some properties of materials—such things as fuels, waters, sulphur, acids, salts, chlorine, lime and cements, glass, cyanides, wood, tar, mineral oils, oils and fats, soaps, resins, starch and glucose, yeasts, explosives, fabrics, paper, glue, leather and metals—are interspersed between notes on the processes that produce or utilize them.

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Railway Specifications

SOME FOREIGN SPECIFICATIONS FOR RAILWAY MATERIALS: Rails, Wheels, Axles, Tires—By G. K. Burgess Physicist, and P. D. Merica, Associate Physicist. Washington, D. C.: Bureau of Standards. Technologic Paper No. 61. Paper; 7x10 in.; pp. 132. 25c.

With the coöperation of consuls in the various countries named, the Bureau of Standards was able to collect and here present specifications for rails, wheels, axles and tires for the United Kingdom, Italy, France, Belgium, Germany, Austria, Holland and Sweden. The specifications are preceded by a brief discussion of each class. A few accident statistics are given. These include derailments on account of rails, wheels, axles and miscellaneous, together with persons injured, miles of track and other figures.

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It is now becoming the fashion, and the fashion is a good one, for important departments of the various states to publish some kind of bulletin or journal, usually at monthly intervals. One of the latest publications of the sort is the "Minnesota Highway Journal," issued by the State Highway Commission, St. Paul, Minn. The first number (May) starts off very modestly with four 9x12-in. pages. It contains an account of road work in Minnesota in 1915, some figures and comments on the advance in steel prices, as affecting steel bridges with concrete floors and reinforced-concrete bridges, and facts about Minnesota bridge lettings and the duty of state highway commissions to supply bridge plans for use in connection with state-aid work. The two inside pages of the "Journal" are devoted to a tabulated statement of 1916 bridge work by counties. This promises to be an interesting and valuable feature of the "Journal," as it appears to be the intention to publish the statement at intervals, if not indeed every month.

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A map of the State of New York, showing the improved highways and many points of historical interest, was issued by the New York State Commission of Highways on May 1, 1916. No less than 122 different points of historical interest in various parts of the state are marked by numbers, and on the back of the map is printed a brief tatement concerning the important events in history vhich occurred at each place. The map is on a scale of mi. to the inch. It shows 7,300 mi. of state and county ighways, 6,000 of which are completed. It also shows, y different symbols, 4,000 mi. of road improved by towns nd counties and about 6,500 mi. of unimproved roads.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or mphlets listed in these columns is given in each entry. If e book or pamphlet is for sale and the price is known by e editor, the price is stated in each entry. Where no price given it does not necessarily follow that the book or pamlet can be obtained without cost. Many, but not all, of the mphlets, however, can be secured without cost, at least by closing postage. Persons who are in doubt as to the means be pursued to obtain copies of the publications listed in ese columns should apply for information to the stated pubher, or in case of books or papers privately printed, then the author or other person indicated in the notice.]

HE ACTIVATED-SLUDGE PROCESS IN TREATMENT OF TANNERY WASTES—By Harrison P. Eddy and Almon L. Fales, 14 Beacon St., Boston, Mass. [Reprinted from the "Journal of Industrial and Engineering Chemistry," Vol. 8, No. 7, p. 648, July, 1916.] Paper; 6x9 in.; pp. 7.

NUAL REPORT OF DIRECTOR OF THE CHOSEN RAILWAYS, 1914—Ryuzan, Chosen, China: Railway Bureau of Government-General of Chosen. Paper; 7x10 in.; pp. 91; illustrated.

NUAL REPORT OF THE ASSOCIATION OF ONTARIO LAND SURVEYORS, 1916—Toronto, Canada: L. V. Rorke, Secretary. Paper; 6x9 in.; pp. 385; illustrated. $1.

PORTIONMENT OF RAILROAD EXPENSES AND PROPERTY VALUES ON BASIS OF USE—By A. M. Sakolski, Delaware & Hudson Co., Albany, N. Y. [Reprint from the "Journal of Accountancy," August, 1916.] Paper; 7x10 in.; pp. 13.

TOMOBILIST'S POCKET COMPANION AND EXPENSE RECORD: Includes Owner's Record, Fixed-Charges Memorandum, Weekly Expense Record for One Year, with Monthly and Yearly Summaries, etc. New York: Norman W. Henley Publishing Co. Leather; 5x8 in.; pp. 169. $1 postpaid.

ICK ROADS—By Vernon M. Peirce, Chief of Construction, and Charles H. Moorefield, Senior Highway Engineer. Washington, D. C.: United States Department of Agriculture. Bulletin No. 373. Paper; 6x9 in.; pp. 40; illustrated. 15c. a copy, from Superintendent of Documents, Government Printing Office, Washington, D. C.

EMICAL AND BIOLOGICAL SURVEY OF THE WATERS OF ILLINOIS: Report for Year Ended Dec. 31, 1914, of the Illinois State Water Survey—Urbana, Ill.: University of Illinois. Bulletin, Water Survey Series No. 12. Paper; 6x9 in.; pp. 261; illustrated. $1.

CISE TECHNICAL PHYSICS—By J. Loring Arnold, Ph.D., Professor of Electrical Engineering at New York University. New York: McGraw-Hill Book Co. Cloth; 5x8 in., pp. viii + 275; 294 illustrations. $2 net

CONSTRUCTION OF ROADS AND PAVEMENTS—By T. R. Agg, C. E., Professor of Highway Engineering, Iowa State College. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. vii + 132; 116 illustrations. $3 net.

NOMIC GEOLOGY—By Heinrich Ries, A. M., Ph.D., Professor of Geology at Cornell University. Fourth edition, thoroughly revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xviii + 856; 291 illustrations; 75 plates. $1 net.

CTRICAL CONSTRUCTION: An Elementary Course for Vocational Schools—By Walter B. Weber, Instructor in the Seneca Vocational School, Buffalo. Peoria, Ill.: The Manual Arts Press. Cloth; 7x10 in.; pp. 130; illustrated. $1.25.

CTRICAL TABLES AND ENGINEERING DATA: A Book of Useful Tables and Practical Hints for Electricians, Foremen, Salesmen, Solicitors, Estimators, Contractors, Architects and Engineers—By Henry C. Horstmann and Victor H. Tousley, authors of "Modern Wiring Diagrams," "Modern Electrical Construction," etc. Chicago: Frederick J. Drake & Co. Cloth, 4x7 in.; pp. 331, 31 illustrations. $1 net.

ELECTRIC MOTORS, DIRECT AND ALTERNATING; PRINCIPLES, CONSTRUCTION, OPERATION AND MAINTENANCE: A Practical Book for the Practical Man—By David Penn Moreton, B. S., E. E., Associate Professor of Electrical Engineering, Armour Institute of Technology. Chicago: Frederick J. Drake & Co. Cloth; 4x7 in.; pp. 328, 115 illustrations. $1 net.

ELEMENTS OF CHART MAKING—By E. Lester Jones, Superintendent. Washington, D. C.: United States Coast and Geodetic Survey. Special Publication No. 38. Cloth; 6x9 in.; pp. 15; 30 plates.

ELEMENTS OF MINING—By George J. Young, M. Am. Inst. M. E. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 628; 271 illustrations. $5 net.

FINANCIAL STATISTICS OF CITIES HAVING A POPULATION OF OVER 30,000 (1915)—Washington, D. C.: United States Bureau of the Census. Cloth; 9x12 in.; pp. 338.

THE MECHANICAL HANDLING AND STORING OF MATERIAL: Being a Treatise on the Handling and Storing of Material Such as Grain, Coal, Ore, Timber, Etc., by Automatic or Semi-Automatic Machinery, Together with the Various Accessories Used in the Manipulation of Such Plant—By George Frederick Zimmer, Assoc. M. Inst. C. E. New York: D. Van Nostrand Co. Cloth; 7x10 in.; pp. xiv + 752; 1,044 illustrations. $12.50 net.

METHODS OF SAMPLING DELIVERED COAL AND SPECIFICATIONS FOR THE PURCHASE OF COAL FOR THE GOVERNMENT—By George S. Pope. Washington, D. C.: United States Bureau of Mines. Bulletin No. 116. Paper; 6x9 in.; pp. 64; illustrated. 15c. a copy, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

MINING DEVELOPMENTS AND WATER-POWER INVESTIGATIONS IN SOUTHEASTERN ALASKA—Papers by Theodore Chapin and George H. Canfield. Washington, D. C.: United States Geological Survey. Bulletin No. 642-B. Paper; 6x10 in.; pp. 127; illustrated.

MORTALITY LAWS AND STATISTICS—By Robert Henderson, Actuary of the Equitable Life Assurance Society of the United States. New York: John Wiley & Sons. [Mathematical Monograph No. 15.] Cloth; 6x9 in.; pp. v + 111; illustrated. $1.25 net.

NAVAL ARCHITECT'S AND SHIPBUILDER'S POCKET-BOOK of Formulae, Rules and Tables and Marine Engineer's and Surveyor's Handy Book of Reference—By Clement Mackrow, late Member of the Institution of Naval Architects; late Lecturer on Naval Architecture at the Bow and Bromley Institute, and Lloyd Woollard, Royal Corps of Naval Constructors; Member of the Institution of Naval Architects; Instructor in Naval Architecture at the R. N. College, Greenwich. New York: Norman W. Henley Publishing Co. Eleventh edition, thoroughly revised, with a section on aeronautics. Leather; 4x7 in.; pp. xii + 742; 264 illustrations. $5.

OZONE: Its Manufacture, Properties and Uses—By A. Vosmaer, Ph.D., M. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xii + 197; 67 illustrations. $2.50 net.

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL—By C. A. Edwards, D.Sc., Professor of Metallurgy, Manchester University. Cloth; 6x9 in.; pp. x + 229; 181 illustrations. $3.50 net.

PRACTICAL SAFETY METHODS AND DEVICES: Manufacturing and Engineering—By George Alvin Cowee, E. M., S. B., Manager, Bureau of Safety, Utica Mutual Compensation Insurance Corporation. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. ix + 434; 128 illustrations. $3 net.

PRINCIPLES OF THE TELEPHONE: Part I. Subscriber's Apparatus—Prepared in the Extension Division of the University of Wisconsin by Cyril M. Jansky, B.S., B.A., Associate Professor of Electrical Engineering, and Daniel C. Faber, E. E., Assistant Professor of Electrical Engineering, University of Wisconsin. New York: McGraw-Hill Book Co. [Industrial Education Series.] Cloth; 6x9 in.; pp. xiii + 160; 125 illustrations. $1.50 net.

THE RAILWAY LIBRARY, 1915: A Collection of Addresses and Papers on Railway Subjects, Mostly Delivered or Published During the Year Named, Also Statistics for 1915—Compiled and edited by Slason Thompson, Director of Bureau of Railway News and Statistics, 1529 Railway Exchange Building, Chicago, Ill. Cloth; 6x9 in.; pp. 466; illustrated. $1.

REVENUE AND OPERATING EXPENSE OF MUNICIPALLY OWNED WATER-WORKS IN MASSACHUSETTS FOR THE YEAR 1913—By Charles W. Sherman, 14 Beacon St., Boston, Mass. [Reprinted from "Journal" of the New England Water-Works Association, Vol. XXX, No. 2.] Paper; 6x9 in.; pp. 260-266.

STANDARD METHODS OF GAS TESTING—Washington, D. C.: United States Bureau of Standards. Circular No. 48. Paper; 7x10 in.; pp. 202; illustrated. 40c. a copy, from the Superintendent of Documents, Government Printing Office, Washington, D. C.

STEAM POWER—By C. F. Hirshfeld, M. M. E., Professor of Power Engineering, and T. C. Ulbricht, M. E., M. M. E., Assoc. M. Am. Soc. M. E., formerly Instructor, Department of Power Engineering, Sibley College, Cornell University. New York: John Wiley & Sons. [Wiley Technical Series.] Cloth; 5x8 in.; pp. viii + 420; 232 illustrations. $2 net.

THE UNDERGROUND AND SURFACE WATER SUPPLIES OF WISCONSIN—By Samuel Weidman, Wisconsin Geological and Natural History Survey, and Alfred R. Schultz, United States Geological Survey. Madison, Wis.: Wisconsin Geological and Natural History Survey. Bulletin No. XXXV. Cloth, 7x10 in.; pp. 664; illustrated.

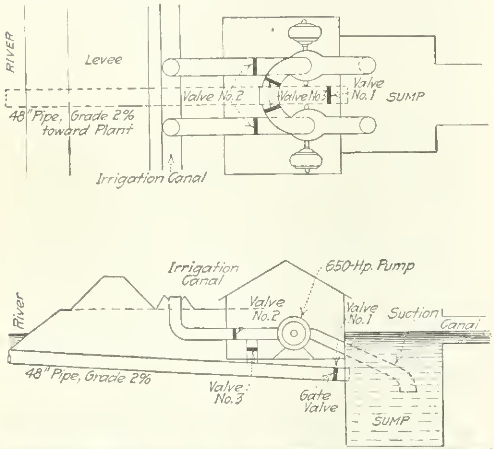
After a discussion of the water supplies of the state in general and by sources, including geological and chemical features, local water-supplies are described by counties, under these heads: (1) Geological formation, (2) supplies for cities and villages, (3) quality and analyses.

Field and Office

Pump for drainage and irrigation—Plank foundations unsuitable for permanent structures—Brick and tile sewers both fail under equivalent of 40 ft. of earth—Cinders packed around sheetpile joints stopped all leaking—Special roller for track paving—Standard Howe truss of Utah highway bridges—Pulling wagons from a cellar excavation in New York

Pumping Station Used for Both Drainage and Irrigation*

The Pritchard Lake pumping plant on the Sacramento reclamation district of the Natomis Co., in California, is used for both land drainage and irrigation. In this station there are two 36-in. centrifugal pumps, each driven through a flexible coupling by a 300-hp. 230-r.p.m. induction motor. The pumps operate against heads of 8 to 28 ft., the ordinary condition being against 18 ft. Minimum investment has been secured throughout. The pump motors are controlled from a main switchboard in the station gallery, being started directly from the main transformer bank, which delivers 1,100 volts for starting and 2,200 for running. Interlocked single-throw oil switches make the connections. The line is 51,000 volts.



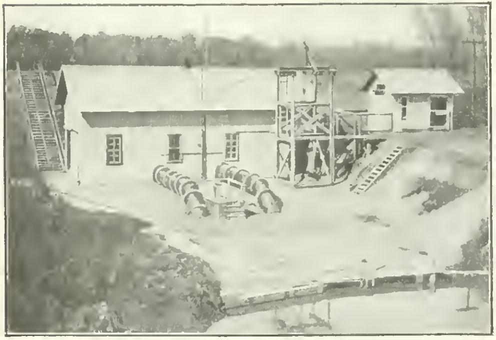


FIG. 1. PUMPING LAYOUT. FIG. 2. THE STATION

The scheme of using the pumps for both irrigation and reclamation is shown in Fig. 2. The pumps are placed below water level and draw from a sump excavated t 10 ft. below the canal level and 8 ft. below river lo water. A 42-in. pipe was laid on a 2% grade from th river to the sump. The pump discharges were connecte through valves to this pipe and motor-operated valve were placed on each discharge line going to the irrigation ditch. There is a fifth valve (hand-operated since it is opened only a few times a year) on the lowe end of the 42-in. river line. By closing valves 1 and and opening valve 3 (Fig. 1), water can be pumped fro the sump into the river. By closing valve 3 and openin 1 and 2, river water can be elevated to the irrigation ditch

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Saving Canal Walls Built on Old Plank Foundations

By Walter H. Sawyer*

In some of the older hydraulic construction where fin sand or quicksand was encountered it was common practice to build permanent structures on wood-plank platforms surrounded, in some cases, by wood sheetpiling (se

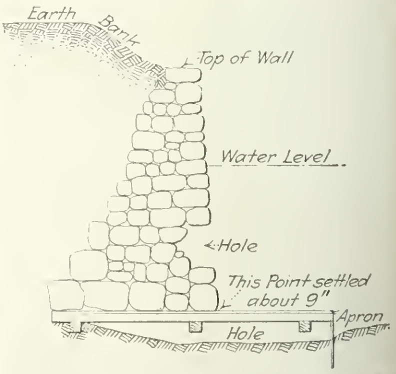

FIG. 1. CROSS-SECTION OF BREAK IN CANAL WALL. LEWISTON, MAINE

Fig. 1). Many of the canal walls of the Union Wate Power Co. at Lewiston, Maine, are built on such platform foundations. After 60 years' use the platforms hav become water-worn, although the timber is still sound With the wearing of the platforms and the wooden tree nails used to fasten them, the planks are frequently loos ened so that water gains access to the filling under th platform, sometimes allowing the wall to settle.

A recent instance is a place immediately below th gatehouse of the Union Water Power Co. at Lewiston

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*From information furnished by the Westinghouse Electric and Manufacturing Co., Pittsburgh, Penn., maker of electrical equipment in the Pritchard station.

*Consulting Engineer, Lewiston, Maine.

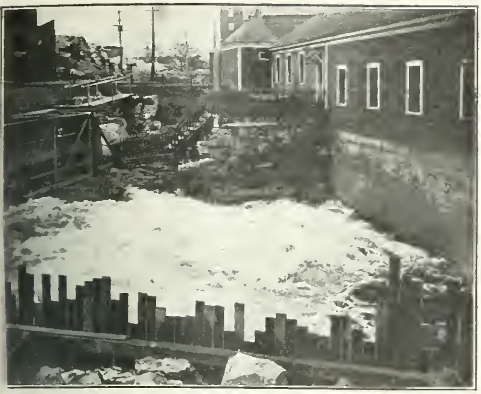

FIG. 2. CANAL IN FRONT OF COFFER-DAM, SHOWING DIFFICULTIES ENCOUNTERED FROM CURRENT

here a section of wall about 20 ft. in height was placed a plank platform over a sand pocket. The platform ojected into the canal about 10 ft. as a protecting apron. he constant rush of water over the apron has worn the anks so that during the last winter many of them were shed away, the filling under the apron was washed out d a portion of the wall settled and cracked. The place s a particularly difficult one to repair, as work must done at night and on Sundays when the canal could emptied.

Owing to the rapidity of the current, which would ve washed away the concrete before it could set, a akwater of heavy cribwork was built in the canal surrounding the break. The holes in the wall left by the falling stones were filled with concrete placed behind forms. The plank apron was covered with a concrete apron about 1 ft. in thickness, the apron being reinforced with old steel rods. Some sections of 2-in. pipe were inserted in various places in the wooden apron and concreted in. The voids under the apron were then filled with cement grout placed under a pressure of about a 20-ft. head.

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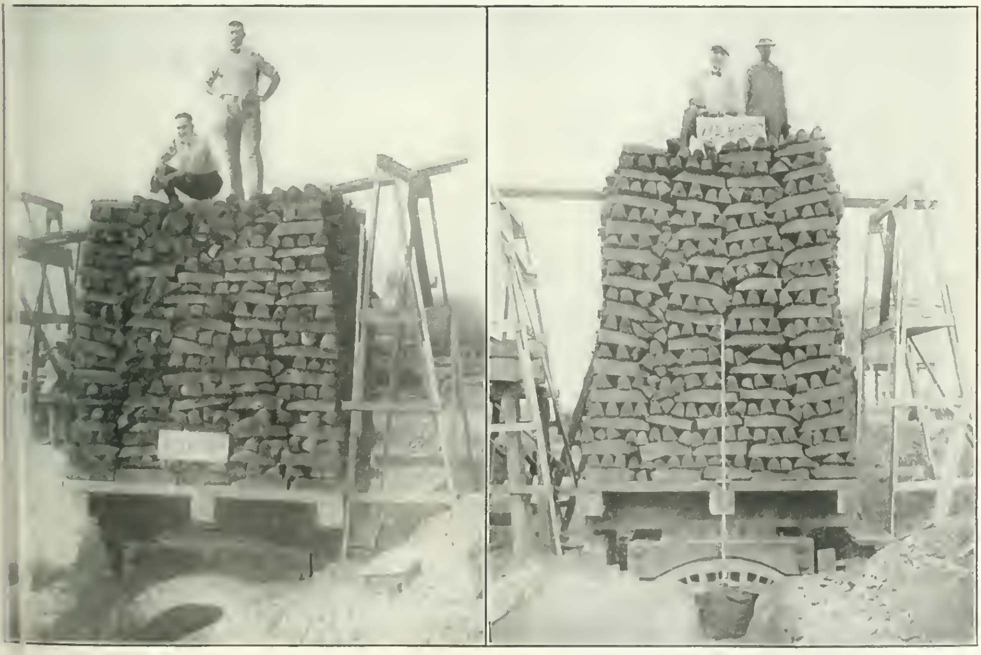
Brick and Tile Sewers Cracked Under Same Loading

As a result of some discussion in St. Louis of the relative merits of brick and segment sewer blocks for street construction, comparative tests were made recently on 60-in. sewers of each type. The brick sewer was built in two rings and was an exceedingly good piece of work. The tile sewer is of "Ferguson Block" (manufactured in St. Louis). Sections 7 ft. long were built underground, and an area in the center 4 ft. long by 3 ft. 4 in. wide was loaded. The load was applied through a sand bed wrapped in canvas and inclosed in a heavy bolted timber saddle, the timber not touching the sewer. The 4x4-in. timbers shown in end view rested loosely on the sand and supported the cantilever platform. The soil in which the sewers were built is a very stiff yellow clay.

Both constructions showed the first crack at approximately 53,000 lb. The loading was continued to about 113,000 lb., at which time several cracks had opened up in the brickwork, and the tile was seriously cracked. At this load the deflection in the brick sewer at the crown was ½ in., and in the tile sewer about ⅞ in. The tile



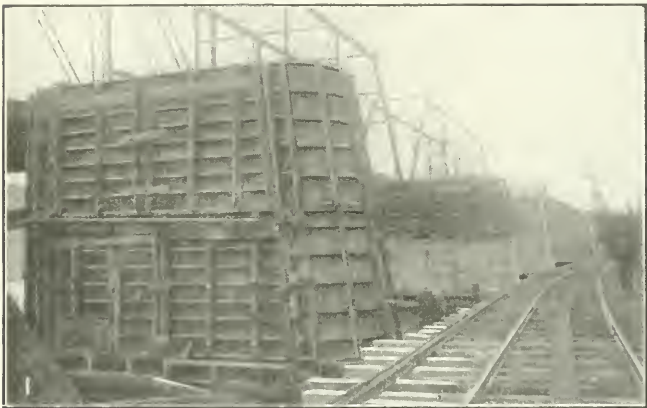
BRICK SEWER AND TILE SEWER LOADED TO CRACKING sewer continued to hold this load for 1½ days, after which it collapsed. The brick sewer showed no further deflection and was unloaded after about 10 days. It is interesting to note that the load at which each sewer cracked is equivalent to about 40 ft. of earth weight on the central portion of the arch, without relieving weight on the quarters or haunches, and indicates that both constructions are strong enough for all ordinary cases.

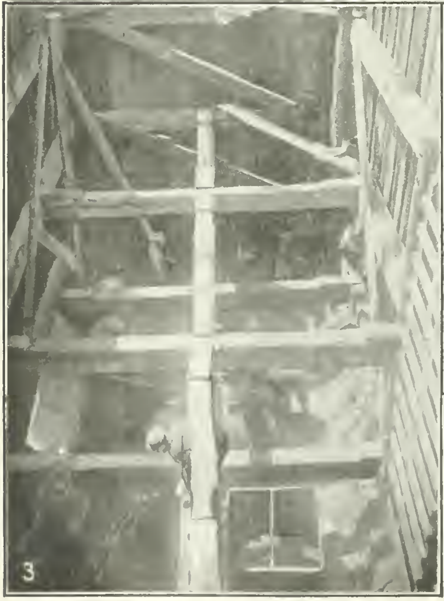
The only other conclusion to be drawn is that the two-ring brickwork in this size is somewhat stronger than the 7¼-in. thickness of the two-ring segment blocks.

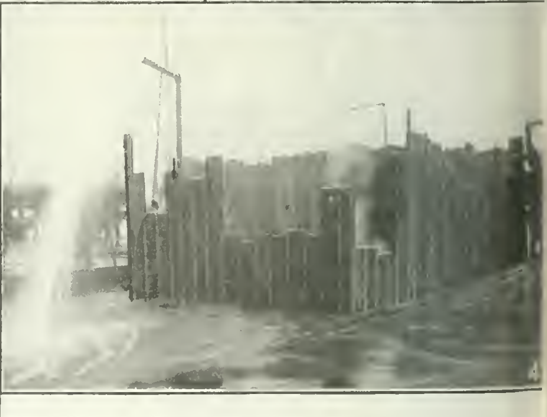
Cinders Make Steel Sheeting Tight in Swift Current

Eliminating grades on the Philadelphia & Reading Ry., in the town of Milton, Penn., necessitated the building of two new girder bridges on that railway across the Susquehanna River, alongside the existing truss bridge. The two new bridges are in reality but one crossing, being connected by an earth fill on an island in th middle of the river. The foundation of each bridg consists of two concrete abutments and seven concret piers. The connecting embankment contains 10,000 y of earth. The concrete in the foundations of the tw bridges aggregates 12,000 yd.

The river at Milton averaged about 14 ft. in dept during the major portion of the pier work. The velocit was as high as 10 or 12 mi. per hr. At the pier sit steel sheetpile coffer-dams were put down, each abou 20x40 ft. in plan, containing 104 sheetpiles, about 30 f long and 8 ft. above water. This meant that there wer 104 joints in each coffer-dam, and each joint was 22 f long. The result was that leakage was excessive. Th was obviated, however, when F. P. Kemon, the co tractor's superintendent, put down outside of each ste joint a V-shaped wood trough consisting of two boar nailed edge to edge, and filled the space between woo and steel with cinders. These cinders were obtained







FIGS. 1 TO 4 BUILDING FOUNDATIONS FOR READING BRIDGE AT MILTON, PENN.

Fig. 1—Showing service trestle, pier forms; old steel bridge of Philadelphia & Reading Ry. in background. Fig. 2—Finished span, note appearance of grooved concrete piers. Fig. 3—Bottom of a pier coffer-dam 28 ft. deep. Note practical absence of water. Fig. 4—Pumping from a sheetpile coffer-dam

near-by electric-light plant and were transported to he bridge in ordinary cement bags, which were dumped nto the V troughs. Mr. Kemon states that the leakage topped under this treatment almost as if the water had een shut off by valves.

The concrete piers have been marked into courses, as hown in Fig. 2, and the piers are faced with a ranolithic mixture. This mixture is disposed as follows: teel forms are placed 1 in. inside the pier forms and re raised as the concreting proceeds, the granolithic ixture being put between the steel forms and the eet-steel-lined wood forms of the piers.

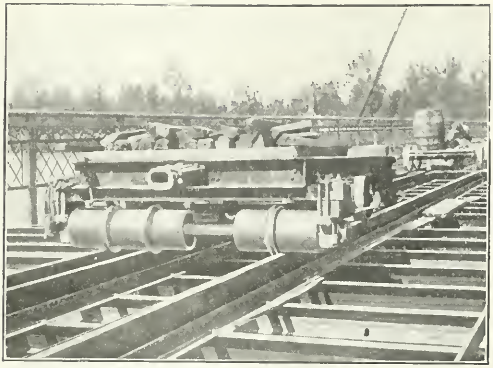
The work was carried on from a timber service trestle ected alongside the site of the new bridge. At Milton out 10 ft. of sand overlies the rock, so that the trestle sts could be driven. The trestle was therefore a ancher structure than the one being used at Harrisburg erect the Susquehanna bridge of the Cumberland alley R.R.

The foundations were placed by the Robert Grace ontracting Co., of Pittsburgh; F. P. Kemon, superin-ndent on the job. The Pennsylvania Steel Co. is ishing the erection of the girder spans, while at the esent time the Reading Construction Co. is dismantling old steel bridge for the Philadelphia & Reading Ry. E. F. Gorman is Resident Engineer, C. Dillenbeck, gineer of Bridges and Buildings, Samuel T. Wagner, ief Engineer.

⁂

Roller Shapes Bridge Paving Alongside Car Track

The Interstate Bridge, across the Columbia River near tland, Ore., is paved with asphaltic concrete laid on oncrete slab floor. The header adjacent to the car t ks, which are for both wide and narrow gage, is of concrete, formed monolithic with the floor slab. The contractor, the Pacific Bridge Co., developed the rather novel roller shown in the accompanying view for forming the flangeways in these concrete headers. An axle, carrying turned cast-iron rollers of proper form was supported by bearings bolted on one end of a small steel car. By using a moderately wet concrete and passing this car over the surface several times, a very smooth and uniform flangeway was secured.

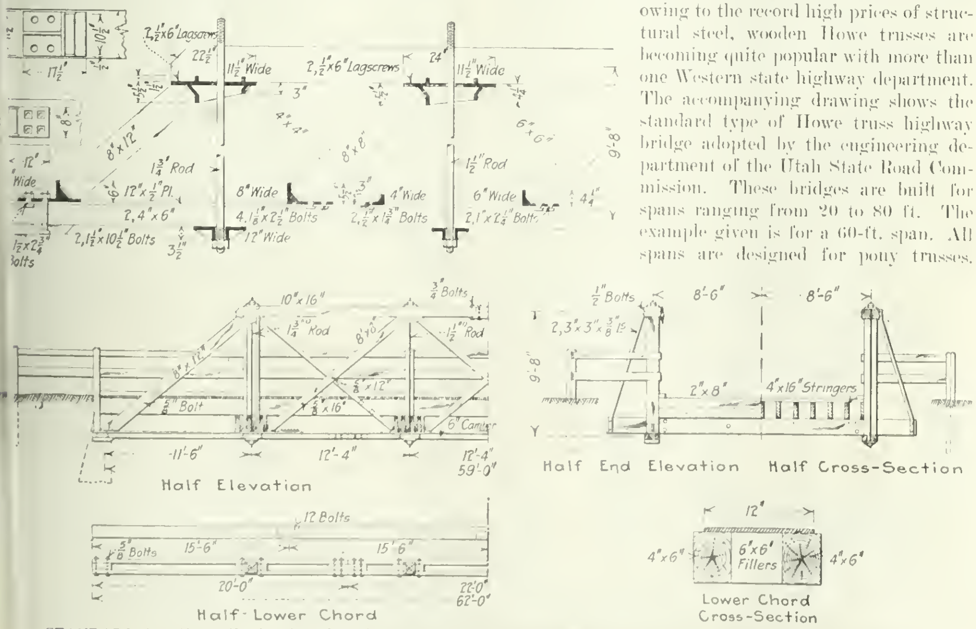


ROLLER ON CAR FORMS CONCRETE PAVING ON BRIDGE

⁂

Howe Truss Highway Bridge with Composite Chord

The day of the timber truss for highway bridges is by no means past. There are many sections of the country, particularly in the Northwest, where timber trusses will be used for many years to come. Right at this time, owing to the record high prices of structural steel, wooden Howe trusses are becoming quite popular with more than one Western state highway department. The accompanying drawing shows the standard type of Howe truss highway bridge adopted by the engineering department of the Utah State Road Commission. These bridges are built for spans ranging from 20 to 80 ft. The example given is for a 60-ft. span. All spans are designed for pony trusses.



STANDARD PONY HOWE TRUSS HIGHWAY BRIDGE, WITH COMPOSITE LOWER CHORD, UTAH STATE HIGHWAY DEPARTMENT

The bridge illustrated has a clear width of nearly 16 ft. It is designed for a dead-load of 680 lb. per lin.ft., a uniform live-load of 100 lb. per sq.ft., and a concentrated live-load of an 18-ton roller. The impact allowance for the trusses is 18% of the maximum live-load and for the floor system 25%. The 60-ft. trusses shown are given a camber of 6 in.

The essential feature of the bridge is the makeup of the lower chord, all the tension in which is carried by a steel plate laid on top of two 4x6-in. timbers, which give the necessary stiffness. The floor-beams and panel-point castings are laid on top of the lower chord plate.

The trusses are braced laterally at the panel-points by means of 3x3x⅜-in. angles extending from the upper chord to the ends of the floor-beams. In the 60-ft. truss shown braces are required at the end panel-points only.

A highway bridge of this type can be built for about half the cost of a steel truss or concrete-girder bridge designed for the same live-load. The standard steel bridges of similar spans have concrete floors, and possess correspondingly greater durability. The wooden bridge, however, requires less attention in certain localities, such as in the alkali country.

The bridge shown contains 14,407 board feet of lumber, 4,247 lb. iron in angles, plates, bolts and nails, 1,856 lb. castings and 729 lb. hangers and nuts.

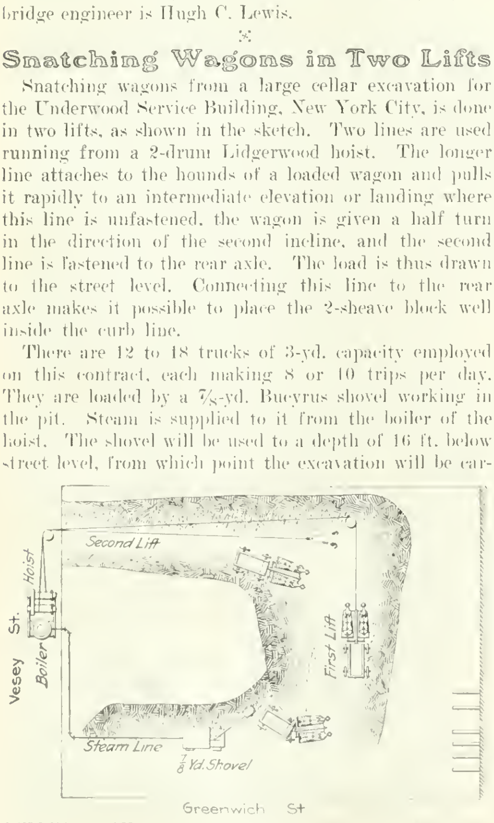
The state road engineer of Utah is E. R. Morgan; the bridge engineer is Hugh C. Lewis.

⁂

Snatching Wagons in Two Lifts

Snatching wagons from a large cellar excavation for the Underwood Service Building, New York City, is done in two lifts, as shown in the sketch. Two lines are used running from a 2-drum Lidgerwood hoist. The longer line attaches to the hounds of a loaded wagon and pulls it rapidly to an intermediate elevation or landing where this line is unfastened, the wagon is given a half turn in the direction of the second incline, and the second line is fastened to the rear axle. The load is thus drawn to the street level. Connecting this line to the rear axle makes it possible to place the 2-sheave block well inside the curb line.

There are 12 to 18 trucks of 3-yd. capacity employed on this contract, each making 8 or 10 trips per day. They are loaded by a ⅞-yd. Bucyrus shovel working in the pit. Steam is supplied to it from the boiler of the hoist. The shovel will be used to a depth of 16 ft. below street level, from which point the excavation will be carried by hand work to a depth of 20 ft. The limiting factors in moving the material are the matter of available scows and the weather. The spoil has to be taken 3 mi. out to sea, which restricts a scow to one load per day.

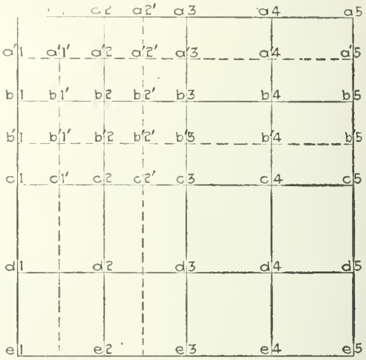


PULLING DUMP WAGONS FROM BUILDING EXCAVATION IN TWO LIFTS

The excavation on this 83x132-ft. plot is being done by F. H. Chapman. The architects for the building are McKenzie, Voorhees & Gmelin.

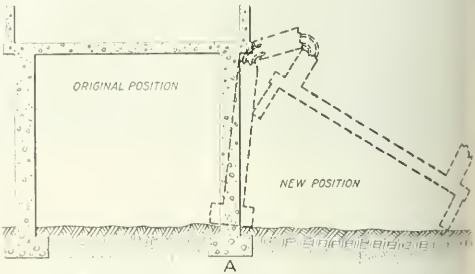
NOTES

Proposed Method of Designating Section Corners—In the "Michigan Engineers' Annual," 1894, appear four different systems of designating corners of sections and quarter sections. One of these was offered by F. Hodgman and is also found in his work on surveying. The discussion dwelt upon the fact that surveyors should adopt some easily remembered system of designating corners, so that a letter, figure or character might be jotted down and thus do away with the necessity of writing a more extended note, possibly under unfavorable conditions. I have a plan that I think is much better than any other I know of. It offers a designation for each corner of each 40-acre division of a section. This is of course particularly adapted to the regular subdivision of sections. I believe the more one studies the system and becomes familiar with its merits, the better it will be liked. It is very flexible and can be manipulated to indicate much by a brief note.—H. H. Rankin, C. E., Stronghurst, Ill.



PROPOSED METHOD OF DESIGNATING DIVISIONS OF PUBLIC LAND SURVEY SECTION

A Bridge Span Turned Upside Down by a flood is shown diagrammatically in the accompanying sketch. It is one span of the reinforced-concrete girder section of the Sloans Ferry bridge across the Catawba River in North Carolina, which was wrecked by the July floods, as described in "Engineering News," July 27, 1916, p. 185. S. H. Lea, City Engineer of Charlotte, N. C., who sent the sketch, says that this one span is overturned completely. The downstream post A, which was founded some feet below river bottom, has been raised to the ground line; it served as a pivot on which the span somersaulted, breaking off one post completely and severing the other in two places. The pressure of the flood water which was 4 ft. over the balustrade, was evidently tremendous



CONCRETE BRIDGE TURNS A SOMERSAULT

Editorials

What Happened at Quebec

A steel rocker casting under one corner of the suspend- l span of the new Quebec Bridge first gave way. This is onclusively proved by the convincing array of structural idence set forth in another part of this issue, obtained rst hand by a member of the editorial staff of *Engineer- g News*, who made a careful examination of the entire fting equipment left in place after the accident.

The results of this examination of the bridge are shown this issue in a peculiarly graphic manner—with plan d perspective photographs accompanied by key sketches. is full record confirms the explanation of the accident ven in *Engineering News* last week.

The statement of the condition of the lifting equip- nt and the explanation of the events of the disaster en in this issue have been verified by conference with engineers of the St. Lawrence Bridge Co. and are rmonious with the official views.

Exactly how the accident happened can now be stated h certainty. To summarize concisely the more detailed tement made elsewhere: A steel casting by which the ight of the south upstream corner of the suspended n was transferred to the lifting girder broke in such anner that the girder kicked back from under it. This ner of the span dropped into the water, starting trans- sal rotation of the whole south end of the span. For instant there was heavy extra load on the down- am corner of the span, but the hanger held, and when t tipping progressed far enough the southeast corner a left its hanging support and went down into the w er. Owing to the weakness of the laterals, the r ation of the south end of the truss was not very largely municated to the north end, the trusses crumpling at t pin-connected joints. Both north corners therefore h g on until the other end of the span had disappeared u er water and then let go, practically simultaneously.

o much for what actually happened. The question arose at first in the minds of laymen and, indeed, he minds of engineers not daily engaged in structural was, "Why was not provision made against the effect uch a casting breaking?" The answer of structural gners, of course, is that there was no more reason to e such provision at the corner support that gave way at each and every one of a hundred other parts of ridge where treachery of material would have started ccident. There was no suspicion that here danger d unseen, and it was impossible to provide against failure of material everywhere in the bridge.

conclusion it is merely giving credit where credit e to express our appreciation of the broad-minded, al attitude of the company and of the Board of Engi- in the face of this accident, and particularly of president of the bridge company, Phelps Johnson. y piece of information in the possession of the com- has been made accessible. Every facility for examin- has been provided. Every suggestion has been wel- d in the search for the cause. The whole procedure is a splendid example of high professional ethical standards in the administration of a gigantic construction enterprise at a time of great stress.

*

Watch Drifting-Sand Filters

It will be worth while to watch the results obtained from the large installation of drifting-sand water filters that will soon go into operation at Toronto, Ont. The major features of this new type of mechanical filters are filtration through (1) drifting sand and (2) a lower body of stationary sand, there being no physical separation between the two. The sand drift is provided by constant removal of a portion of the upper and moving sand body and the return of this sand through a vertical induction washer. The drifting action is depended on to render precoagulation unnecessary, while the constant washing of the drifting sand is expected to lessen materially the frequency of backwashing the entire sand body.

As is so common in both water and sewage treatment, the gains in the drifting-sand filters are to some degree offset by losses, or at least by added expense. Coagulation basins are cut out, and the effective filtering area is doubled, the engineers for the process state; but the sand bed is unusually deep. Frequency of complete washing is greatly reduced, but a part of the sand is being washed and returned every minute. The numerous units per filter tank add to the amount and complexity of both the structural work and the piping, as compared with the ordinary type of mechanical filter. All these things combined are not necessarily serious, but what the net gain of the new process will be is a matter to be determined by experience.

In passing, it may be noted that the early mechanical filters were operated without precoagulation; that one mechanical-filter company was wrecked by tackling a very turbid water without precoagulation; and that as experience with both mechanical and slow sand filtration has increased, coagulation basins have become more and more common and larger. All this, however, does not prove that drifting sand may not prove to be an efficient substitute for precoagulation, just as the activated-sludge process of sewage treatment may yet make preliminary sedimentation unnecessary.

The last remark suggests a likeness between the drifting-sand and the activated-sludge processes. In each case the liquid being treated is brought in contact with a moving medium. To go farther than has yet been attempted, or perhaps conceived before this, might the sand removing and renewing device in the drifting-sand filter be adopted for use in the removal of activated sludge and sewage and the return of a portion of the sludge to the activation tank? This question is rendered somewhat pertinent, perhaps, by the recently expressed opinion—in England and perhaps also in America—that mechanical agitation of sewage would serve as well as, if not better than, forced aëration.

The Toronto drifting-sand filters, described elsewhere in this issue, were made more costly and made also to cover more area than was necessary, because of a preference on the part of the city authorities for steel rather than reinforced-concrete tanks. The alternative bid for concrete was considerably lower than the accepted bid. At the same time, the accepted bid was deemed materially lower, according to Commissioner Harris' report (*Engineering News*, June 25, 1914) than the lowest competing bids for mechanical filters. To what extent this was due to a determination to install a large plant of the drifting-sand type in America we cannot say. One test of the new type of mechanical filters worth watching will be how it meets first-cost competition in the future. Another important factor to watch will be unit operation costs, and still another will be purification results.

Finally, the stress here laid upon watching the drifting-sand filters is not prompted by skepticism. These filters should be watched because, although brilliantly novel in the main principles of operation and in several details, they possess both the promise and the uncertainty of new processes or apparatus not yet tried on a large scale and under the varied conditions of many localities. It is a fine thing that Toronto had the courage to lead the way and afford the engineering profession a first-rate opportunity for watching drifting-sand filters.

⁂

Progress of the New England Water-Works Association

Milestone 35 was passed by the New England Water-Works Association when it closed its annual convention at Portland on Sept. 16. The 52 names added to the membership list during the convention equalled the total number of members at the time an ex-secretary of the association in attendance at Portland assumed office a quarter century or more ago. Thus far this year 150 new members have been enrolled. The aim is to make the gain for 1916 at least 200. This would bring the total up to 1,100. Since all water-works men everywhere are eligible to membership, it should be no hard task to get 50 more to join in the next three months.

The Portland convention accorded with the traditions of the Association in having business sessions and excursions sandwiched together so as not to give rise either to weariness or surfeit and to afford no lack of opportunity for social intercourse.

The number of papers and committee reports scheduled for most of the business sessions was perhaps too large, tending to haste and the curtailment of discussion. This might readily have been avoided, as some of the subjects hardly called for discussion, making presentation to the Association quite unnecessary. Of the half dozen papers and reports printed for circulation at the meeting, some might have been read by title only or in very brief abstract. It is a rare society and a rarer author that has sufficient restraint to refrain from reading at least the greater part of a paper, even if it is already in the hands of all the members.

The two sessions for superintendents narrowly escaped the pitfall that has invited disaster at conventions of the American Water-Works Association, namely, the monopolization of time by some controversial subject that does not greatly concern the superintendents, or else the use of overmuch time by engineers, material men or other special interests, so that the superintendents listen rather tha discuss.

A weakness that besets all associations is the creation o numerous committees and the subsequent failure of th membership to give them support in the way of answer to questionnaires. This lack of coöperation was empha sized in the case of inquiries on pipe leakage recentl sent out by a committee of the New England Water-Work Association. Only 20 or 25% of replies were received an many of these were scanty. It may be that some com mittees are given or themselves assume tasks that shoul not be attempted; or that inquiry blanks are not wel framed; or that committees should not stop short wit sending out one set of inquiries to the persons on thei list. Still, more coöperation should be given or fewe committees should be created.

Notwithstanding the difficulties attending committe work, the Portland convention voted for the appoint ment of two new committees, each with much hard wor to do if worthy results are accomplished. These we committees on accounting and on meter specification It is to be hoped that the members will support the committees in their arduous and important tasks.

It should be understood that none of the dangers he mentioned are peculiar to the New England Water-Work Association; that it has a good record for steering clear of them as can be expected of any technical societ and, finally, that the Portland convention was pronounce by all in attendance to be one of the best water-work conventions ever held.

⁂

Indianapolis Fails To Protect Citizens from Typhoid

Some years ago, the 580 cases of typhoid fever Indianapolis during the last three weeks in August wou have been officially and popularly charged against t Indianapolis Water Co. Both general knowledge a local facts make that impossible now. Any city w a well purified water-supply, like that supplied by t Indianapolis Water Co., rests assured that it is p tected against typhoid from water, if it will only that and will shun less safe supplies.

A detailed investigation made years ago by an outs expert indicated that the excessive typhoid then preval at Indianapolis was due to thousands of unsewer premises and private wells. Some progress may have b made since then in bettering these dangerous conditio but not enough. Four years ago an ordinance aim at unprotected privies and the typhoid fly was defeat in the city council because of opposition on the groun of expense and, we presume, interference with freedom of the individual. Presumably, the people Indianapolis have paid a yearly typhoid toll ever sin and this year there is no question about it.

Of course there may be other causes than privies a polluted private wells for this typhoid outbreak Indianapolis. Whatever the causes may be, it is duty of the city to locate and eradicate them. T state and local health authorities appreciate this, the city council seems to lack either the intelligence the courage to do its part. The water company, howev if we understand local conditions, has the satisfaction knowing that it has done its part toward eliminati typhoid from Indianapolis.

Post Bellum Influx Unlikely

There is a widespread belief in the United States that nmediately after the close of the European War there ill be an enormous influx of emigrants from Europe; nd further that when the manufacturers of Europe turn om making munitions of war to making goods for sale, ere will be a vast output of cheap goods dumped onto e American market. Concerning these predictions, it of interest to note the following statement by the nerican Association of Commerce and Trade of Berlin inted in its bulletin for June:

> The American press is at present teeming with articles rerding immigration to the United States after the war. this subject and that of dumping foreign goods, especially German manufacture, on the American market after this rible struggle is over there is wide misconception of the o states of affairs. There will be no emigration from Gerny after the war for the reason that every able-bodied n will be able to find work at good wages. There will be dumping after the war for the simple reason that there l be nothing to dump. German stocks are more or less deted and those that are left will be required for home conoption, so the anti-dumping laws will be unnecessary.

⁂

Looking at the Inside of Reinforced Concrete

A most useful adjunct to the inspection of reinforced crete has been developed in Switzerland, if the report the United States consul at St. Gall in that country be taken at its face value. According to Consul , an engineer of the Swiss Railway Department, one Stettler, has perfected a Roentgen ray apparatus reby he is enabled to take photographs of a reined-concrete member so as to show, clearly enough practical purposes, the disposition and size of the forcing steel embedded in the concrete.

rovided the cost can be brought within commercial ts, such photography has great possibilities, not only he inspection, but in the test of concrete structures; the misplacement of reinforcing steel is an old but rring evil the effects of which are well known. Its overy, however, is more than often difficult. Instrut manufacturers and testing engineers would do well ook further into the official report.

⁂

With the Sympathy of the Engineering Profession

ne years ago, in the issue of *Engineering News* diately following the collapse of the south cantilever e Quebec Bridge, on Aug. 29, 1907, we said:

> is with the keenest regret that we record the disaster e great cantilever bridge under construction over the awrence River at Quebec. We are sure this regret is d by every engineer who takes the least pride in his ssion and its achievements. And the feeling is even r than regret. When the newspapers spread the news terrible disaster at Quebec to every corner of the counthousands of engineers, as they read the story, were ed and sick at heart. They felt not only horror at the of life, sorrow and sympathy for their brothers of the ssion, but also a sense of personal loss as well.

ere is no doubt that the engineering profession at the nt day is, if possible, more deeply shocked and d than at the time of the catastrophe nine years

e new Quebec Bridge represents the highest achieve- ever recorded in structural engineering. The lestaught by the unfortunate catastrophe of 1907 have e well learned. In the design, manufacture and erection of the new Quebec Bridge there has been nowhere any sparing of expense, any failure to employ the best technical skill, any lack of precautions to make certain that the finished structure should be as perfect as could possibly be built at the present day. That the failure of the material in one small detail, designed for use in the erection process and not in the finished structure, should destroy in a few seconds the great suspended span, the final link to complete the greatest bridge in the world, is a piece of most undeserved bad luck.

It is always easy to criticize after the event. Hindsight is always wiser than foresight. Who in the engineering profession has the cocksureness to say that he would have been wise enough beforehand to have imagined the possibility of this spectacular failure occurring in the way it actually did occur?

The men in charge of this most remarkable feat of bridge erection ever undertaken went to well-nigh unheard of lengths in computing and testing and determining beforehand the safety and certainty of each step of the process.

But experience teaches again that disaster may come, even to the most careful. In the light of what has happened at Quebec, engineers in every rank of the profession must realize anew that there is a lurking possibility of failure in every task that the engineer performs and that when such failures come those who suffer by it deserve the broad and generous sympathy of their brethren.

The final success of any great engineering work depends on a multitude of details and on eternal vigilance to see that none are neglected. It is the engineer's duty to study disasters to engineering works because of the useful lessons they may teach; but let him study them with all sympathy for his brother engineer who has borne the responsibility, remembering that he himself might have been in a like situation.

⁂

Explosions in Grain Separators

Any engineer who still has any doubt that fine dust floating in the air in proper proportions constitutes a powerful explosive and can be ignited without the presence of any inflammable gas will do well to study Bulletin 379 just issued by the Department of Agriculture. This bulletin reports the results of an investigation of the explosions and fires that have occurred in the grain separators of threshing machines in the Pacific Northwest. Its authors are David J. Price, of the Bureau of Chemistry, and E. B. McCormick, of the Office of Public Roads.

The investigation was made in eastern Washington, northern Idaho and northeastern Oregon. No less than 166 fires and explosions which occurred in grain separators while the wheat crop of 1915 was being threshed, were investigated. This section has an arid climate; and in the fall of the year when wheat threshing is going on, the air is usually very dry. The wheat crop of 1915 contained a large percentage of smut; and the investigations indicate that it was the very fine dust from this smut that exploded. The ignition of the dust-charged air appears to have occurred in most cases from a spark due to static electricity generated by some part of the machinery. The means suggested for preventing these explosions is grounding the separator to prevent the accumulation of static electricity and the attachment of a suction fan to the separator to remove the dust as it is formed.

Letters to the Editor

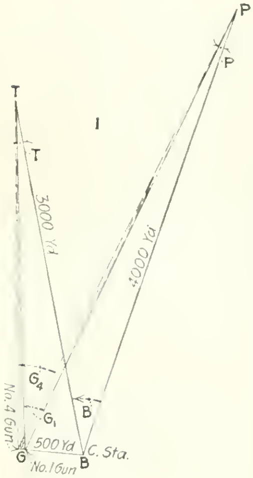
Field-Artillery Service for Civilian Engineers

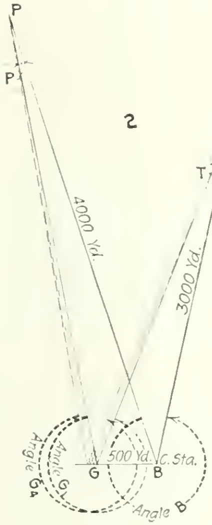
Sir—I have read with interest the article entitled "Field-Artillery Service Should Attract Engineers," by Ernest McCullough, in *Engineering News*, Aug. 24, 1916.

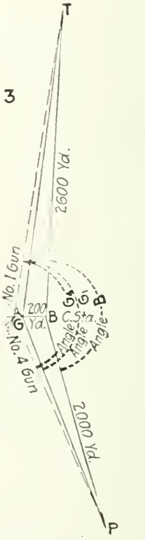
In order to visualize the problem of gun pointing for indirect fire clearly, I have found it helpful to lay out on a celluloid triangle a small circle about 3 in. in diameter, divided into 64 equal parts, numbered counterclockwise. With this protractor and a scale, any problem may be laid out with sufficient accuracy. The method of solution is interesting to the civilian engin used to making calculations of this sort with a sev place logarithm table.

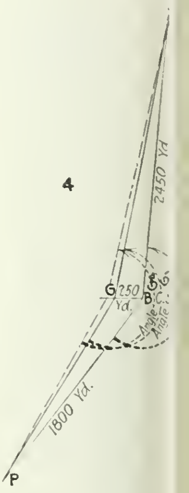
The rule of plus and minus signs is perhaps the m difficult one for the beginner to grasp, and the best w to illustrate this law is to solve several problems.

In measuring angles the battery commander's te scope is used. This telescope is mounted on a tri similar to an engineer's transit, but the telescope vertical instead of horizontal and arranged exactly the periscope on a submarine. The horizontal circl divided into 64 equal divisions. The telescope has









PROBLEM 1

Range, 3,000 yd., target, left front; B C station, 500 yd., right flank. Aiming point, 4,000 yd., right front.

B = 520 520 mils

P = $\frac{500}{4} \times 1 = 125$

T = $\frac{500}{3} \times 1 = +170$

P — T = −45 −45 mils

G = B + (P — T) 475 mils

Deflection Difference

For converging fire

P′ = $\frac{20}{4} \times 1$ = 5 mils

T′ = $\frac{20}{3} \times 1$ = 7 mils

P′ — T′ = −2 mils

Therefore "close by 2."

For parallel fire

P′ = $\frac{20}{4}$ = 5 mils

T′ = 0 mils

P′ — T′ = +5 mils

Therefore "open by 5."

PROBLEM 2

Range, 3,000 yd., target, right front; B C station, 500 yd., right flank. Aiming point, 4,000 yd., left front.

B = 5,870 5,870 mils

P = $\frac{500}{4} \times 0.9 = +120$

T = $\frac{500}{3} \times 1 = 167$

P — T = −47 −47 mils

G = B + (P — T) = 5,823 mils

Deflection Difference:

For converging fire

P′ = $\frac{20}{4} \times 1$ = +5 mils

T′ = $\frac{20}{3} \times 1$ = 7 mils

P′ — T′ = −2 mils

Therefore "close by 2."

For parallel fire

P′ = $\frac{20}{4}$ = +5 mils

T′ = 0 mils

P′ — T′ = +5 mils

Therefore "open by 5."

PROBLEM 3

Range, 2,600 yd.; target, right front; B C station, 200 yd., right flank. Aiming point, 2,000 yd., right rear.

B = 2,880 2,880 mils

P = $\frac{200}{2} \times 0.96 = -90$

T = $\frac{200}{2.6} \times 1 = +77$

P — T = −167 −167 mils

G = B + (P — T) 2,713 mils

Deflection Difference.

For converging fire

P′ = $\frac{20}{2.0} \times 0.9$ = −9 mils

T′ = $\frac{20}{2.6} \times 1$ = +8 mils

P′ — T′ = −17 mils

Therefore "close by 17."

For parallel fire

P′ = −9 mils

T′ = 0 mils

P′ — T′ = −9 mils

Therefore "close by 9."

PROBLEM 4

Range, 2,450 yd.; tar right front; B C station, yd., right flank. Ain point, 1,800 yd., left rear

B = 3,760 3,760

P = $\frac{250}{1.8} \times 0.8 = -110$

T = $\frac{250}{2.45} \times 1 = +100$

P — T = −210 −210

G = B + (P — T) 3,550

Deflection Difference

For converging fire

P′ = $-\frac{20}{2.4} \times 1$ = −8

T′ = $\frac{20}{1.8} \times 0.8$ = +9

P′ — T′ −17

Therefore "close by 17"

For parallel fire

P′ = −8 mils

T′ = 0 mils

P′ — T′ = −8 mils

Therefore "close by 8"

movements similar to the transit, and a micrometer permits the reading of horizontal angles to single mils—$^1/_{6400}$ of the circumference—and also vertical angles to 100 mils through a small arc. The graduations on the horizontal circle are numbered counter-clockwise. The upper plate is notched at the even 100-mil divisions, and a spring engaging the notches sets the instrument automatically at these divisions. The micrometer takes the place of the slow-motion screw of the transit.

This telescope, properly leveled, with the index set at zero, is first pointed at the aiming point, usually an easily defined object whose distance to the battery is approximately known. The lower motion is then clamped, the plates released, and the telescope is pointed at the target. The angle with the aiming point—angle *B* it is usually called—is read on the micrometer.

The distance from the battery commander's station, which is usually some multiple of a platoon front for convenience, is divided by the distance to the aiming point expressed in thousands of yards, and the quotient is multiplied by a percentage correction for the obliquity of the line *BP* with the line *GB* from No. 1 gun to the battery commander's station. The result is the angle *P*. The above correction is the sine of the angle which the line *BP* makes with the line *GB*. The sines of the angles 400, 800, 1,200, etc., to 6,400, are usually memorized. For an angle between 400 and 500 mils this correction is approximately 90%. For 800 mils it is 70%; for 1,200 mils, 40%; for 1,600 mils, zero, etc.

The angle *T* is found in the same way and is always given the positive sign. The angle *P* is positive or negative as the aiming point happens to be in the front of or in the rear of the battery. The angle *G*, or *PGT*, the deflection angle of No. 1 gun, is then equal to angle *B* plus (*P* — *T*).

The deflection of No. 2 gun is found in exactly the same way, angle *P'* being equal to 20 yd. divided by the distance from the battery to the aiming point, and *T'* 20 yd. divided by the distance from the battery to the target, corrected as above, both divisors being, of course, expressed in thousands of yards. This deflection difference, *P'* — *T'*, is added algebraically to the deflection of No. 1 gun. For the deflection of No. 3 gun the difference is multiplied by 2, and for the deflection of No. 4 gun this is multiplied by 3.

The above difference is for converging fire. The process of finding the deflection difference for parallel fire is exactly the same as for converging fire, the angle *T* in this case becoming equal to zero.

TRESHAM D. GREGG.

Minneapolis, Minn., Aug. 30, 1916.

[It seems justifiable to publish the preceding letter, which in connection with Ernest McCullough's article brings before civilian engineer readers a development in reconnoissance surveying that might otherwise be lost sight of. It is easily conceivable that the mil-graduated circle and the quick methods of roughly estimating distances could be utilized to advantage in rough preliminary or reconnoissance surveys for a variety of purposes. The incipient surveyor-inventor looking for opportunities to introduce new methods may possibly see the germ of a valuable improvement in the decimal system above described. Moreover, a little careful study of the two articles will enlighten civilian engineers generally on a subject with which the majority are entirely unfamiliar. —Editor.]

No Residence Restrictions for Engineers

Sir—I was much interested in your editorial in *Engineering News* of Aug. 31 regarding the evil of local license laws for engineers. Your views reflect the enlightened thought of the time. The competent man fears no fair and honorable competition and needs no so-called protective legislation. The advocacy of license laws implies the conviction of incompetence in the consciences of the advocates thereof.

Some eighteen months ago I wrote a letter to the Secretary of the Western Society of Engineers opposing the bill then pending for licensing structural engineers in Illinois. I quote from that letter as follows:

> This bill avowedly is intended to mitigate certain intolerable conditions growing out of the architects' license law and, like the latter, is a piece of class legislation. In my opinion there is only one proper way of accomplishing the object desired—namely, the repeal of the architect's license law.
>
> All such laws, in the last analysis, are founded upon the principle of the closed shop, no matter how plausible may be the pretext for their necessity. They grow out of an economic misconception and will most surely have the same ultimate effect upon public welfare as sumptuary laws have had throughout all history.
>
> In my opinion the advocacy of such laws by the engineering profession seriously detracts from professional dignity and, in fact, places the engineer in the public mind upon the same or a similar level with the plumber and similar classes, who have had class legislation enacted for their selfish interest. Such legislation must ultimately be borne by the public, and it is becoming an increasing public burden.
>
> Experience has shown that examining boards are very sensitive to the exigencies of politics rather than the requirements or the intent of the law under which such boards operate, in such matters, and we all know how easy it is for an examining board to disqualify any candidate they may choose. We also know how humiliating it is for a man who has been practicing fifteen years or more to take examinations of this character, when he knows that the examining board have it in their power to stigmatize his reputation by disqualification, if they choose. Such examining boards at first are actuated only by altruistic motives, but sooner or later they succumb to the temptations of politics.
>
> When the Federal Constitution was adopted, it was expressly provided that the Government should control the commerce between the states. The object was to prevent the establishment of tariff walls between the states. Recently the Supreme Court of the United States decided that the preferential railway rates established by the Texas Railroad Commission were repugnant to the Constitution because of an interference with interstate commerce. The writer therefore strongly feels that the adoption of such a law would ultimately be harmful—first, to the engineering profession and, second, to the public at large.

F. W. GREEN,

General Manager, Louisiana & Arkansas Ry.

Stamps, Ark., Sept. 4, 1916.

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Vocational Guidance

Sir—The article on "Professional Misfits," by Prof. W. M. Wilson, in *Engineering News* of Aug. 31, 1916, is extremely interesting. When the writer attended the Massachusetts Institute of Technology in 1893, a system of vocational guidance was in operation there. It is necessary that a committee of three competent men should consult with and advise each student before he makes his final choice. The problem is distinctly one for the college authorities. Each instructor and professor should appoint himself a committee of one to improve his acquaintance with the students.

LOUIS P. BUFF.

Jamaica Plain, Boston, Sept. 2, 1916.

Drifting-Sand Water Filters for Toronto, Ont.

SYNOPSIS—72,000,000-gal. (Imp.) maximum-capacity mechanical water-filtration plant of the Ransome drifting-sand type will soon be in operation at Toronto alongside the 48,000,000-gal. (Imp.) maximum-capacity slow sand filters completed in 1912. Major features are the constant removal, washing and replacing of a portion of the filtered sand by untreated water; filtration through drifting renewed sand above and nonmoving sand below, and the entire absence of a coagulating basin. Novel details are the alum-storing tank, alum-solution trough, constant-density alum-feed control, raw-water control and the large quick-discharging wash-water tank for backwashing the entire body of filter sand with filtered and disinfected water at weekly or 10-day intervals.

The rapid growth of Toronto having made necessary a large addition to its filtered-water supply from Lake Ontario, and the combination of occasional high turbidities and low winter temperatures having convinced the city authorities that the new filter should be of the mechanical rather than the slow sand type, general specifications for mechanical filters were drawn and bids were received in January, 1914, by R. C. Harris, Commissioner of Works of Toronto. The accepted bids (June, 1914) were for Ransome drifting-sand filters. The plant was designed by the John verMehr Engineering Co., Ltd., of Toronto, Canada, and London, England, with William Gore as consulting and William Storrie as chief engineer (154 Simcoe St., Toronto). It is being constructed by the company named and William Cowlin & Son (Canada), Ltd., of Toronto, and Bristol, England. It will be by far the largest drifting-sand filter plant ever built and the first one of considerable size in North America. The contract price for the plant was $1,066,282.[1]

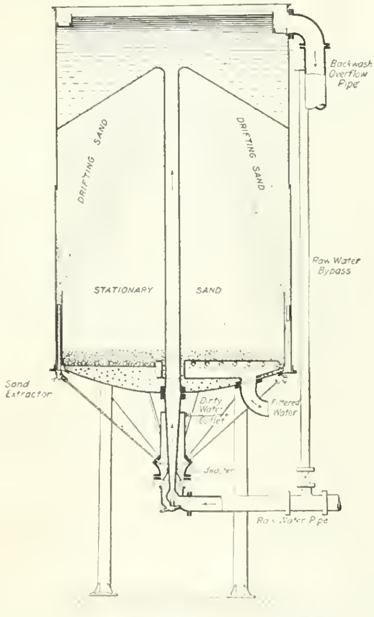

FIG. 1. TYPICAL UNIT OF DRIFTING-SAND FILTER

There are 30 of these units in each of the 10 filters of the Toronto plant

FIG. 2. GENERAL VIEW OF NEW FILTER PLANT

The plant has a contract capacity of 60,000,000 gal. (Imp.) in 24 hr., but must be able to work at the rate of 72,000,000 gal. per day for a period of 10 hr. It is located on Toronto Island, close by the slow sand filters completed in 1912 (see *Engineering News*, Mar. 9, 1911, p. 302). The two plants combined will give a safe working capacity of 100,000,000 gal. (Imp.) a day. The present estimated population of Toronto is 500,000.

The following description is based on information obtained from Messrs. Gore and Storrie by a member of the editorial staff of *Engineering News* during a visit to the plant in the latter part of August, 1916.

PRINCIPLE OF DRIFTING-SAND FILTER

Before describing the plant in detail, the design and operation of a typical working unit (Fig. 1) may be outlined. The object is to do away with precoagulation and to obviate the necessity for frequent shutdowns to wash the whole bed of filtering material.

The coagulant is introduced as the water goes to the filters. By causing the upper part of the sand bed to drift across the path of the raw influent water the bulk of the impurities are swept out, together with a part of the drifting sand—the latter being washed and returned by the constant circulation of the water and sand. The fixed lower portion of the sand bed takes out the remaining impurities. As often as local conditions demand, the whole bed is washed by a reverse flow of filtered and disinfected water.

The fine sand is 9 ft. deep, of rounded water-worn material. It has a maximum size of 1.2 mm., with 60% less than 0.7 and 10% less than 0.35 mm. Beneath the sand is a 9-in. layer of water-worn graded gravel, from 20 to 30 mm. in size. No screens are used between the gravel and the sand.

The coagulated raw water enters the filter partly by a standpipe at the center of the unit, passing up through a

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[1] See "Engineering News," June 25, 1914, p. 1446, for a account of the contract letting, and Apr. 8, 1915, p. 680, for a description of the demonstrating plant at Toronto and relate matters.

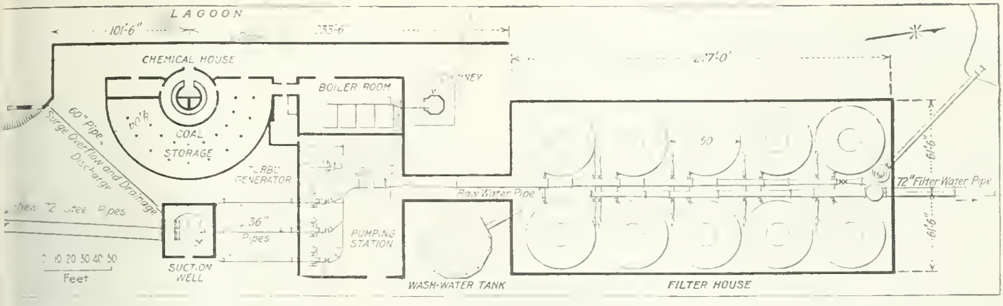

FIG. 3. LAYOUT OF TORONTO DRIFTING-SAND FILTRATION PLANT

parator or sand washer at the bottom, and delivers ove the sand at the top and partly through a bypass. ithin the sand washer the raw-water pipe is constricted e the tube of a venturi meter, and the drifting sand llected and washed in the separator is inducted into e raw water at the throat of the venturi tube. This nd passes up the standpipe with the water and is livered with it above the top of the sand already there. rming a volcano-like cone that continuously drifts away d is continuously being replaced, leaving a round-ped body of stationary sand below, resting upon the ered-water collecting system. The stationary sand s the final filtration. Its surface is more than twice plan area of the unit and economizes the plan area the filters. The drifting sand passes down all round boundary of the stationary sand to a slot and ultitely through converging ports to a system of outlets extractors and thence by pipes to a sand washer. re the sand falls to the bottom through a current of water and is picked up by the inductor. The dirty ter passes upward and out at the top by an outlet tably controlled. The sand traps are of such a form t the sand is kept out of the piping system except n the inductor is in full operation. That is to say, sand moves only when there is an abundance of ning water to carry it forward.

The question of sand scour is an important one. The form of the inductor is such that the sand enters the high-velocity water at the center of the stream and can only touch the sides of the pipe after the sand and water have been reduced to nonscouring velocities. The loss of head at the inductor is about 3½ ft., but a bypass is provided so that the induction may be varied either at will or automatically in such a way as to suit the amount of the impurities and of the coagulants in the water, it being understood that the greater the proportion of the total raw water flowing through the inductor the greater will be the rate of the drifting sand.

So much for the principle of the drifting sand. We now deal with its application to the Toronto plant, a general view of which is shown by Fig. 2, while Fig. 3 shows the layout of the plant.

The two 72-in. intake pipes from Lake Ontario enter a suction well provided with a surge overflow and with duplicate screens having an area of 360 sq.ft. of ¼-in. mesh copper wire. The coagulant in the form of a solution of about 5% strength of aluminum sulphate is added to the water in the suction well by means of a perforated pipe (Fig. 4).

Chemical House and Coal-Storage Bin

The chemical house and coal-storage bin (Fig. 4) are of reinforced concrete with a partial brick façade and are arranged in one group of buildings 120x80 ft. in order that the facilities for unloading and loading materials from the wharf shall be common to both. Storage for 1,500 tons of coal and 800 tons of aluminum sulphate, as well as a general store, are provided for.

The arrangements for the supply of aluminum sulphate to the water before filtration are novel. The underlying

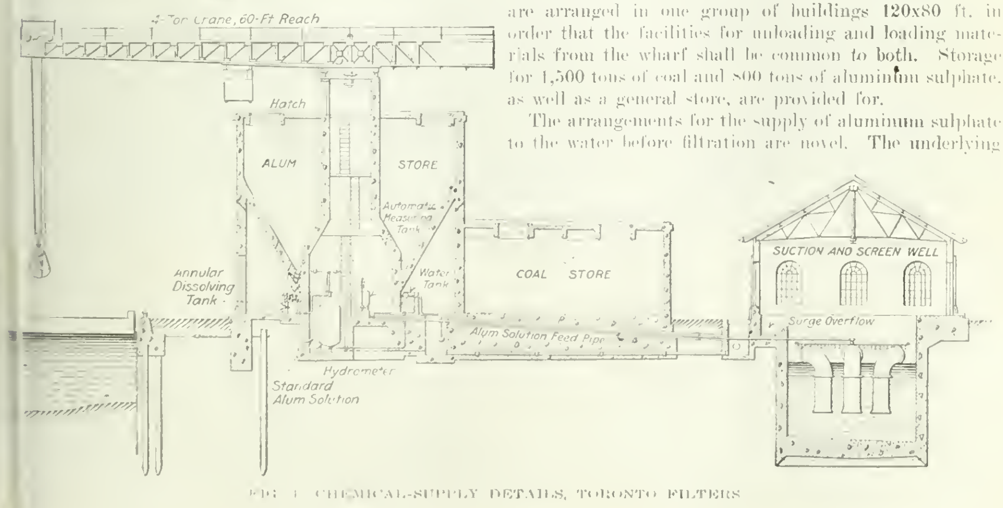

FIG. 4. CHEMICAL-SUPPLY DETAILS, TORONTO FILTERS

idea (Fig. 4) is to allow the dry chemical to feed down automatically from the storage bin through a number of control doors to a tray at midlevel in a dissolving channel maintained full of water. The solution formed may be of any strength in excess of 5%, and this solution is fed from the bottom of the dissolving channel into a dilution tank in which it is automatically diluted down to the standard 5% by a hydrometer-like arrangement. From this tank the standard solution is fed into a measuring tank controlled by the 72-in. venturi raw-water meter in the pumping station through a combined electric and hydraulic relay. From the bottom of the measuring tank the solution gravitates through lead pipes to the suction well and is there distributed over the water as previously described. The apparatus is in duplicate. In the section (Fig. 4) some of the parts have been displaced in order better to illustrate their working. The annular dissolving-channel tank is maintained full of filtered water by a float valve. From the water tank the water flows freely to the dissolving tank or channel and after dissolving the aluminum sulphate passes through a valve at the to of the hydrometer (hydrogravimetric balance). At tl same time the water also comes from the water tank a valve at the bottom of the hydrometer.

The hydrometer is poised in the solution between tl two valves. Any vertical movement of the hydromet opens one valve and closes the other. Thus it will let strong solutions at the top and water at the bottom unt the balance is obtained, when the hydrometer just floa in a solution containing 5% of alu inum sulphate. Any change from th strength causes the hydrometer to mo and close one valve and open tl other. It should be remembered th a 5% solution of aluminum sulphate about 2½% heavier than water, ar it is due to this fact that the appa atus works properly, not only from tl point of view of supplying the e ergy to move the hydrometer, but al to mix the diluting water with tl solution already in the chamber. Tl heavier liquid put in at the top ten to sink rapidly to the bottom, and the other hand the lighter liquid f in at the bottom tends to rise rapid to the top; thus the liquid is mai tained in a rapid state of circulatio A beam with knife-edges above tl hydrometer provides for permane adjustment and also for working wit any desired density of solution. The is a scale with divisions for each 0. grain of coagulant per gallon of ra water, so that by simply moving weight along a beam any desire amount of aluminum sulphate may l added to the water. The standard solu tion passes freely to the measuring tan and away to the suction well. F every rate of water passing throug the raw-water meter there is a corr sponding position for the hydrauli piston and gaging slot in the measurin tank. The filters are 10 in numbe placed in two rows (Fig. 3), leaving wide space between for the main pipe below and for the operating floor abov Each filter tank (Figs. 5, 6 and 7) i of steel, 14 ft. high and 50 ft. in diam eter, divided into 30 units similar i every way to the unit shown by Fig 1. These units are nested together i two rings of 18 and 12 respectively leaving a space at the center 16⅔ ft. in diameter, i which is placed the raw-water control balance.

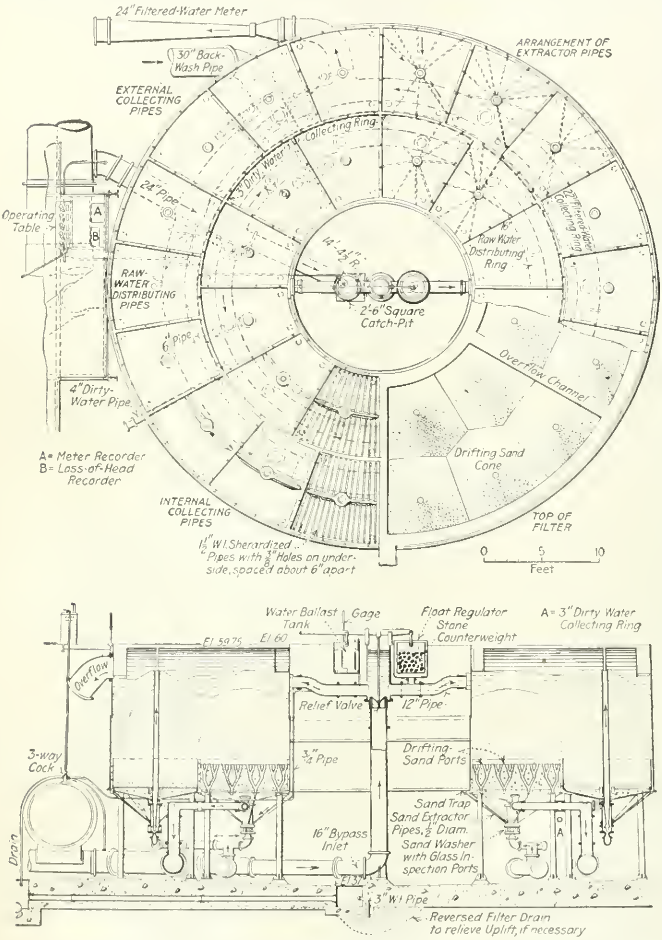

FIG. 5. DETAILS OF DRIFTING-SAND FILTER AT VARIOUS HORIZONTAL AND VERTICAL PLANES

The combined horizontal sand area of the 10 filters i 17,450 sq.ft., but the effective final filter area, or th area of the 30 conically or rounded tops of the stationary sand, is 35,000 sq.ft., or 0.8 acre. The stationary-san cones have a slope of about 64° with the horizontal plane The drifting-sand cones slope about 32°. The averag total depth of sand in a filter is 9 ft.; minimum dept of stationary sand, 2 ft. 2 in.; and of drifting sand, 2 ft 6 in. The total sand volume per filter is 600 cu.yd.

The loss of head in the sand washers is 3½ ft. and in the sand 10½ ft., or a total of 14 ft. The raw water that escapes from the sand washers as dirty washed water is 2% of the water filtered.

It is expected that the whole bed of sand will have to be backwashed once in 10 days. This will be done with filtered and disinfected water from a 200,000-gal. (Imp.) wash-water tank of steel 60 ft. above the ground surface and 45 ft. above the surface level of the filters. Half the ontents of the tank will be discharged at a gradually increasing rate in 10 min. and half at the maximum ate in 5 min., the maximum vertical rise through the ilter being 2 ft. per min. The wash water will pass hrough a measuring tank to lagoons, where the spent ydrate of alumina will be settled out.

The raw water enters each filter partly through the and washers and partly through a bypass, controlled by loaded valve. By means of this raw-water control alance, the rate of flow through the sand washers and hus the drift of the sand may be increased or decreased nd the rate of direct admission of raw water be changed.

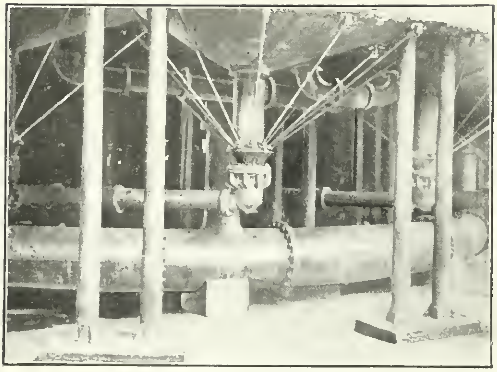

FIG. 7. SAND TRAPS, EXTRACTOR PIPES AND WASHERS

The small inclined pipes lead from the sand traps to the sand washer, which extends up through the bottom of the tank. There are 264 traps and sand pipes and 30 washers to each of the 10 filters

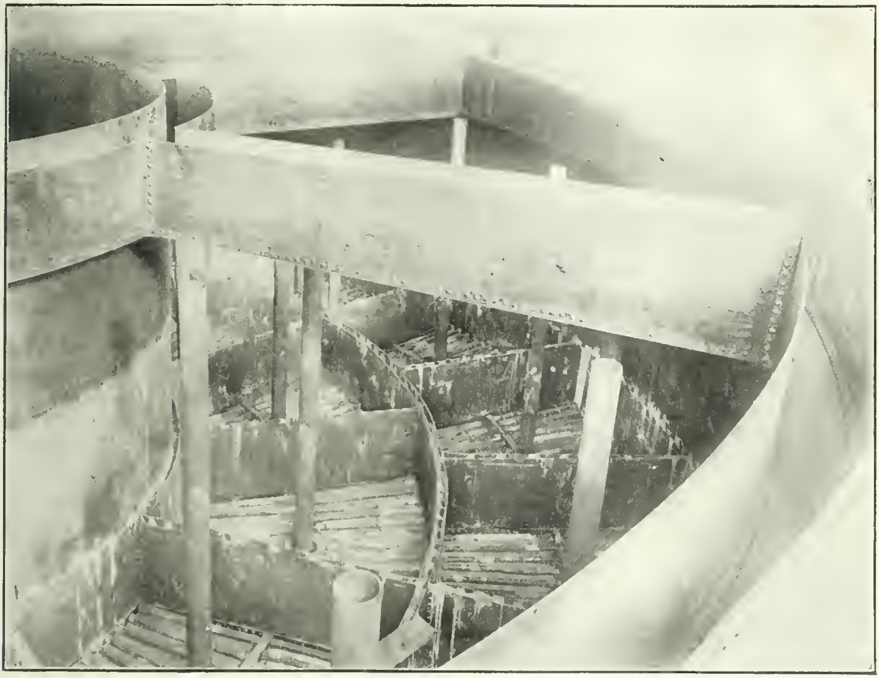

FIG. 6. INTERIOR OF TORONTO FILTER HOUSE, SHOWING A TANK READY FOR GRAVEL AND SAND

Filtered water collection and reverse-flow wash-water system in bottom and standpipe for raw water and washed and in center of each unit. Sand-extracting ports are placed in the radial and annular walls. Backwash overflow channels bove

The filter underdrains and wash-water pipes are of -in. sherardized steel, 6 in. c. to c., perforated with -in. holes also 6 in. c. to c. There are 771 pipes and 92 holes to each filter.

The pumps are all electrically driven. Three 36,000,-)-gal. pumps with 32-ft. lift supply the filters, besides ich there are a 2,000,000-gal. auxiliary pump with ft. lift, two 500,000-gal. backwash tank pumps with)-ft. lift, two 1,000,000-gal. drainage pumps with 20-ft. lift and two hydraulic pressure pumps with a capacity of 8,640 gal. a day under 700 lb. per sq.in. All the pump capacities are in Imperial gallons. The discharge of the main pumps is controlled automatically by the level of the water in the filter tanks, through pilot valves operating hydraulic valves on the discharge of the pumps.

The electric current is supplied either by purchase from the Toronto hydroelectric system (from Niagara Falls) or from a steam turbo-generator at the filter plant.

The contract requires that the filtration plant shall remove 90% of all organisms where there are 50 to 500 bacteria per cubic centimeter in the unfiltered water; 95% where there are 500 to 2,000; and 98% where there are 2,000 or more in the unfiltered water. The plant must also remove 98% of the *B. coli* as determined by the standard methods of the American Public Health Association.

All turbidity must be removed, leaving a bright, colorless water free from taste. Such results must be obtained by the use of not more than one grain of alum per Imperial gallon of water under average conditions.

At the time tenders were received an alternative design was submitted for the filters being built of reinforced concrete. Such a design shows economy of space and construction cost, but for local reasons the steel design was preferred and adopted.

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New England Water-Works Men Do Things at Portland

All things good joined in making a success of the thirty-fifth annual convention of the New England Water-Works Association at Portland, Maine, last week. Business proceedings, excursions on Casco Bay and on Lake Sebago, a clambake, a recital on the great municipal organ in the City Hall resulted in a happy combination of work and play, while the large exhibit of water-works appliances, in charge of genial associate members, was always at hand for a tour of inspection and enlightenment.

A new feature was a water registrar's session at which several papers on accounting and meter records were presented. Two superintendents' sessions were held.

A feature of the opening session was an address by Rear Admiral R. E. Peary, who plead for 16 new fast first-class battleships, an aeronautic department with a place in the Cabinet for its head, and universal military training. Local addresses of welcome were also made at the opening session. In addition, Charles W. Sherman presented the report of the Dexter Brackett Memorial Committee. This committee has raised about $1,200, of which $1,000 had been expended for a medal. (See *Engineering News*, Sept. 7, 1916, p. 478.) The Association adopted rules suggested by the committee, which provided for awarding the medal annually to the author of the best paper presented to the association during the year.

Water-Supplies Described

The water-supply system of Portland, consisting of gravity conduits from Lake Sebago, was described by David E. Moulton, and the history and general scheme of the Maine water districts was outlined by Harvey D. Eaton, of Waterville. A constitutional municipal debt limit established in 1877 was largely responsible for private ownership of all but two of the water-works built in Maine for many years. To get around the debt limit, water districts have been created, consisting of two or more municipalities. Many privately-owned works have been acquired by these districts, but the publicly-owned works are still in the minority.

The new water-supply for Anson and Madison, Maine, is a modification of the district plan, in that the supply main is under joint ownership and the distribution systems under independent town ownership. The new main, divided between wood and cast iron, was described by L. L. Wadsworth, President of the Hanscom Construction Co. Owing to the high cost and poor quality of labor, a gasoline-driven trenching machine and a drag scraper were used for trenching and backfilling. Where quicksand was encountered it was considered cheaper to remove the material that slid in than to sheet the trench.

Service Pipe Materials and Methods

The Water Service Committee of the Association submitted a preliminary report through the chairman, William S. Johnson, of Boston.

As usual, the mere mention of water services gave rise to animated discussion. Desmond FitzGerald said he had a cement-lined wrought-iron service in continuous and satisfactory use for 35 years. F. N. Speller, of the National Tube Co., and James Aston, of the A. M. Byers Co., had a tilt over the relative lasting qualities of steel and wrought-iron pipe, each making a good case from his own viewpoint. Patrick Gear, of Holyoke, remarked in his usual mirth-provoking manner that every superintendents' day some one butts in—if not a fire-insurance man, then a young fellow who wants to sell pipe. He suggested that the superintendents be given the right of way. A. A. Reimer, of East Orange, N. J., urged flexible rather than rigid connections between services and mains and said that his own men, not highly skilled, made wiped joints that gave satisfaction. W. C. Hawley, of Wilkinsburg, Penn., had given up wiped joints for commercial couplings.

Leakage in Pipe Joints

Speaking for himself alone, F. A. Barbour, of the Committee on Leakage from Pipe Joints, summarized replies to a questionnaire. He first emphasized the lack of coöperation evidenced by the receipt of only a hundred replies or so to questions sent to some five hundred water-works men—and many of the replies gave but little information. Even where all or nearly all the services are metered, 20% of the water distributed is not paid for. It is an open question whether this is due to main and service leaks or to meter slip. It is gratifying to note that the general practice reported is to test new mains before backfilling and to require almost absolute tightness. The reports received indicate that meters are the great factor in conserving water and leakage a relatively minor matter, but there are cases of heavy leakage. Leakage surveys are needed. It was voted to have Mr. Barbour's paper sent to all the members and made the subject of discussion at a later date.

Breaks in Water Mains and Their Repair

Seventeen years' experience with breaks in the trunk mains of the Boston Metropolitan Water-Works was reviewed by S. E. Killam, superintendent of pipe lines and reservoirs. There have been 25 breaks in this period, fairly well distributed by years. Of these, 18 were probably due to slight settlements of cast-iron pipes onto rigid supports. Allowance for settlement should be made and care should be taken not to have solid matter for the pipe to settle onto.

The make-up, equipment and work of emergency repair gangs were described by George H. Finneran, general foreman water service, Boston. The gang is divided into three 8-hr. shifts, provided with a motor car, which can carry 14 men when necessary, besides required tools. The ar is equipped with a gate-closing attachment, driven y the car mechanism. The emergency gang generally reports at all large fires, so as to be ready in case of need.

Grading Water-Works for Fire Protection

The committee on this subject (through Charles W. herman) reported for discussion but not for adoption s yet a grading schedule proposed by the National Board f Fire Underwriters, after study by their engineers. he scheme assigns cities or towns to ten classes, according to the number of deficiency points shown after local vestigation. The Committee has conferred with George . Booth, chief engineer, and Clarence Goldsmith, principal assistant, representing the Underwriters, who have greed to some modifications. Two notable outstanding ifferences are that the proposed Underwriters' schedule signs no penalty for overlarge fire service connections d penalizes 4-in. fire hydrants under all conditions. In scussing the report, R. E. Thomas, of Lowell, Mass., id that on the recommendations of the Underwriters, owell has spent $300,000 in water-works improvements. stead of getting fire-insurance rates reduced they have en increased—an experience common to other Massausetts cities. This, Mr. Thomas thought, is not due to e National Board of Underwriters, but rather to secnal boards in direct charge of rate fixing, not in touch th the water-works side of the matter, as are the engiers connected with the Underwriters. Further discusn indicated that the failure to secure lower rates after ter-works improvements urged by the Underwriters ve been effected is at least in part due to the bad build- laws and risks so prevalent in many cities.

Mr. Booth explained that only recently has a start been de toward classifying fire losses in such a way as to e a working basis for reducing rates as local improvents of one kind or another are made.

Accounting and Records Practice

A classified cash book was described by A. L. Sawyer, istrar of Haverill, Mass., who also exhibited the first h book of the Haverill Water Co., considerably over a dred years old. A. W. F. Brown, superintendent, chburg, Mass., showed a three-card meter-record scheme ich has been found to serve the needs of that city. A f paper on water-works accounting was read by E. L. de, public accountant, Boston. Besides advocating unim accounts, the author spoke for a 2% depreciation rge against income, the proceeds to be used to keep works in shape. In reply to criticisms of a flat rate, ardless of all local conditions, Mr. Pride explained that seemed more likely than any other plan to secure formity. A motion to appoint a committee on acnting led to mention of conferences under the auspices the Bureau of the Census, some years ago, and a gthy report submitted to the American Water-Works ociation. It was finally voted to appoint an accounting mittee, which should consider previous studies of the ject by the other associations, the Bureau of the sus and various utility commissions.

rguments in favor of the appointment of a committee standard specifications for water meters were made by J. Thomas, superintendent, Lowell, Mass. It was d that such a committee be created and that it work uniformity in parts and names of parts. Mr. Thomas as one reason for carefully drawn uniform specifications the fact that many cities and towns are compelled by law to advertise for bids and award the contract to the lowest bidder. Where the acceptance of the lowest bid is compulsory there is need for rigid specifications.

Other Papers and Business Matters

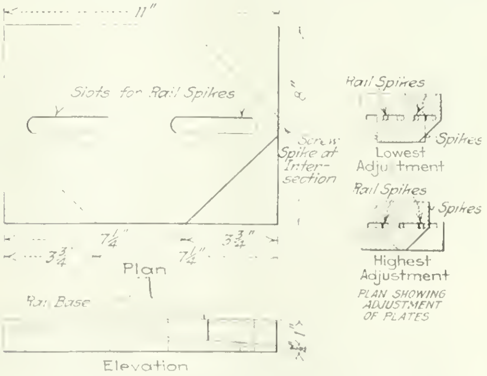
A description of the intermittent use of an excess of coagulant before slow sand filtration at Springfield, Mass., was submitted by E. E. Lochridge, of that city. A general review of the sanitary phases of the public water supplies of New Hampshire was presented by C. D. Howard, chemist State Board of Health. Of the 8 filter plants in the state, 6 use chlorination. Informal remarks on public utility commissions were made by a member of the Maine Commission. He said that such commissions, the utilities regulated and the public should consider themselves as partners. He outlined the need of control of water pollution in Maine in such a way as to suggest that the state is backward in the matter.

During the convention 52 new members were elected. This brings the membership to about 1,050, of which it is said that 150 have been secured this year.

Wedge Tie-Plates for Track Under Turntables

Wedge-shaped tie-plates which permit variation both of the position and of the level of the rail are used to carry the pit rail for the new 100-ft. turntables of the Atchison, Topeka & Santa Fe Ry. The track consists of 90-lb. rails on creosoted ties $5\frac{3}{4}$x8-in., 36 in. long, laid radially on a concrete wall around the bottom of the pit. On each tie there is a pair of the wedge-shaped plates 8x11 in., having a thickness of $\frac{1}{4}$ in. at one end and 1 in. at the other end. By driving the upper plate forward or back (at right angles to the rail) the thickness may be varied from a minimum of $1\frac{1}{16}$ in. to a maximum of $1\frac{7}{16}$ in.

The tie-plates are made of both rolled steel and malleable cast iron. The latter cost less and have proved satisfactory. The plates are six-sided in plan and have slots for the rail spikes. When adjusted to the required elevation they are secured by a pair of screw spikes against their ends. These tie-plates were devised by A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Santa Fe Ry., in connection with some new turntables.



TIE-PLATES FOR ADJUSTING TURNTABLE TRACKS

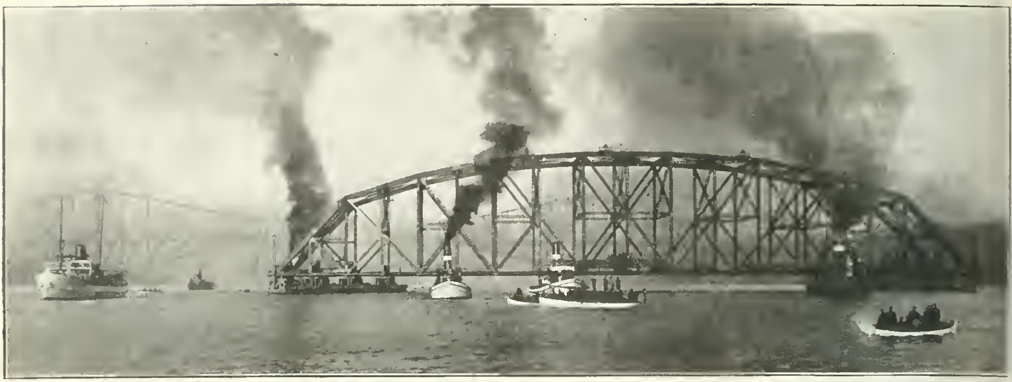


FIG. 1. AFTER DAWN ON THE MORNING OF MONDAY, SEPT. 11, 1916. THE SPAN BEING FLOATED TO PLACE

The Full Evidence on the Fall of the Quebec Bridge Span

The Inexplicable Accident Fully Cleared Up—A Complete and Accurate Account of the Events Which Occurred from Instant to Instant; with Insert Sheet Presenting a Graphic Record of All the Evidence Left Concerning the Mishap to the Suspended Span

Investigation has revealed a complete and exact record of how and why the Quebec Bridge suspended span fell from its supports on Sept. 11. This record, affording a remarkable picture of the whole mechanism of failure, is found in the condition of parts left at the truss seats on the lifting girders. It seemed at first, immediately after the span disappeared, that no structural evidence could possibly be left to give a clue to what happened. Later, examination of the lifting equipment showed numerous significant injuries and marks, and when the investigation got down to a detail study of the four supporting chairs or "lifting girders," the full story was obtained of what happened in the few seconds from the time the span first started until it had pulled loose from the last support.

A scrupulously detailed sketch memorandum of the examination of the lifting girders was made by *Engineering News*. With the consent of the engineers of the Board and officials of the St. Lawrence Bridge Co., whose observations and findings are in entire agreement with it, this record is here presented. Through excellent work done by the St. Lawrence Bridge Co.'s staff photographer, E. M. Finn, under difficult conditions, it has been possible to illustrate this sketch memorandum in most striking manner by a series of plan and elevation photographs, amplifying and explaining the sketches

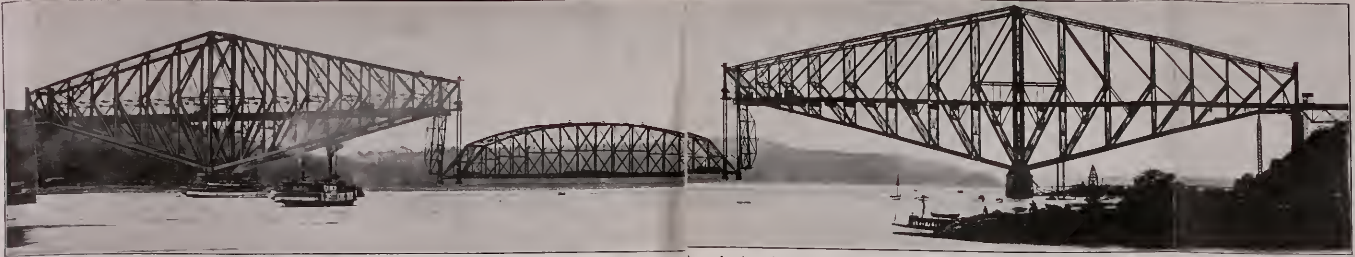
What the record of the lifting-girder conditions tells—so soon as the language that it speaks is understood—is that the bridge first smashed down through the southwest supporting rocker and then skidded diagonally off this seat as the hanger was kicked back southwesterly, and that subsequently at the three other supports it twisted or pulled away. The remarkable photograph shown on our insert sheet, of the bridge while on its way to the water, is in perfect agreement with the story told by the lifting-girder conditions, and makes it certain that this story is not falsified by any incidental subsidiary effects.

The work of making minute examination of the stru ture to detect any evidence of cause was started within few hours after the collapse. Engineers of the St Lawrence Bridge Co. and outside engineers retained b them, as well as members of the Board of Engineers, too part in these examinations. On invitation a completel separate survey of the conditions was made by one of th editors of *Engineering News*. The St. Lawrence Brid Co. facilitated this examination in every possible man ner, providing equipment needed for lowering over th ends of the cantilevers and giving assistance as aske Largely through this ready accommodation, it is possib to present the results of this examination in the complet and graphic form presented by the insert sheet of th issue. The results given by this sheet have been subject to careful check and are known to be correct.

Condition of Hangers

Before examining the exhibits of the condition of t lifting equipment, it is necessary to have well in mi how the span was supported on the lifting girders acro the end of each pair of chains. Briefly, on the top of t girder there was a steel shoe casting with a longitudin pin groove, carrying a 9½x16½-in. pin parallel to th line of the bridge. On this pin was seated the suspecte steel rocker casting, which in turn carried a short tra verse pin, 8x26¾ in. The upper shoe, attached to th base of the end post of the span, rested on this trans e pin.

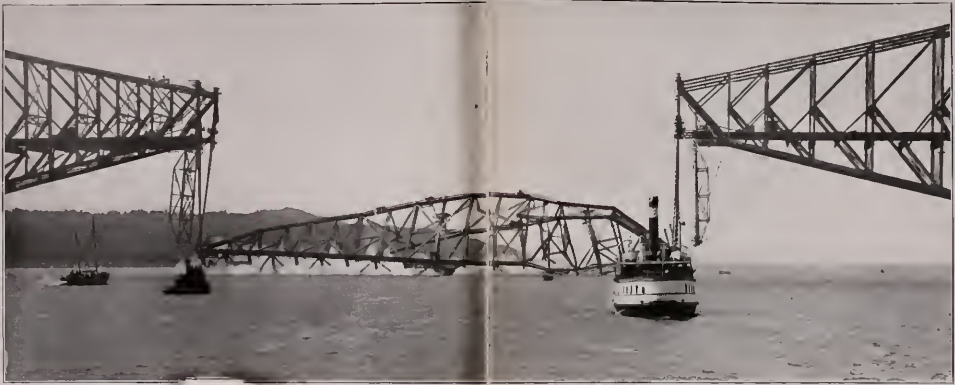
This detail served as the universal joint needed dur the five weeks that the suspended span stood on its supports at Sillery, awaiting the day of floating a hoisting. When the span finally was supported by th scows, the lifting girder was no longer supported fro below, and therefore was hung by a pair of bridles fro the upper shoe. To keep the castings in proper cent bearing when the hangers picked up the lifting girde



The span linked to the chains and raised clear of the scows, completing the last hazardous operation in the construction of the bridge.

The view of the fall shows the southwest corner of the span well under water, and the other four corners still on the hanging chairs. The southwest hanger has been kicked back.

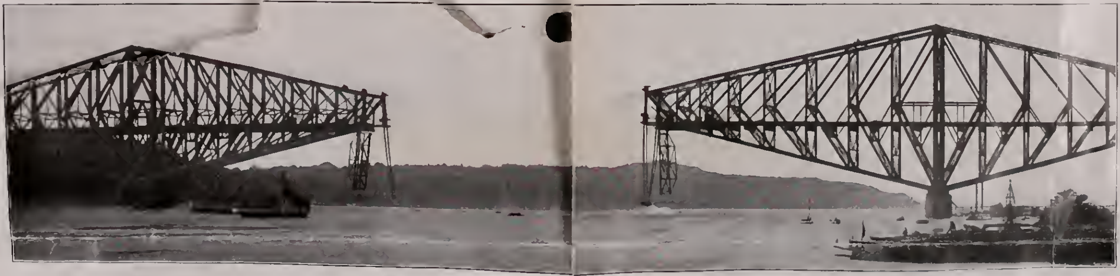
The south end of the span has rotated westward about the southeast seat. The top lateral system has failed except at the north end. The span portals have retained their shape.



The upper and lower views were taken only a few moments apart. The boats are in nearly the same position. The suspended span went down in the meantime. The broken water in the wake of the span's plunge is still visible in the lower view. Note the violent swinging of the hangers, the south (left) hangers in opposite phase. The splash at the right is falling wreckage from aloft.

C[illegible] by Interna[illegible] Service Co.

The falling span snapped by a lucky newspaper man—a moment before the southeast corner of the span tore loose from its seat.



A few seconds after the fall

Quebec Bridge Suspended Span Being Lifted, Sept. 11, 1916. Its Fall. The Tell-tale Marks Left on the Truss Seats Recorded by Photographs and Sketch Diagram.

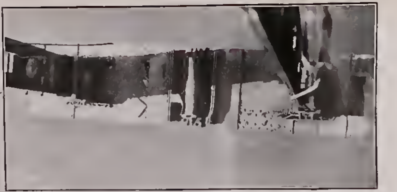
oth north seats show movement straight forward toward idspan. After both south ends were in the water, the orth ends of the span slipped off their rockers, once the ower end portal strut was torn past the inner hanger chains.

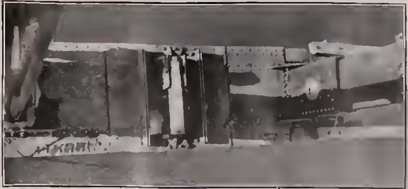
The lifting girders were tipped forward by the pressure of the end strut against the back of the inner hanger chain and the corresponding backward reaction of the shoe. The rear upper tie-plates of the box hangers are bent back.

A few seconds after the fall

Quebec Bridge Suspended Span Being Lifted, Sept. 11, 1916. Its Fall. The Tell-tale Marks Left on the Truss Seats Recorded by Photographs and Sketch Diagram.

Both north seats show movement straight forward toward midspan. After both south ends were in the water, the north ends of the span slipped off their rockers, once the lower end portal strut was torn past the inner hanger chains.





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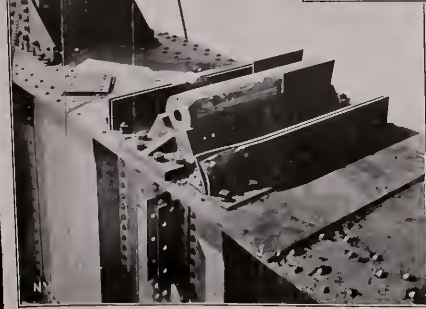
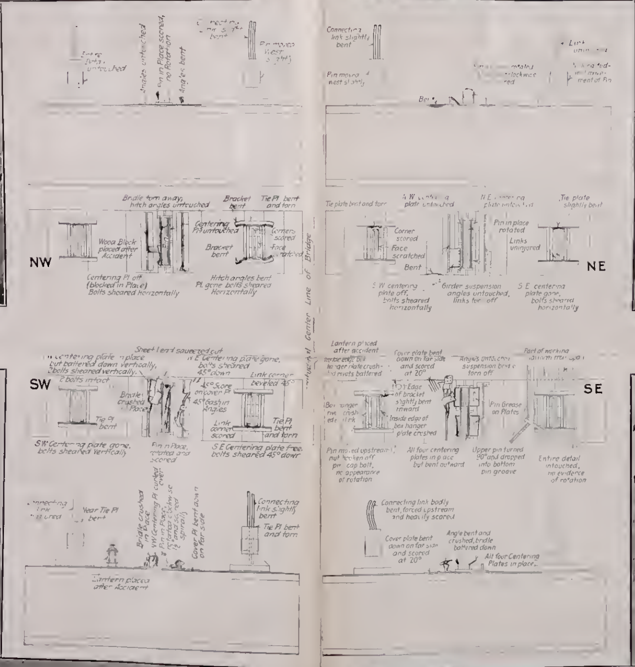
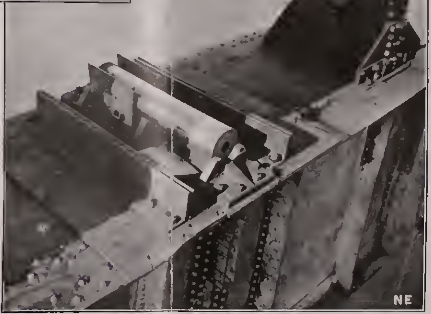
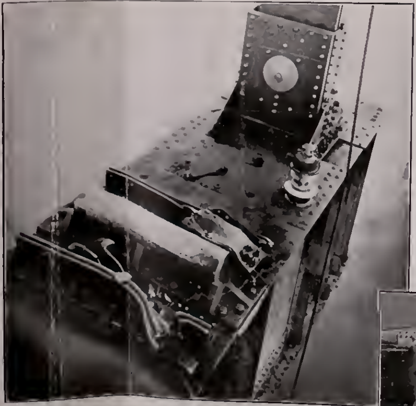




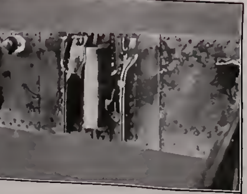
NW
NE
SW
SE
Center Line of Bridge
Bridle torn away, hitch angles untouched
Bracket bent
Tie Pl bent and torn
Centering Pl's untouched
Corners scored
Face scratched
Wood Block placed after Accident
Bracket bent
Centering Pl off (blocked in Place) Bolts sheared Horizontally
Hitch angles bent Pl. gone bolts sheared Horizontally
Tie plate bent and torn
Tie plate slightly bent
Corner scored
Face scratched
Bent
Pin in place rotated
Links uninjured
S W centering plate off, bolts sheared horizontally
Girder suspension angles untouched, links torn off
S E centering plate gone, bolts sheared horizontally
Sheet lead squeezed out
Centering plate in place but battered down vertically, 2 bolts sheared vertically.
2 bolts intact
N E Centering plate gone, bolts sheared 45° down
Link corner beveled 45°
45° Score on cover Pl
45° Gash in Angles
Bridle crushed in Place
Tie Pl bent
Link corner scored
Tie Pl bent and torn
SW Centering plate gone, bolts sheared Vertically
Pin in Place, rotated and scored
S E Centering plate free, bolts sheared 45° down
Near Tie Pl bent
Bridle crushed in Place
Cover Pl bent down on far side
Connecting link slightly bent
Tie Pl bent and torn
Lantern placed after Accident
Lantern placed after accident
Cover plate bent down on far side and scored at 20°
Part of working
Edge of bracket slightly bent inward
Inside edge of box hanger plate crushed
Pin Grease on Plates
Pin moved upstream, nut broken off pin cap bolt, no appearance of rotation
All four centering plates in place but bent outward
Upper pin turned 90° and dropped into bottom pin groove
Entire detail untouched, no evidence of rotation
Connecting link badly bent, forced upstream and heavily scored
Cover plate bent down on far side and scored at 20°
Angle bent and crushed, bridle battered down
All four Centering Plates in place
Connecting link slightly bent
Pin moved west slightly

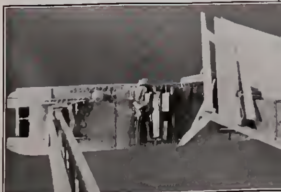


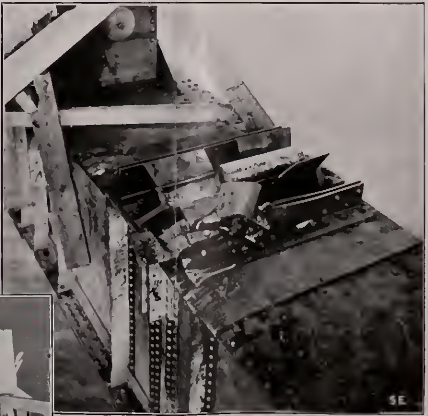


The rocker casting at the southwest hanger broke, dropped this corner of span and started the fall of the span. The truss corner barely grazed the girder.

Photographs by E. M. Finn, staff photographer of St. Lawrence Bridge Co.



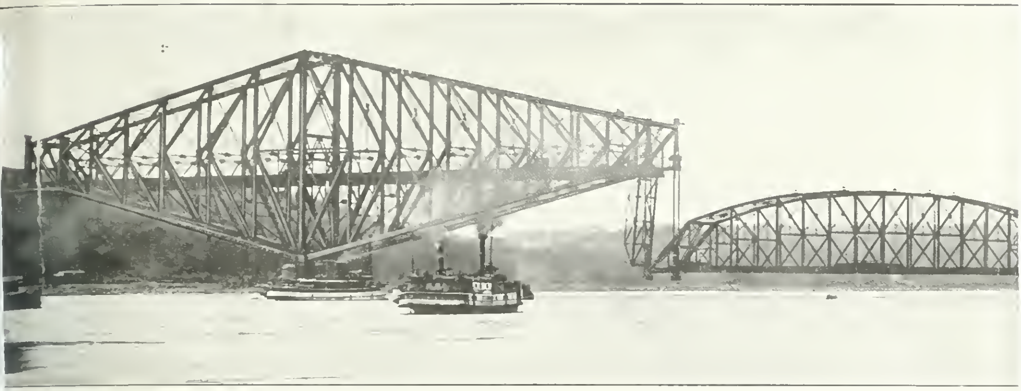




The south end of the east truss was turned to horizontal by the fall of the southwest corner; the rocker canted, leaving the centering plates in place.

Diagram sketched by Engineering News and checked by S. P. Mitchell

Supplement to Engineering News, September 21, 1916. Vol. 76 No. 12.



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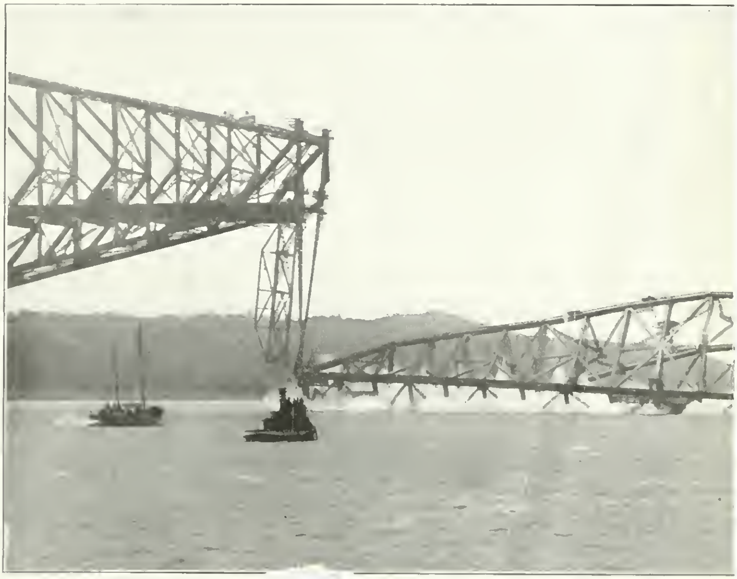

The falling span snap [illegible] newspaper man a moment

four centering plates were bolted to the bottom casting and carefully fitted (in the shop before erection of the span) into the inner corners of the cruciform rocker, and matchmarked. Placing these centering plates was one of the last jobs before the span was towed out. They were inspected by Mr. Porter, the engineer of construction, and Mr. Mitchell, the consulting engineer of erection.

For an appreciation of the condition of the hangers after the accident, it is necessary to remember that the two double hanger chains coming down to each corner of the span were made up of heavy slabs (as noted in detail in *Engineering News*, Aug. 31, 1916), ending in a slotted bottom link and below this a connecting link pinned into a box-girder hanger built into the lifting girder.

Evidence from Condition of Southwest Hanger

Descending the southwest hanger, the condition of the top of the lifting girder was as noted in the insert plate of sketches and photographs. The most prominent thing observed was that, of the four centering plates, the northwest plate was in place but crushed down vertically with two of its bolts sheared off vertically and two intact. Alongside of it was the girder suspension bridle, in place, also crushed vertically. The southwest centering plate was missing, but its bolts had been sheared off vertically, also indicating the descent of some vertical load upon it. Probably both northwest and southwest plates were crushed down by the same action, and their different behavior is due to incidental effects.

The presence and condition of these two centering plates really is the key to the whole evidence on this hanger. It proves that there could have been no departure from normal conditions up to the moment some vertical blow was delivered to the west centering plates of the southwest hanger. These plates are the only points on any of the hangers where direct vertical action is indicated—all else shows a combination of turning, twisting and sliding. The vertical injury to these two plates must have preceded all other effects noted elsewhere.

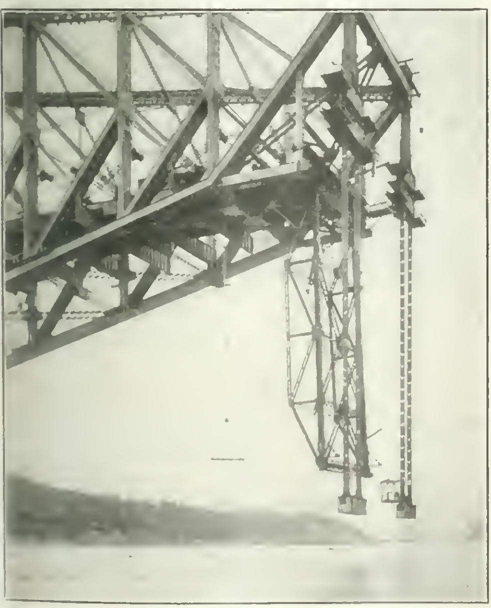

FIG. 2. NORTH HANGERS AFTER FALL OF SPAN
Showing cage used in reaching lifting girders

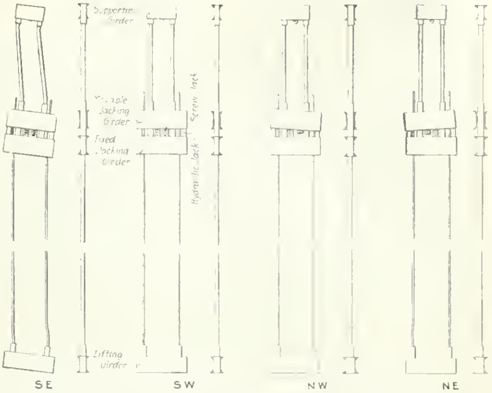

FIG. 3. DIAGRAM SHOWING HANGERS AFTER ACCIDENT

On all hangers the screw jacks were being run up as the hydraulic-jack plungers were coming down. But on the north side jacks—due to the shock or to the screw operators' grasping the handles—one of each pair of screws spun up and allowed the top jacking girder to settle out of parallel with the lower one

The other two centering plates at this hanger showed the bolts sheared downward and forward (i.e., toward the suspended span) at 15°; the southeast centering plate was free and the northeast one was missing. These conditions indicate backward movement of the girder occurring on the east side of the pin simultaneously with the dropping of the truss shoe.

The lower pin was in place, but rotated eastward on top 1½ in. and scored spirally, indicating backward movement of the girder and crosswise movement of some superimposed burden. The east bridle hitch angles close by showed a deep 15° gash, indicating the same movement as shown by the pin.

The south tie plates on both the box hangers were found bent by contact against the connecting link of the hanger chain, the easterly one being the more damaged. These bent plates indicate positively a strong rotation of the lifting girder. The inner (east) chain shows a scored edge, which can be explained by the chain's shearing through the bottom end strut between trusses. This end strut consisted of two ribs each made up of a 54x⅝-in. plate and two 6x6x⅝-in. angles, and the inner chain passed through between the two ribs; before the span could separate from the lifting girder or hanger chains, the inner chain had to tear its way out through one rib of the end strut.

How the Wreck Started

The earlier steps of the accident are made apparent by the just-described conditions at the southwest hanger. Something must have broken in the northeast quarter of the shoe detail. It could have been only the intermediate or rocker casting (see sketch Fig. 5 and view Fig. 4). The fracture most probably occurred near the root of the front lower pin-bracket of this rocker, putting the bearing on the lower pin out of service; and in all likelihood

The fracture entered the upper pin seat and one of the upper brackets also.

Concentration of the enormous 1,200-ton load on the fracture edges must have caused crushing, tipping of what was left of the rocker, and some backward movement of the lower shoe and lifting girder.

It was incidental to this quickly-passed stage of the catastrophe that the westerly fragment of the rocker bore down on the two west centering plates, curling one of them over and forcing the other off by downward shear. In the same action, however, the fragments of the broken rocker were ejected from between its two pins like a smooth wet orangeseed, and, the impulse kicking back the entire swinging girder, the corner of the span fell free, only grazing the pin and the girder cover-plate as it went off.

These events, written in the markings on the southwest girder, make all the other actions subsidiary. And, indeed, the examination of the other three hangers shows the very actions there that must follow from the starting of the fall as just sketched.

The Southeast Hanger

Some parts of the southeast hanger were severely punished, while others escaped very easily. Some 8 ft. above the girder top the inner hanger chain was badly bent, forced to the west, and heavily scored. The pressure accompanying the movement at this point is indicated by signs of high local heating of the steel in the score marks on the inner hanger chain.

The pin in the box hanger was moved west 1 in., but showed no signs of rotation. The top inside edge of the west plate of the west box hanger was crushed, and the box rivets were forced into the link. The south bracket at this box hanger was untouched, and the north bracket had its east edge only slightly bent inward. The corresponding detail at the east box hanger is entirely untouched.

Looking at the lower shoe detail, it is seen first that all four of the centering plates are in place and bent outward. On both the east plates are found large splashes of pin grease, and the direction of these splashes indicates that some turning of the rocker casting must have neatly spooned the lower pin out of its pocket. The turning of the casting undoubtedly bent down the westerly plates, and the pin forced over the easterly pair. Remarkable to record, the upper pin lies in the lower pin bearing; to drop into this position it must have turned 90° from its original direction. The crushed and bent-in west bridle hitch angles and bridle are further evidence of this action. The bent and scored edge of the girder cover plate nearby marks the final path of the edge of the truss end post as it left the lifting girder.

What happened at the southeast hanger is easily understood. The photograph of the falling bridge gives a perfect picture of the action, the same as read out of the conditions of damage. The overturning west truss, through the action of the portal and top laterals, twisted the end post of the east truss to the westward and down. The bottom end strut, already torn loose from the west truss when that ripped through the hanger chain, offered no resistance to the tipping movement. The truss was tilting on its lower rocker pin at the start, and after reaching the limit of the rocker's turning freedom it canted and slid on the transverse pin, forced the rocker out backward and eastward, and dropped the upper pin, now vertical, into the lower shoe, where it dropped into the bearing. The end post now was on the point of slipping off, having in the meantime banged heavily against the inside face of the west hanger; it dropped to the river, hardly touching the top of the lifting girder. The blow from the end post, possibly supplemented by downward pressure from the end strut, tilted the whole girder series of the hanger about the longitudinal supporting pin on top of the upper chord of the cantilever arm. But there was no rotation about an east-west axis; the eas truss tipped purely westward, remaining a span betwee its two end bearings until the moment it slipped off th southeast bearing.

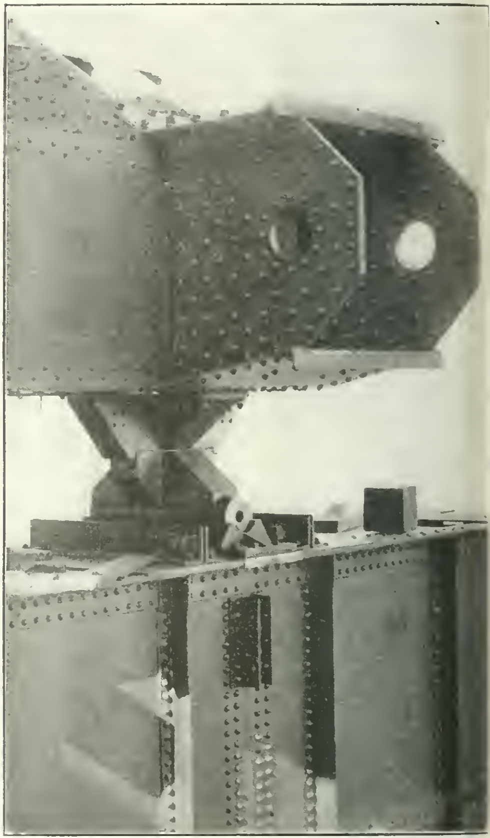

FIG. 4. VIEW OF ROCKER IN PLACE

At Sillery, on falsework; incomplete. The bridles an centering plates are missing, and the box hanger and connecting link as well as the permanent hangers are not yet i place

Condition of the Two North Hangers

Almost identical pictures were presented by the northwest and northeast hangers: Lower pin in place, apparently not rotated, its top half wiped clean of grease; rear (north) centering plates in place untouched; front centering plates gone or at least torn loose, and showing horizontal shearing of the bolts; and practically no other damage except to the respective inner hanger chains, which had to tear out through the end strut. The movement of the north end of the span was evidently straight forward, in the direction of midspan. As might be expected, both lifting girders tipped forward during the fall; the northeast one shows the strongest evidence of tipping.

The north mooring span was appreciably warped; the lower end was rotated clockwise, probably from the sequence in which the four mooring lines parted. This damage appears to have no relation to the other evidence or to the cause of the fall.

At the northwest hanger, the two forward centering plates were gone. The bridles were gone; the east bridle hitch angles had the south end bent inward slightly. The west hanger chain was untouched. At the east chain the connecting link was slightly bent to the west, and the pin through the box hanger was moved a bit to the west. The edges of the bracket plates on this box hanger showed some damage. The upper edges of the rear tie-plates on oth box hangers had come into contact with the link, howing rotation. The rocker pin had longitudinal ratches and its front end was scored.

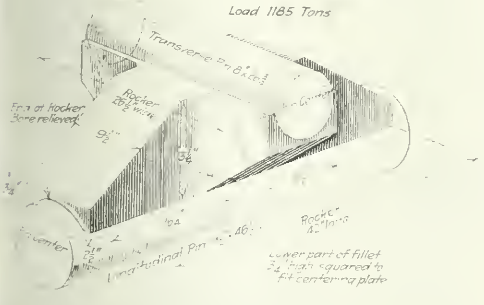
Load 1185 Tons
Transverse Pin 8" x 26 3/4
Rocker 26 1/2" wide
Fin at Rocker Bore relieved
9 1/2"
3 1/4"
3/4"
Center
2 1/2"
Longitudinal Pin
46"
Rocker 42" long
Lower part of fillet 3/4" high squared to fit centering plate
Center

FIG. 5. SKETCH SHOWING DIMENSIONS OF ROCKER
Low-carbon steel casting

On the northeast lifting girder the southeast centering late was gone, and the southwest plate off but lying earby. The cover plate of the girder showed a small end at its front edge. The east hanger chain was unamaged except for slight bending of the rear tie-plate f the box hanger, which had come into contact with the onnecting link by rotation of the girder. The west hain showed the same effect more strongly, the tie-plate eing bent and torn; here the outer rear corners of the onnecting link were scored. The link also had a bend the west, and the pin through link and box hanger was ushed westward a trifle.

he Fall of the Span a Simple Sequel to Failure at the Southwest Support

The above description of conditions tells its story fully. hen the southwest support moved away from under the an, the long and heavy 610-ft. span could not maintain integrity; its laterals, sways and portals were incapable holding it together when resting on only three supports. That the span kept up its integral action long enough complete failure of the south end to precede the ll of the north end, however, is excellent testimony to good construction. In this respect the photograph of e falling mass and the investigational evidence are in ost perfect accord. The photograph caught the moment st preceding the dropping of the southeast corner, and it shows the north end still maintaining full alignment and verticality although both trusses are practically horizontal at their south end and the lateral system is completely wrecked.

Coming to a period a few moments later, the happenings are recounted by the story recorded on the lifting girders. The north corners remained in place until the south end had cleared entirely and was falling free, and then they both slid off forward into the stream. Only a slight twist had been transmitted through the bridge, just enough to let the lower end strut crowd the inner chain of each hanger over to the west and by the same impulse push the pin of the box hanger in westward direction.

Strength Exhibited by the Three Rockers

A point of great moment, in view of the failure of the southwest rocker, is the clear evidence that lies in the investigational findings as to the behavior of the other three rockers. These rockers remained intact throughout, as is amply proved by the absence of severe punishment to the girder cover plate, hitch angles, and shoe. They held the truss corner high above the lifting girder so that it slid off without touching the girder, or at best barely grazing it. Yet these rockers were subjected to a severe duty. The southeast rocker had to carry, in addition to its normal load, an extra reaction great enough to wreck the portal and lateral system of the bridge, and the unknown impact produced by the start of the failure. At the same time it was subjected to extreme canting and tipping actions, continued to the point of concentrating the whole load on one corner and forcing the rocker out of its seat. The north rockers bore nearly as severe a tipping effect, and they too held up intact.

The span rested on these same rockers for five weeks at Sillery, and they bore variously in that time about 10% more load than they carried during the hour and a half in which the span was suspended from the cantilever arms before its fall. This extra load was due to a very heavy material track (removed before the floating) on which ran a locomotive crane and material cars.

The destruction of the southwest rocker therefore did not develop from inherent weakness in the design, even though the rocker may have been overstressed (on the commonly-used assumption of uniform load-distribution along each pin, the maximum tension in the base would be computed at about 30,000 lb. per sq.in.). Defects in the southwest rocker made it weaker than its three mates.

*

Bridge Company Will Rebuild

Very shortly after the Quebec Bridge suspended span fell—as soon as the officials of the St. Lawrence Bridge Co., the members of the Board of Engineers of the Quebec Bridge, and the Government officials could confer—the bridge company announced that it would accept the responsibility of the accident and bear the expense of replacing the lost span. The company also announced that no changes of moment would be made in the design or the method of erection, floating and hoisting. At the same time it is certain that the detail in which the accident started will be considerably modified.

Orders have already been placed for steel and it is probable that, owing to the emergency, the bridge company will secure quick deliveries.

News of the Engineering World

Correcting the Area of the Croton Watershed

Hydraulic engineers in making computations requiring data of rainfall and runoff in connection with the design of works for water-supply, stream storage, etc., have for many years been accustomed to make use of the data obtained by the long period of observations on the Croton watershed. Very great importance attaches therefore to the announcement just made by the New York Department of Water Supply that a material change has now been officially made in the area of the Croton watershed. The official figure for that area will hereafter be 375 sq.mi. in place of the 360 sq.mi. which has been hitherto used in most computations.

We are indebted to Wm. W. Brush, Acting Chief Engineer of the department, for an interesting historical review of the changes in official measurements of the Croton watershed which have been made in the past three-quarters of a century. The first survey of the watershed of which the department has present records appears to have been made in 1857-58. The annual report of the Croton Aqueduct Department, dated Jan. 3, 1859, contains the following statement:

> The total area or watershed of the Croton above the commencement of the aqueduct is ascertained to be 352 sq.mi.

A map prepared as a result of this survey, however, in about 1860, which was lithographed by J. Bien, then of 24 Vesey St., bore an inscription that the total area of the watershed was 338.82 sq.mi.

This latter figure appears to have been generally used for many years. Need of a more certain determination of the area, however, was brought to the attention of the Aqueduct Commission in the early '80's, and a new topographic survey of the watershed was authorized in January, 1889, in charge of the late W. E. Worthen.

Mr. Worthen will be remembered by the older generation of engineers as the President of the American Society of Civil Engineers in 1887, and for a short time Chief Engineer of the first New York City rapid transit commission. His principal assistants were C. C. Vermeule and J. R. Bien. The map made as a result of these computations was finally delivered on July 21, 1889. The area of the watershed was determined from this map by carefully scaling the parallels of longitude and latitude, using the graphic scale on the map, computing the areas of the various zones, and adding to them the planimetered areas of the irregular portions along the borders of the watershed. As a result the following areas were obtained:

Area of new Croton watershed..............	375.815 sq.mi.
Area of old Croton watershed..............	352.84 sq.mi.
Area of watershed between old and new dams..	22.975 sq.mi.

Controversy immediately arose as to the accuracy of these newly determined areas, which made a material change in the figures so long used. After this survey and map had been made, the site of the new Croton dam was moved slightly upstream. The adopted area of the new Croton watershed was changed to 360.44 sq.mi. A number of the engineers of the Aqueduct Commission, however, were not satisfied that this figure was correct, and from 1900 to 1903, the commission officially used an area of 373 sq.mi. as a compromise, but later returned to the 360.44 sq.mi. previously used.

In 1909 it was determined to measure more accurately than by scaling the area of the watershed as determined by the Worthen survey. The area of the zones of latitude on the Worthen map was determined by computation, assuming the earth to be a sphere 40 million meters in circumference at the sea level. The area of the irregular border of the watershed was determined by the planimeter. One meter was taken as equivalent to 3.280869 ft. The resultant area was 374.979 sq.mi. Another computation of the area was made at the same time, using the Clark's equivalent method adopted by the U. S. Coast and Geodetic Survey. This gave the area as 375.55 sq.mi.

Since 1909 this matter has been given consideration from time to time, and in the early part of the present year it was agreed by all the engineers now in the Board of Water Supply who had taken part in the investigation that an area of 375 sq.mi. should be adopted officially as the area of the Croton watershed.

The above is an interesting illustration of how hard it is to kill an error. The area of 360 sq.mi., which ha so long been used, had its sole foundation in the printe figures appearing on the lithograph copy of the map o 1858. This figure was an error as is proved by measuring, by computation and planimeter, the lithograph ma itself and also by errors found in the table of subdivisions given on the lithograph. In one case an area i given as 75 sq.mi. which should have been 85 sq.m The now officially adopted area of 375 sq.mi. is show to be correct not only by the Worthen map of 1889, bu by the map of 1858 when both are accurately measured The alteration of this figure may necessitate correction in many of the standard treatises on various branches o hydraulic engineering.

*

New Municipal Bridges for Kansas City, Missouri

The St. Louis & San Francisco Ry. and the Missou Pacific Ry. have both agreed with the Board of Park Commissioners of Kansas City, Mo., to pay one-third the cos of a new bridge and viaduct in Swope Park. The rai roads will divide their one-third share in proportion to th width of right-of-way of each. The Park Commissione have ordered J. A. L. Waddell & Son, who prepared th preliminary plans, to hasten the detail plans and speci cations so that a contract can be let this fall.

The total length of the bridge will be 700 ft. It wi provide a 40-ft. roadway with a 7-ft. clear sidewalk o each side. The bridge will be an ornamental reinforce concrete arch structure with a central span of 120 ft. ove the Blue River. This arch will be flanked by two 100-f arches, the one on the west side spanning the railwa tracks. There will also be two 60-ft. arch spans at eac nd. The approaches at either end will be cantilevered om the abutments. The estimated cost is $160,000.

The Board of Public Works opened bids on Sept. 26, for ree bridges, the first work to be contracted for from e $450,000 bond issue voted over a year ago for bridges nd viaducts. One of these will replace the present steel-uss highway bridge over Brush Creek on Troost Ave., d will be 126 ft. long. It will be a reinforced-concrete ch with a clear span of 71 ft., providing a 42-ft. road-ay for a double-track car line and highway traffic, and a -ft. sidewalk on each side. The estimated cost is $20,000.

A second of the proposed bridges will carry a part of th St. over McGee St. Trafficway by means of a rein-rced-concrete arch of 80-ft. span. There will be a 17-. brick-paved roadway and a 5-ft. sidewalk on the south de. The estimated cost is $11,500.

The third structure will carry 31st St., which is now ing graded, over Wyandotte St. and Penn Valley rafficway. It will be on a slight skew and about 94 ft. ng. There will be two rows of columns supporting a -ft. girder span and cantilever beams for the approaches each side of 18 and 25 ft. The roadway will be 36 . wide and carry two car tracks, and there will be a 7-ft. alk on each side. A stairway at one side will accommo-te pedestrians. The estimated cost is $11,700.

The plans for these structures were drawn by V. H. chrane, in charge of the bridge department of the City ngineer's Office. Plans for a number of other structures similar size are in course of preparation, while two or ree large viaducts are being planned for the city by ivate engineering firms.

⁂

oncrete-Bridge Patent Called Invalid in Lower Court

In a decision handed down Aug. 28, 1916, Judge Sater, the United States District Court, Southern District Ohio, Eastern Division, ruled against two of the rein-rced-concrete bridge patents held by Daniel B. Luten, Indianapolis. The suit was by Mr. Luten against illiam F. Whittier *et al.*, for infringement of patents the construction of two highway bridges in Delaware unty, Ohio.

The plaintiff charged the defendants with infringe-ent of three of his patents. As the trial progressed, e plaintiff withdrew his charge as to patent No. 853,-2, issued May 7, 1907, for the reason it was manifest at, if the patent is valid, it had not been infringed. he court, after learning that all the evidence pertinent patent No. 1,070,903, issued Aug. 19, 1913, on a inforcing bar, had been introduced, decided from the nch that it had been anticipated, lacked both novelty d invention and is invalid. The anticipations were e United States patent to Hyatt, No. 206,112, United ates patent to Thacher, No. 617,618, and British pat-t to Hyatt, No. 289 of 1877.

There remained patent No. 853,203, issued May 7, 07, which is in effect a patent on a reinforced-concrete andrel-wall arch in which the reinforcement of the b and the spandrel walls is continuous. In regard to is patent Judge Sater ruled partly as follows:

> This patent and others were before the District Court of dorado in the case of Luten vs. Washburn et al[1]. A copy Judge Lewis' opinion is before me. He reached the follow-g conclusion
>
> On consideration of prior patents and publications introduced by the defendants to meet the separate and several claims, I am unable to rid myself of the firm belief and conclusion that each and all of complainant's claims were nonpatentable at the time he made his several applications and also at the two times prior to applications when he claims he first, within two years prior to such applications, made practical use of the claimed inventions in those two instances. The prior patents as anticipations and the prior patents and publications as showing the then state of the art lead to the clear conviction that complainant in each instance only then made application of mere mechanical knowledge and skill, and that what he did is in no sense a demonstration of inventive genius.
>
> I concur in the conclusion thus reached. An analysis of the prior patents and art will not be undertaken. The development of the art of reinforced concrete began about 1870 and was much pressed about 1890. Some of the patents to which allusion may be properly made are the French Monier patent, No. 77,165 (1873); Monier's American patent No. 486,535 (1892), and especially Fig. 19; Hinckley, No. 623,904 (1899); Von Emperger, No. 583,464 (1897); Brannon's English patent No. 2,703 (1871), especially Fig. 11; Hyatt's English patent No. 2,968 (1877), especially Fig. 3-A; Hennebique's English patent No. 8,814 (1900); and Bone, No. 705,732 (1902).
>
> In some of the patents the horizontal rods are connected to those extending up into the spandrel by ties or other means, so that the inventor employed two rods to accomplish what Luten did by one continuous rod, but the union of two rods into one by welding or casting them together does not rise to the dignity of invention. Monier, at an early date, indicated that his devices might be used in bridge building. He adapted them also to the making of flower pots and the like of that, but his inventions related to the concrete art, and in view of Fig. 19 of his American patent No. 486,535 there was nothing left for Luten but the application of the ordinary skilled mechanic trained in the art.
>
> Other patents of an anticipatory nature might be mentioned, but it is not deemed necessary. A number of decisions in uncontested cases have been submitted, in which decrees were taken in favor of Luten. The manner of obtaining such decrees is too well known to lend importance to them, and the view entertained by this court touching such decrees is the same as that of Judge Lewis in the case of Luten vs. Washburn et al.
>
> An order may be taken dismissing the bill.

Mr. Luten was represented by Arthur M. Hood, of Indianapolis, and the defendants by Edward N. Pagelsen, of Detroit.

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Santa Monica, Calif., Buys Water-Works—The city commissoners of Santa Monica, Calif., have purchased the plants of four water companies, now serving the city, for a total of $712,500.

A Bridge Across the Hudson River below any now existing is projected at Castleton, 10 mi. south of Albany, by the Hudson River Connecting R.R. Co. A public hearing on the proposed bridge is to be held by the U. S. Engineer Officer at Albany on Sept. 25.

Paving Bids in Competition with Contractors will be submitted by the City of Santa Monica, Calif., hereafter. The Board of Commissioners has given notice that if the city's bid brings it the award of the contract, only Santa Monica workmen will be employed.

Scarcity of Labor is claimed to be so acute in the Middle West that no contractors can be found to make bids on some of the Illinois state-aid roads. Recently work on four contracts, three in Greene County and one in Edwards County, has been held up by not having attracted a single bid.

Concrete Road Building—Figures recently compiled by the Road Bureau of the Portland Cement Association indicate that in each of the five states, Illinois, Ohio, Indiana, New York and Iowa, contracts have so far been awarded this year for over one million square yards. In Michigan, Wisconsin, California and Texas over 500,000 sq.yd., each, are contracted for. Most of the yardage in Iowa is for city streets, while the greater part of the yardage in the other states is for country highways.

A Serious Gasoline Shortage in 1917 was predicted by W. R. Hamilton, of San Francisco, in a paper presented at the Arizona meeting of the Institute of Mining Engineers last week. The only possible means of increasing gasoline production, he said, are an increase in the production of the lighter petroleums, increasing the gravity of gasoline on the market, or innovations in refining methods. He believed that such increases as were likely to occur from any of these causes would be inadequate to keep pace with the steady increase in demand.

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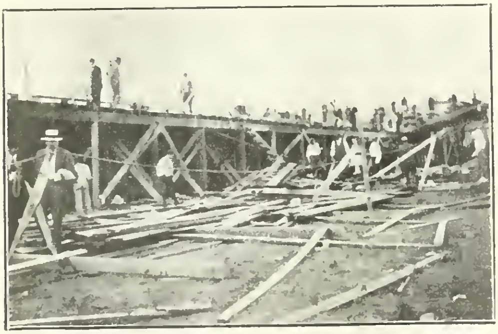
[1] See "Engineering News," Dec 2 1915, p. 1094

An Experimental Water Filtration Plant at Detroit, Mich., is being built to determine at what rate the water could be handled by mechanical filters and to serve also as an educational exhibit. The raw water is low in turbidity and bacteria and is relatively soft, but its sanitary quality could be improved by filtration and if lime and sulphate of iron were used as chemical reagents same softening would be effected. Theo. Leisen is general superintendent of the Detroit Water-Works and R. Winthrop Pratt, of Cleveland, Ohio, is consulting engineer for the test plant.

Large Cooling Tower—What is believed to be the largest natural draft cooling tower so far built has recently been completed at the Anderson, Ind., plant of the American Steel and Wire Co. This tower is of the Wheeler-Balcke type built by the Wheeler Condenser and Engineering Co., of Carteret, N. J. The tower is approximately 150 ft. long, 50 ft. wide and 75 ft high and has a yellow-pine frame with cypress sheathing and filling. The tower has two chimneys which rise above the cooling stacks and create the air circulation by natural draft. The capacity of the tower is 7,300 gal. per min. cooled from 115 to 85° F.

The Minnesota Joint Engineering Board has just been formed with the hope of making the various engineering societies in the state of more value to their several communities. The constituent societies represented on the board are the Northwestern Association of Members of the American Society of Civil Engineers; the Minnesota Section of the American Society of Mechanical Engineers; the Minnesota Section of the American Institute of Electrical Engineers; the Minnesota Surveyors' and Engineers' Society; the Engineers' Club of Minneapolis, and the Civil Engineers' Society of St. Paul. George W. Rathjens, of St. Paul, is secretary of the board.

A Section of Wooden Field Stand Collapsed just before a championship prize fight at Colorado Springs on Sept. 4. A length of 150 ft. fell to the ground, dropping some 500 people, of whom almost half had to be sent to hospitals. The portion of the stand which fell was in the upper half, 12 to 15 ft. above ground. There is dispute as to whether the stand was properly braced. A coroner's inquest is in progress.



COLLAPSED SECTION OF TEMPORARY SEAT-STAND FOR PRIZE FIGHT AT COLORADO SPRINGS

A Dike to Divert the Flood Waters of the Los Angeles River, heavily laden with silt, from entering Los Angeles Harbor will probably be undertaken within a short time. The River and Harbor Bill recently enacted provided an appropriation of $1,080,000 for this work, of which $500,000 was made immediately available. The appropriation was conditioned, however, on Los Angeles guaranteeing to assume the responsibility for right-of-way and the construction of roads and bridges, and also agreeing to maintain the work after completion. The voters will probably pass on this proposition, which involves an expense to Los Angeles of nearly $1,000,000, at the November election.

The Electrolytic Sewage Testing Plant at Decatur, Ill., is being continued in operation beyond the test period, both for demonstration purposes and to ameliorate, to the extent of its capacity, the pollution of the Sangamon River. The Electro Chemical Co., 824 Monadnock Block, Chicago, will continue to pay the wages of plant attendants. The city has engaged H. R. Lee as chemist in charge. The city is under contract to install an electrolytic plant to treat all its sewage, in case this 1,000,000-gal. test plant is found to have met the contract requirements. The city is also under orders from the Illinois Rivers and Lake Commission to cease polluting the Sangamon River by Jan., 1916. W. S. Shields, Hartford Building, Chicago, described the Decatur test plant in "Engineering News," of Aug. 24, 1916, p. 371.

A Suspended Monorail Railway, similar in general design to the Barmen & Elberfeld Ry. in Germany, was recently projected in California between Hopland and Lakeport, a distance of 24 mi. A standard-gage steam railway was projected over the same route two years ago, but after spending some $86,000 on the enterprise the company was financially unable to carry it further. The Monorail Co. applied to the California Railroad Commission for permission to issue stock and bonds to raise money for constructing this road. The Commission, in an opinion filed June 10, 1916, shows that the estimates of the cost of construction of the monorail road were about $50,000 per mi., or about double the cost of a standard steam road, and that the estimates of expenses and earnings on which the company based its hopes of selling its stock and bonds were contrary to general experience in railroad operation. The Commission therefore refused to approve the project.

Kansas City to Try Reinforced-Concrete Water Main—The Board of Fire and Water Commissioners of Kansas City, Mo., and Burton Lowther, water-works engineer have returned from a trip to Oregon and Washington where they went to investigate the success of reinforced-concrete conduit under pressure. Kansas City's water-supply is taken from the Missouri River above Kansas City, Kan., and by means of a 48-in. riveted steel pipe and a 36-in. cast-iron main is carried under a maximum head of 50 ft., for a distance of about 18,000 ft. to a 7-ft. tunnel under the Kaw River, and thence to the main Turkey Creek pumping station on the Missouri side. The 48-in. steel main has developed several bad leaks recently, although it is only 12 yr. old, and at other places where it has been uncovered it has been badly corroded. It is proposed to build a new 48-in. line immediately to provide for the increased water consumption and to replace the 48-in. steel main with a fourth line as soon as necessary. By using reinforced concrete a very material saving can be effected, estimated at from $20,000 to $40,000 per mi. The United States Reclamation Service projects examined by the city representatives showed that concrete had been successfully used for flow lines. One 46-in. pipe on the Umatilla project in Oregon has carried 110 ft. head for 10 yr., and showed but two surface leaks of minor character when inspected. The Board has asked Mr. Lowther to prepare plans and estimates for one 48-in. reinforced-concrete flow line.

PERSONALS

George E. Clifford has been appointed Chief Engineer of the Philadelphia Bureau of Charities.

W. R. Woolrich, of the University of Wisconsin, has been appointed Assistant Professor of Mechanical Engineering at the University of Tennessee.

Oliver W. Connet, M. Am. Soc. C. E., recently with the city engineering department of Baltimore, Md., has been appointed Valuation Engineer of the Western Maryland Ry.

P. C. Powers has been appointed Street Commissioner of Memphis, Tenn., to succeed Thomas Estes. Mr. Powers was Street Commissioner under a former administration.

Charles Palmer, of Latrobe, Penn., has been appointed Engineer of the Shenango Land Co., of Sharon, Penn. He was formerly Engineer of the Latrobe and Connellsville Coal and Coke Co.

A. L. Kenyon, M. Am. Inst. E. E., has resigned as Manager of the Alabama Power Co., Anniston, Ala., to accept the same position with the Columbia Railway, Gas and Electric Co., Columbia, S. C.

Homer C. Johnstone, formerly with the Midvale Steel Co. as Manager of its Chicago and New York offices, has been made Manager of the Steel Department of Gaston, Williams & Wigmore, Inc., New York City.

J. M. Rabb, a civil engineer formerly with J. E. Sirrine, Mill Architect and Engineer, Greenville, S. C., has accepted a position with the Southern Engineering Co., Charlotte, N. C. and will have charge of a branch office at Greenville.

Charles P. Jaeger has resigned as Commissioner of Water of Cleveland, Ohio, because, it is stated, he is no longer willing to assume the responsibility of the Water Department with no voice in selecting or dismissing his assistants.

Elmer E. Yoke, of Annville, Penn., has been appointed Works Engineer of the Gilbert & Barker Manufacturing Co., Springfield, Mass. He is a graduate of Lehigh University and has been with various steel companies in Pennsylvania

C. J. Reoner. Assoc. M. Am. Soc. C. E., has resigned as perintendent of the Louisiana Water Co., Louisiana, Mo., to cept a position in New York City. He is succeeded by A. F. rzelius, of the Birmingham Water-Works Co., Birmingm, Ala.

Charles Scott Landers. Assoc. M. Am. Soc. C. E., Consulting gineer, New York City, **Reuben Davis** and **Alan M. Ferebee** nounce the formation of the Substructure Co., Inc., 115 oadway, New York City, specializing in foundation and derpinning work.

John R. Lapham, Jun. Am. Soc. C. E., former Instructor in il Engineering at Pennsylvania State College, has been apnted Assistant Professor of Civil Engineering at George ashington University, Washington, D. C., succeeding Prof. than W. Dougherty, resigned.

George C. Andrews. Assoc. M. Am. Soc. C. E., former sident Engineer of the New York State Barge Canal at kport, N. Y., has been appointed Supervising Engineer of water-works of Buffalo, N. Y., under the new commissionn government. He will give particular attention to sysatizing records and similar work.

Prof. E. A. Fessenden. M. Am. Soc. M. E., has been elected d of the Department of Mechanical Engineering of the nsylvania State College. He was graduated from the versity of Missouri in 1904. After several years with the a Foundry and Machine Co., of Springfield, Ill., the Babk & Wilcox Co., Bayonne, N. J., and the turbine and conser departments of the Westinghouse Machine Co., Pittsgh, Penn., he was appointed Associate Professor of Menical Engineering at the University of Missouri.

OBITUARY

Frank McMillan Stanton. M. Am. Inst. M. E., died at his e in New York City, Sept. 11, aged 51 years. He was a of John Stanton once widely known in the copper-mining ustry. He was graduated from the Columbia University ool of Mines in 1887. For over 20 years he was Superinlent of the Atlantic Mining Co., of which his father was sident. Later he was identified with the management of r Lake Superior copper-mine properties.

John V. Beekman. M. Am. Soc. M. E., for many years conted with the Lidgerwood Manufacturing Co., New York , died at his home at Plainfield, N. J., Sept. 11. He was a in 1842 at Somerville, N. J. About 1870 he engaged in manufacture of rotary engines, pumps, etc., being a memof the firm of John A. Lighthall-Beekman & Co., with ks at Imlay St., Brooklyn, N. Y. This company was abed by the Lidgerwood Manufacturing Co. in 1873, Mr. kman assuming charge of the works of that company. He the inventor of many improvements in hoisting en-s.

ENGINEERING SOCIETIES

OCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS
pt. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
pt. 19-22. Convention in New York City. Secy., P. J. McAndrews.

HIGAN GAS ASSOCIATION
pt. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

ERICAN PEAT SOCIETY
pt. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

ERICAN CHEMICAL SOCIETY.
pt. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

ERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
t. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

ERICAN ELECTRIC RAILWAY ASSOCIATION
t. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

ERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
t. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

ERICAN GAS INSTITUTE.
t. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickly, Penn.

The Efficiency Society is planning an open conference to be held in New York, Nov. 16 to 18. W. B. Richards is chairman of the committee, 52 Broadway, New York City.

The National Smoke Prevention Association will hold its 11th annual convention Sept. 26 to 29 in St. Louis at the Planters Hotel. The secretary is J. A. Troy, 510 Locust St., St. Louis.

The Engineers Society of Western Pennsylvania, at its first meeting of the season on Sept. 19, will be addressed by J. Lowenstein, Engineer of the American Bridge Co., on the Hell Gate Bridge.

The American Railway Bridge and Building Association has made arrangements for its 26th annual convention, Oct. 17 to 19, in New Orleans, at the Grunewald Hotel. The secretary is C. A. Lichty, C. & N. W., Chicago.

The American Society of Safety Engineers had an outing on Sept. 9, on Point View Island, College Point, N. Y., where the second annual frolic and shore dinner was held. The regular monthly meeting will be held on Sept. 27 in the Engineering Societies Building, New York City.

The Traveling Engineers' Association will hold its annual convention Oct. 24 to 28 at the Hotel Sherman, Chicago. The arrangements will be the same as planned for the Sept. 5 convention, which had to be postponed owing to the railway-labor difficulties. The secretary is W. O. Thompson, General Offices N. Y. C. R.R., Cleveland, Ohio.

The Portland Cement Association held its fall meeting Sept. 11 to 14 in Detroit. Nine sessions were held. An inspection trip was made over the Wayne County road system, and at one of the sessions Edward N. Hines, Chairman of the Board of (Wayne) County Road Commissioners, presented a paper entitled "The Concrete Road."

The Association of Edison Illuminating Companies at its annual convention on Sept. 7 at Hot Springs, elected the following officers: President, Peter Junkersfeld; vice-president, L. L. Elden; treasurer, W. W. Freeman; secretary, Geo. C. Holberton, of San Francisco. The assistant secretary is E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

The National Safety Council's annual meeting and conference will be held in Detroit, Mich., Oct. 16 to 21, in the Detroit Armory, and will include an exhibit. The program is 40 pages in length and will include 140 speakers. The National Safety Council was started a little less than three years ago, for the purpose of establishing a clearing house for information on accident prevention, sanitation, health conservation, etc. From 40 members the list has grown to 2,200. Five bulletins are distributed each week. The secretary is W. H. Cameron, Continental & Commercial Bank Building, Chicago.

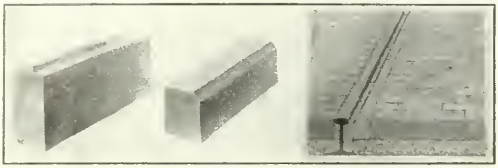
The Fourth Annual Efficiency and Welfare Conference under the auspices of the Pennsylvania State Department of Labor and Industry and the Engineers' Society of Pennsylvania, will be held at the Capitol, Harrisburg, Nov. 21 to 23. Representatives of most of the state's large industries and many engineering authorities will be present to discuss various legislation affecting industrial establishments, accident prevention, first-aid methods, occupational diseases, problems of employment, avoidance and settlement of labor disputes, Americanization of alien workers, fire prevention and factory problems. The complete program will soon be announced by Commissioner John Price Jackson.

The Atlantic Deeper Waterways Association opened a five-day convention in Philadelphia on Sept. 12. Plans were advanced for a continuous inland waterway from New England to Florida, of value both to commerce and national defense. On Sept. 13 the delegates went by water to Trenton, escorted thither by the United States torpedo boat "Barney" and a flotilla of river vessels. About 800 made this trip, which included an inspection of the entrance to the Delaware and Raritan Canal, one of the links in the proposed intra-coastal system. Major J. C. Oakes, in charge of government work on the Delaware River, predicted the dredging of a 25-ft. channel between Philadelphia and Trenton. He said that the Delaware River was comparable to the greatest European waterways, and that the Atlantic coast was the heart of the nation; along its shores were situated great steel and industrial plants and to defend this section, inland waterways were a necessity.

Appliances and Materials

Filler and Stretcher Paving Blocks

The accompanying sketch illustrates two special blocks for use in connection with T-rails in street-railway track paving. The filler block is equal in depth to the rail web and is wide enough to take a part of the wheel-flange way. The stretcher block is merely rectangular with one beveled edge. The blocks are laid with their greatest length parallel to the rails, and with broken joints. The length of these special blocks is three times the width of an ordinary paving brick. They are made by the Nelsonville Brick Co., Nelsonville, Ohio.

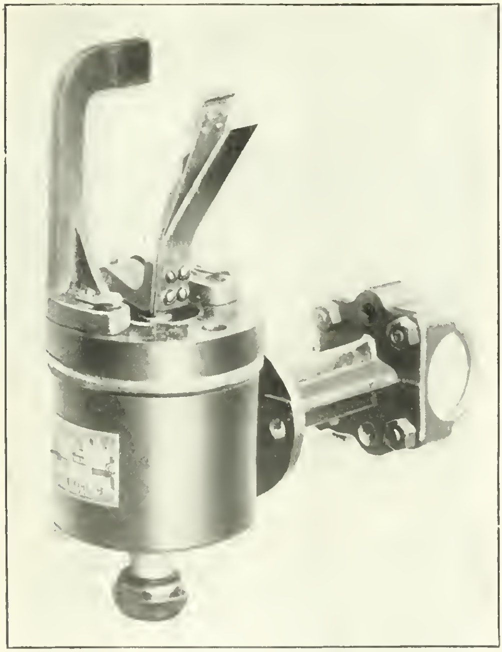


SPECIAL BLOCKS FOR TRACK PAVING

* * *

A New Solenoid-Control Relay

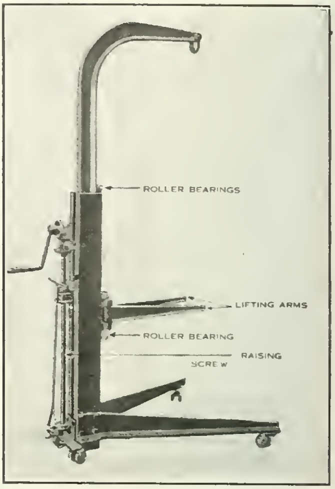
Solenoids for operating large carbon-break or oil circuit-breakers frequently require comparatively large currents in the closing solenoids. In such cases the contacts of the solenoid-control switch that controls the operation of the solenoid are not suited to operate the closing solenoid, and it is necessary to use also a control relay with its operating coil excited by the closing contacts of the control switch and the relay contacts in series with the closing solenoid. A relay for this purpose was recently developed by the General Electric Co. The relay consists essentially of a solenoid, plunger and contacts. There is a metallic connection, consisting of a small flexible lead, between the movable contact arm and its support. The contacts are kept clean by a wiping motion each time the relay is operated.



LARGE SOLENOID-CONTROL RELAY

Light Portable Crane

The portable crane for shop and yard work, shown in th accompanying view, has a telescopic mast with head of th davit type, giving a height of 6 ft. 4 in. to 9 ft. 3 in. I addition, there is a pair of hinged arms for use in lifting o jacking, and these can be swung aside when the boom is be ing used. The operation of mast and arms is effected means of a vertical lead screw with crank-handle drive an gears for high and low speeds. The base consists of t supporting beams with castors under their ends and under t mast. The machine has a hoisting capacity of 4,000 lb. a weighs about 350 lb. This crane is built by the Zin-Ho Man facturing Co., of Chicago.



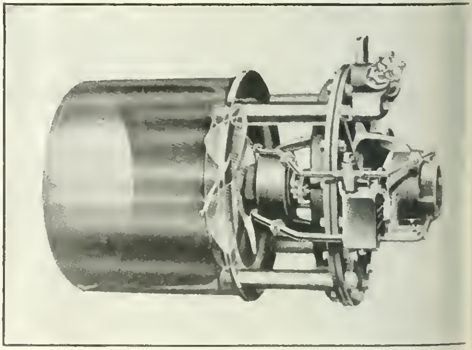
PORTABLE CRANE FOR SHOP AND YARD WORK

* * *

A New Turbine Blower with Novel Lubrication

A turbine blower recently placed on the market by t L. J. Wing Manufacturing Co., New York City, includes its design a new method of lubricating, oil being used on t ball bearings instead of grease. "Power" states that t two ball bearings mounted on either side of the turbi are inclosed in large housings with ample reservoir space either side of the bearings, so that each bearing rotat through a bath of thin oil supplied from a tank in fro of the turbine face.

The method of mounting the bearings is another intere ing feature. Instead of the bearing races being held in t main castings in the machine, they are held in caps that secured to the castings. When the cap is taken off, by moving four screws, the bearing is exposed and can be ea removed.



TURBINE BLOWER, SHOWING OILING SYSTEM

Engineering News

OLUME 76 SEPTEMBER 28, 1916 NUMBER 13

Types of Dump-Cars Used on Construction Work--I

SYNOPSIS—A review of different types of dump-cars, for the engineer, the contractor, the job superintendent and the supplyman, in two installments. In this—the first—are considered small hopper cars and high-body tilting cars. The second article will cover flat-cars and unloader plows; gondolas having side doors or drop bottom; center-dumps and side-doors and combinations of both.

In most kinds of construction work there is involved he handling of material by cars. It may be the delivery f a small amount of gravel to a concrete mixer, or the moval and disposal of a great yardage of excavation. t includes such service as the transportation of raw mateial (such as stone, sand and gravel for road or concrete ork), the distribution of concrete, the distribution of rack ballast or filling, the removal of excavated material serving steam shovels or other machines), and the placing f such material to form new fills or widen banks, levees, tc. The field covers work done by contractors and by ailway or other company forces, and it includes maintenance and improvement work as well as new construcion. The cars employed in such service range from yd. to 10 yd. in capacity and include a variety of forms. ome have movable bodies that dump by tilting, others have fixed bodies with bottom or side doors for discharging, and still others are unloaded by means of traveling plows.

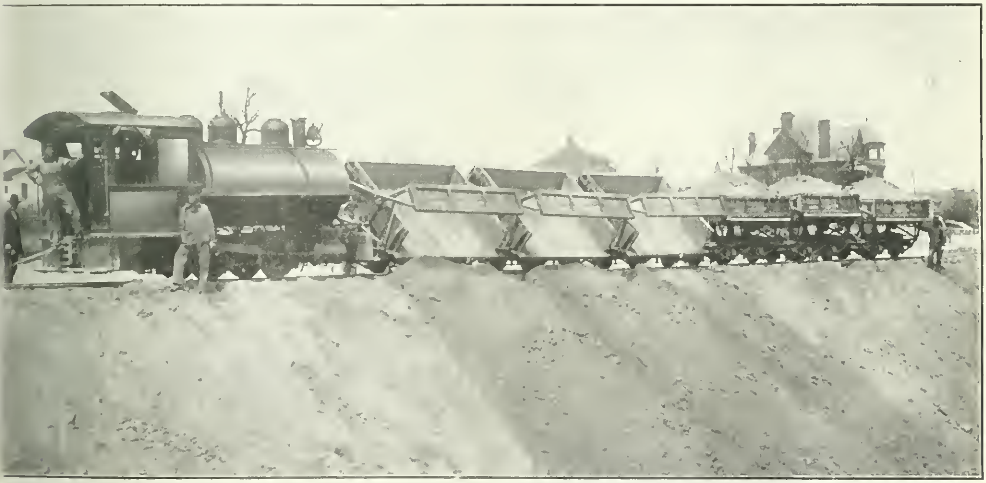


FIG. 1. TRAIN OF 4-YD. SIDE-DUMP CARS
Western Wheeled Scraper Co., Aurora, Ill., builder

In the small steel hopper car the body is a deep V-shaped tilting hopper, swung low between vertical standards or end frames on the main frames. They are built in sizes of $\frac{2}{3}$-yd. to 2-yd. capacity and for tracks of 20- to 30-in. gage, but the smaller cars on tracks of 24-in. gage are those in most general use. These cars are entirely of steel, and they are operated usually on light portable track, with steel rails and ties, built up in sections for convenient handling and placing.

The body is not carried in fixed trunnion bearings, but is so supported as to have a lateral motion in dumping, in order to deliver its contents clear of the track. Fig. 2 shows a car of this type, built by the Orenstein-Arthur Koppel Co., of Koppel, Penn. On each end of the body is a horizontal shelf angle that rests on the curved top of the end frame. In other designs curved rockers on the ends of the body ride on horizontal members of the end frames. In any case the body rolls to the side of the frame as it is dumped.

These cars are used largely in the construction of foundations and large buildings and in other jobs having limited area and close concentration of plant. There they are employed especially for handling material and distributing concrete, and are particularly adapted for the latter purpose, as there is no chance for leakage. On such work they are usually pushed by hand or operated on inclines by cable hoists. The center of gravity is low, whether the car be loaded or empty.

The steel hopper cars are selected frequently for tunneling and similar work. A specially extensive field at the present time is on highway construction, where they distribute material from the railway siding, or other base of supplies, to the work. They are suitable also for excavation, especially where the total yardage is not great and the amount at any one point is so small, or the cut so shallow, that hand shoveling is employed. The cars, being low, are easily loaded by hand and may be partly tilted to facilitate such loading. They are used to some extent with steam shovels. Besides being used in construction work, the cars are often employed at gravel pits and quarries.

For hauls up to 300 or 500 ft. animal traction may be employed, with trains of five or six cars, according to the size of the car and the grade of the line. For longer hauls locomotive traction is economical. Steam, oil, gasoline and electric locomotives are used and are superseding animal power to a large extent, except on very small jobs.

The portable track is usually in 15-ft. lengths, with the rails bolted or riveted to steel ties 3 ft. apart. The sections may be connected by splice bars, permanently attached to one end of each section, or by special shoe joints. A 15-ft. section of 24-in. track with 20-lb. rails will weigh about 270 lb. Curves, switches, turntables, etc., are made in special sections. Occasionally the rails are spiked to small wooden ties. Care should be taken to have the track well laid and bedded and maintained in good condition.

These small cars are of special advantage for construction work where the equipment must be transported to a considerable distance from the nearest railway point, as the units are easily handled on wagons by teams. Where they are to be operated as a connection between the railway and the work, the portable track is of course laid in advance. These cars, although much in favor with contractors, are rarely adopted by railways, as they constitute a special equipment for which there is only occasional requirement and which is not adaptable to other purposes than a special kind of construction.

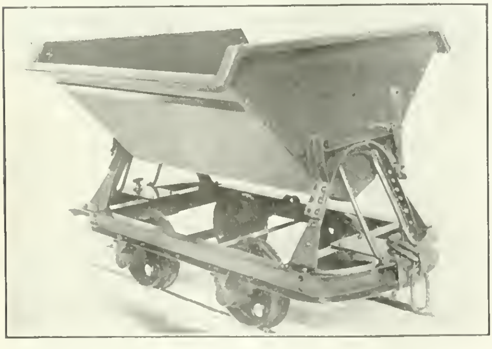


FIG. 2. A 1-YD. STEEL HOPPER DUMP-CAR
Orenstein-Arthur Koppel Co., Koppel, Penn., builder

Cars of this type and of the next type mentioned, with capacities of 1 to 4 yd., present special advantages fo widening railway cuts and fills, as their small size enable them to be operated along the right-of-way. Thus they ca be run adjacent to and outside of the main tracks withou causing any interference with traffic. On small jobs o this kind, with hand or machine loading, the cars may b operated by animal power. Where narrow cuts are t be widened by steam-shovel work, the narrow-gage car may be used first in widening the cut sufficiently to permit laying a standard-gage loading track, thus avoiding all use of the main track for construction trains.

Some railways provide their roadmasters with a few o these cars to aid in cleaning cuts and ditches, where th work is too small or the traffic too heavy for a regula ditcher and work train on the main track.

SMALL HIGH-BODY TILTING CARS

In these cars the body is a rectangular and relativel shallow box supported above the frames and tilting t either side. The sides (or doors) are usually independent of the body proper and are carried by a system o levers so arranged that, as the body tilts downward, th door on that side swings upward. This gives clea passage for boulders, stumps, etc. Fig. 1 shows a trai of 4-yd. cars of this type built by the Western Wheele Scraper Co., of Aurora, Ill. The first three cars ar dumped, showing the operation of the doors. Fig. 3 is larger view of a 4-yd. car of this same type, built by th Orenstein-Arthur Koppel Co.

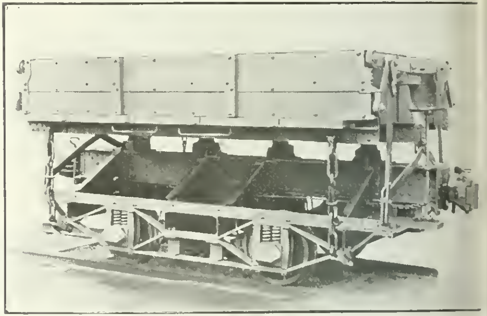


FIG. 3. A 4-YD. SIDE-DUMP CAR
Orenstein-Arthur Koppel Co., Koppel, Penn., builder

In most of the designs the body simply rocks on fixe central bearings beneath the bottom, but in others th body has a lateral motion as it tilts. While the grea majority of the cars are of the side-dumping class, specia designs are made to dump at the end or, with a rotating body, to dump either endwise or sidewise. The car body can be so balanced on its supports that one or two me can dump and right a 6-yd. car without difficulty. Th body is held in normal position by side chains, which ar released for dumping and are coupled up as soon as th body is righted.

Four-wheel cars of this type are built of 1- to 8-yd capacity and for gages of 24 in. to 4 ft. 8½ in. The 8-yd size is exceptional, but double-truck 8-yd. cars of narrow gage have a limited application. The 6- and 8-yd. cars ar built for both standard and narrow gage, but their use on main-line or running tracks is permissible only for a very

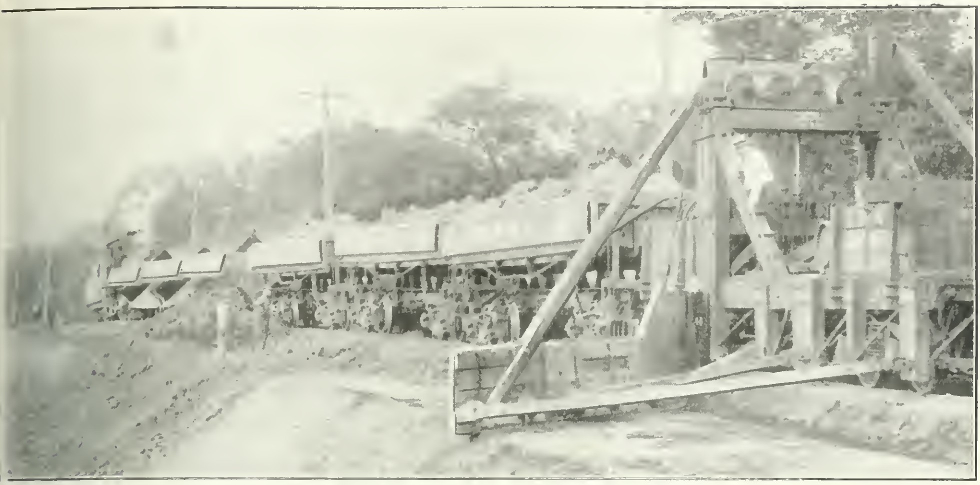


FIG. 4. TRAIN OF 30-YD. AIR-OPERATED SIDE-DUMP CARS WIDENING A FILL
Western Wheeled Scraper Co., Aurora, Ill., builder

rt haul. In such case the larger car has an advantage to its greater capacity. Cars of this class are adopted inly on work accessible by rail or water transportation, even in the smallest sizes they are not so easily trans- ted as the small steel hopper cars already mentioned. e cost per ton of material handled would not be much than with the hopper cars, but the quantity of mate- handled by one outfit daily would be much greater. The smaller sizes, 1 to 2 yd., or even 3 yd., are em- yed particularly on highway and interurban-railway k and also in widening roadbed and for similar service main-line railways. For highway work they serve not only to remove excavated material, but to deliver sand, gravel and stone.

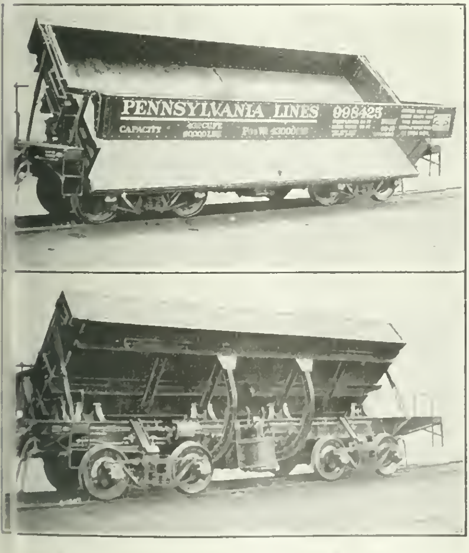


FIG 5. A 16-YD. AIR-OPERATED SIDE-DUMP CAR WIDENING A FILL
llbourne & Jacobs Manufacturing Co., Columbus, Ohio, builder

Cars of 4- and 6-yd. capacity and 30- or 36-in. gage are used extensively by contractors on team-trap work and where the earthwork (in total amount and in depth of cut) is such that a steam shovel can be employed to advantage.

The small narrow-gage cars can be used in widening railway roadbed for additional tracks, where the main track cannot be occupied, as noted previously. In such case there is often room to place the loading track clear of the main track in the cut, and the unloading track on the edge of the fill, so as to avoid the necessity and expense of a trestle for making the new fill. In excavating a single-track cut with a steam shovel, especially in rock, such equipment may enable the cut to be taken out to grade without removing material outside of the established cross-section lines.

These cars (4 to 6 yd.) are of advantage in making fills from trestles on small work, as larger cars require more substantial trestles, which may not be economical for temporary service. To prevent a heavy or sticky load from upsetting the car when the body is dumped, anchors are sometimes used, which the dumpers hook under the rail and over the frame of the car. The cars are of advantage also on new construction where the condition of roadbed and track precludes the use of heavier equipment. Further, with the small car there is a saving in cost of track material and in the work of laying, shifting and maintaining track.

LARGE HIGH-BODY TILTING CARS

Cars of this kind are not often desirable for railway forces, as they constitute a special class of equipment, which is not permanently required and which cannot be utilized for other purposes. One railway, however, uses 4-yd. narrow-gage cars on widening and double-tracking work, where the haul is short, as they can be operated without interfering with main-line traffic. Where the haul is long, this railway prefers 30-yd. cars of the same general type, operating on the main tracks.

In general design these cars are similar to the cars of the previous class, but they are mounted on eight wheels, with standard-gage trucks, and have a capacity of 12 to 30 yd. They are used both by railways and contractors. For operation as work trains on main lines they must have standard coupler and airbrake equipment to comply with the Federal laws. They are suitable, of course, only on work involving considerable yardage of excavation and long haul, with powerful locomotives available.

On some of these cars the dumping and righting of the bodies are accomplished by compressed-air cylinders, the piston rods being either horizontal with chain connections or vertical and connected directly to the body. The air operation conduces to speed, economy and safety in the work, especially on trestles. The angle of dump is usually 45° or over. In some designs the body is held by side chains to prevent accidental tilting during transportation. These chains must be released to permit operation; then they are coupled up when the empty car is righted. In other designs the body is secured by latches that are released by the pneumatic operating mechanism and are engaged and locked automatically when the car body returns to its normal position.

The side doors are separate from the body and are so arranged that as the body tilts downward the door on that side swings upward. This protects the door from damage as the load shifts and gives a clear passage for a load that is piled high or contains stumps and boulders. The cars are of special advantage for handling rock excavation and heavy material. With a wet and sticky or frozen load there is sometimes liability of the car going over when the body is dumped.

A 16-yd. air-operated car of this type, as used by the Pennsylvania Lines, is illustrated in Fig. 5. The upper view shows the door arrangement, and the lower view shows the operating mechanism. This car is built by the Kilbourne & Jacobs Manufacturing Co., of Columbus, Ohio, and is of the type in which the air cylinder is vertical and moves the body without the aid of chains. When in normal position for transportation the body is secured by latches, so that no side chains are used, such as are seen on the cars in Figs. 3 and 4.

For heavy construction and railway work especially there is an increasing tendency to choose these large cars. They are specially desirable when the haul is more than 4 or 5 mi., in order to obtain unit train loads as large as possible. Some contractors consider 1,000,000 yd. about the minimum amount of material for the selection of such cars. Their use applies more particularly where the cars are to be operated on main tracks (whether by the railway or the contractor). It applies also where they are operated exclusively on construction tracks, but of course these tracks (and their trestles) must be built of a more substantial character and must be given more attention for maintenance than is required by smaller and lighter cars.

There is difference of opinion as to the relative advantages of the different sizes of cars of this class, which range from 12 to 30 yd. in capacity. A train of six side-dump cars of 30-yd. capacity and all-steel construction is shown in Fig. 1, with three of the cars dumped. These are built by the Western Wheeled Scraper Co., of Aurora, Ill. The cars are shown placing material for widening a fill, and at the rear of the train is a spreader car to level the material to the subgrade elevation.

The 12-yd. car is considered very satisfactory for general railway or construction work. It can be used o short or long hauls and on running lines or constructio tracks. Some engineers and contractors deem 12- an 18-yd. cars best for making banks where it is possible t raise track as the fill proceeds instead of dumping fron a trestle. They are suitable also for widening banks afte trestles have been filled to grade, provided that the material of the new bank is of sufficiently good quality t enable the track to be maintained economically in condition to carry these cars. Others favor a 16-yd. car o all-steel construction.

Granting that both railways and contractors advocat the use of the larger equipment on account of its economies, they should recognize the necessity of maintainin their construction tracks in such condition that thes economies may be realized. The important point of keeping these tracks in safe and passable condition is apt t be overlooked and neglected by the men in charge. But few derailments of these large and heavily loaded cars with consequent interruption to the work, may so lowe the performance and increase the expense as to wipe ou the expected saving in time and cost.

A point frequently urged in favor of the 12-yd. ca is its relatively high capacity and low weight. On engineer in particular notes that on new fills in we material the engines caused considerable trouble, whil the 12-yd. cars did not affect the track. If cars of 25 to 30-yd. capacity had been used, they would have cause as much trouble as the engines; and probably it would no have been practicable to operate them until the bank ha dried out. Another engineer considers that cars o greater capacity than 12 yd. are desirable for makin high fills where the load easily falls clear of the trac as the cost of train service, dumping, etc., is less wit the larger cars. As pointed out elsewhere, the characte of the work has a strong influence upon the selection o equipment, but in many cases there can be no selection o merits alone, as the work must be done with equipmen already owned.

In filling trestles the shock of dumping these ver large cars must be considered, as it tends to rack th trestle and throw it out of line. This is not of importan with temporary trestles, provided they are of strength su ficient to stand the rough usage—which is not always t case and would require a materially increased cost f timber. It must be taken into account especially in fillin trestles on running tracks, where the structures are pe haps old and more or less weakened. One railway havin both 16-yd. and 30-yd. cars has not used the larger ones f filling from temporary trestles or old main-track trestle as the timber is liable to damage. It has used the 16-y cars on temporary trestles, but considers the 12-yd. mo economical, as the style of trestle to handle the 16-y equipment was unduly expensive.

In this case the engineer considered that the 12-y hand-operated dump-cars were best for filling trestles an that the 16-yd. air-dump cars were most satisfactory f general purposes. The 30-yd. air-dump car, in connectio with an air-operated spreader car, is the more satisfacto in widening banks for second track where the traffic is n too heavy or where the traffic is dense and the haul long. With this equipment the greater part of the ban can be constructed from the main track with little dela to traffic. When the haul is short, however, this engine refers narrow-gage equipment for second-track work, as can be handled independently of main-line traffic.

The 30-yd. air-dump cars are used to advantage also removing slides on new construction, where the track s been raised on ballast and slides have come in after e line was practically ready for operation. In such ses these cars require only a small force and are eco- mical, but they are not satisfactory for use on tem- rary roadbed (unballasted), as they cause excessive st of track maintenance.

On railways that do a large amount of construction or provement work by their own forces cars of this class e considered a good investment. For such work as tching, widening and clearing cuts, etc., there is an in- easing tendency to use short quick-moving trains with o to four dump-cars rather than the usual long and w train of flat-cars (*Engineering News*, Mar. 16, 1916). this way the work may be done enconomically and th a minimum interference with traffic.

A train having a ditching machine or loader mounted tween two 20-yd. dump-cars, or two loaders and four mp-cars, can be loaded quickly and make rapid move- ents to and from the dumping point or the nearest sid- g. Some roads prefer the large all-steel dump-cars th rigid locks instead of side chains, as they are more ble at ordinary speeds and will stand the rough usage tter. Such cars are rated at 100,000 lb. capacity and ll carry 24 to 30 yd. each.

Large high-pitched dump-cars are not suitable for bal- sting, as they would throw the material too far from the ck and deposit it in quantities too large for proper stribution. Nor can they be diverted to freight service en not required in work-train service. In handling terial from steam shovels with dump-cars and flat-cars e Kansas City Terminal Ry. has found the cost per bic yard to be about 11.3c. with 12-yd. dump-cars and .5c. with flat-cars. The greatest difference was in the ms of car repairs and engine service.

Large dump-cars of other types and the use of flat- rs and unloader plows will be dealt with in a suc- ding article.

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Portable Steel Buildings on Construction Work

Portable buildings composed of steel units are being ed for engineers' and contractors' offices on construction rk and for similar purposes. A contractor's building this type is shown in Fig. 1. The structure consists pressed-steel panels, trusses and other parts put together without the use of bolts or rivets. The fastening used is a T-shaped lug, whose stem passes through holes in the units; the stem is slotted to receive a locking wedge. Hand hammers are the only tools required in erecting and dismantling the building.

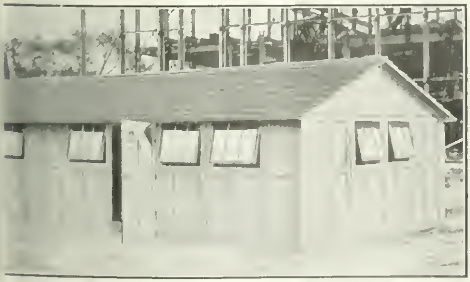

FIG. 1. CONTRACTOR'S OFFICE BUILT OF PORTABLE STEEL UNITS

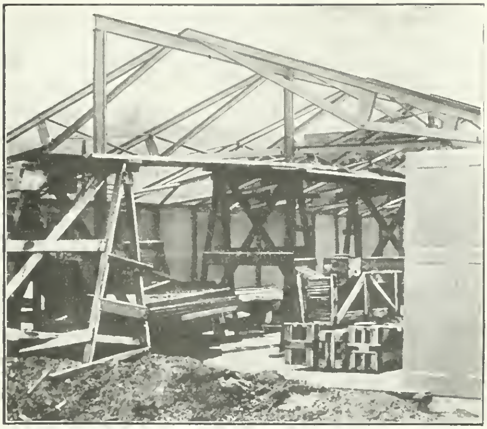

FIG. 2. ERECTING A PORTABLE STEEL BUILDING

The panels are of No. 18 steel plate flanged on all sides, the flanges being slotted for the fastenings. They are uniformly 7 ft. 10 in. high and either 2 ft. or 4 ft. wide. For the corners angle-shaped panels are used to insure a weatherproof structure. The vertical flanges fit the steel mullions placed between the panels, and weather stops are provided in all joints. The panels may be solid or glazed and may have ventilating openings with pivoted sash. End-gable panels and doors with hinges, latches and locks form part of the equipment.

The roof trusses are of different designs for spans of 6 to 28 ft. They have electrically welded connections so that they form single units. Longitudinal bracing is provided. In some designs the trusses are carried only at each end by the mullions, while in others there are central columns carrying a ridge beam. Fig. 2 shows the latter arrangement. The roof sheathing is of longitudinal steel plates, secured to the trusses by clips. They have flanged joints, which are made waterproof by special strips interlocking over the interior flanges of the plates. The buildings may be placed on wood sills or concrete foundation.

These portable steel structures have been used also as railway-yard and switchmen's shanties, section houses, bunkhouses, garages, hospitals, voting booths, roadside waiting rooms on electric railways, camp buildings, temporary offices and various other purposes. They are manufactured by the Trussed Concrete Steel Co., of Youngstown, Ohio.

⁂

A Steamship Company Operating a Round-the-World line of vessels has just begun operation through the Panama Canal. The company is the New Zealand Shipping Co., which has previously routed its vessels around the Cape of Good Hope on the outward voyage to Great Britain and around Cape Horn on the homeward trip. On its outward voyage the vessel sails from Great Britain around the Cape of Good Hope and traverses a distance of 12,916 mi. by way of Teneriffe, Capetown, Hobart and Auckland. From Wellington the homeward route henceforth will be by way of the Panama Canal and Norfolk where coal is taken on for the transatlantic trip and thence to Plymouth.

Successful Sewage Disposal by Broad Irrigation

By Terrell Bartlett*

SYNOPSIS—Some 1,600 acres of privately owned land are irrigated through the agency of an intermediary company, to which the city delivers the sewage. A natural lake, enlarged for the purpose, is used to store the sewage when not needed for irrigation.

No expense for disposing of its sewage has been incurred for many years by San Antonio, Tex., with a population approaching 120,000. The entire flow of sewage, now averaging about 13,500,000 gal. daily, is delivered to an irrigation company, which utilizes the water commercially and under its contract agrees to effect disposal and protect the city from all damage claims.

In the early nineties San Antonio constructed extensive sewers and endeavored to solve the problem of disposal by purchasing a tract of 800 acres five miles from the center of the city. This tract was operated under broad irrigation, at a loss, for two or three years, and proved a complete failure owing to the impossibility of utilizing the water for farming during the winter months. Through the winter and at times of wet weather, the water wasted from the farm to the San Antonio River, in which the flow was at times as low as 10 or 12 cu.ft. per sec.

Irrigation Ditches Polluted

Five miles below the city two irrigation ditches, one on either bank of the river, with water rights going back to Spanish days, take out the entire dry-weather flow for irrigating some 1,000 acres of thickly settled and highly cultivated truck farms. The river and these ditches soon become badly polluted. Suits were filed against the city by riparian owners, and by property holders adjacent to the farm, to the extent of more than $750,000.

These suits were settled by agreement on the part of the city to carry the sewage into the watershed of the Medina River, to Mitchell's Lake, a broad shallow basin, whose owners organized the San Antonio Irrigation Co., which agreed, on consideration of the delivery of the sewage by the city, to protect the city from damages caused thereby. The right-of-way for the 5½-mi. open ditch, together with immunity from damage claims along the line, was secured by granting to the various land owners water rights for stated lands aggregating about 100 acres.

The company secured a lease on favorably located lands adjacent to the lower end of the ditch and lake and the city is secured in its contract with the company by a lien on this leasehold.

In addition to the 100 acres irrigated by various land owners along the ditch, a land company and private owners irrigate about 800 acres above the lake by gravity direct from the ditch, 400 acres by gravity below the lake, and by a 10-ft. lift from the lake, 300 acres more, making a total net irrigated acreage of 1,600 acres.

During the nonirrigating seasons the flow of sewag is stored in the lake. Until recent years this sewag was diluted by the storm runoff from some 7,000 acre which drains into the lake, but this fresh-water inflov is now considerably curtailed by two fresh-water pond which impound a supply of water for the domestic us of the farm tenants and for fishing as well as for irri gating a few acres.

Kinds of Crops Raised

The crops raised have consisted principally of foo stuffs, sorghum, Johnson grass and some alfalfa, wit a small amount of irrigated cotton at times. The rais ing of vegetables has never been permitted by th company although considerable public excitement wa developed in San Antonio several years ago by the dis covery that some land owners along the ditch and n under control of the company were raising garden tru for the local market.

The lands have been farmed on a cash rental basi principally with Mexican tenants of the better class, t the number of approximately 100 families. With a tota population of some 500 people on the farm there has bee very little sickness and only five or six mild cases o typhoid in as many years.

The company has recently inaugurated a policy of con verting the farms into Johnson-grass pastures and stock ing them with several hundred head of cattle. Durin the growing season one acre will carry two head of cattl The forage crop will thus be marketed on the farm di rect without the expense of cutting, baling and shippin and the number of hands reduced to 40 or 50. A fu ther advantage will be the possibility of continuing irr gation through the winter season.

Amount and Disposition of Sewage

The present annual quantity of sewage received fro the city's trunk outlet is roughly estimated at 15,00 acre-ft. Of this some 8,000 acre-ft. are applied to th lands by broad irrigation at an estimated average dail rate of 10,000 gal. per acre during the season. Th remainder is impounded in the lake, together with fro 400 to 800 acre-ft. of storm water. From a small marsh that the lake has been extended by successive increases i the height of the dam until it now covers some 900 acr to an average depth of from 8 to 10 ft. Evaporatio and seepage losses from the lake and ditches probabl average 6,000 acre-ft. annually. In wet seasons hereto fore, when there was no winter irrigation and when th storm water runoff was large and the evaporation small it has been necessary to waste from 500 to 1,500 acre-f into the Medina River which forms the southern bou dary of the lands. This has been done at times o freshets when the dilution was very considerable, an has caused no serious complaints.

The owners expect to construct a reservoir in the riv bank above natural gravel beds through which some wate from the lake may be filtered and wasted into the rive

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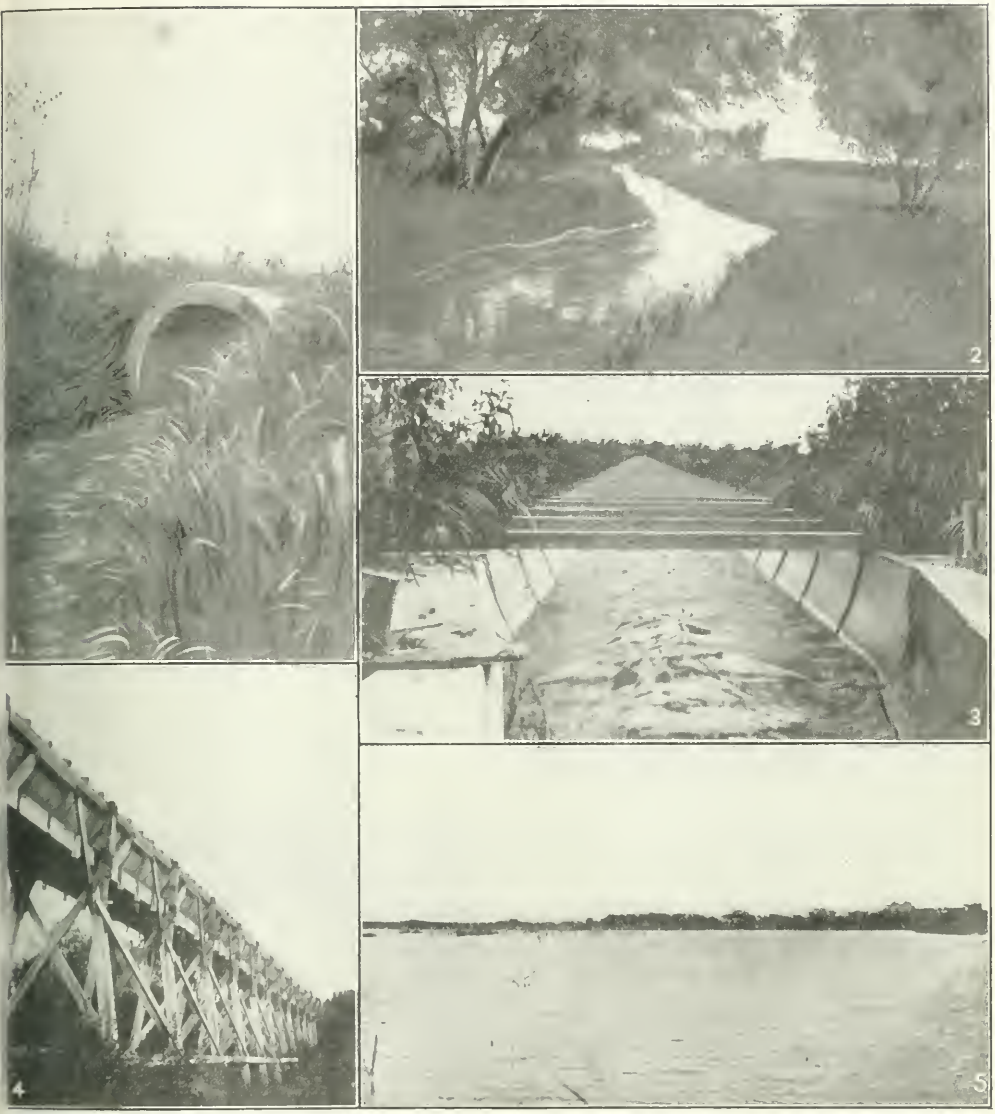
*Of Bartlett & Ranney, Inc., Consulting Engineers, San Antonio, Tex.



UTILIZING SEWAGE FOR BROAD IRRIGATION, SAN ANTONIO, TEX.

1—Outlet of 72-in. sewer. 2—Sewer ditch 4 mi. below city limits. 3—Hess metallic flume on sewer ditch. 4—Carrying Hess metallic flume on old bents that originally carried cypress box flume. 5—Looking over 900-acre lake for storing sewage flow

The bed of the Medina lies some 60 ft. lower than he general level of the irrigated lands and there is a mall seepage flow into it which has caused no nuisance.

The results of the disposal from the standpoint of voidance of nuisance are extremely successful. Along he line of the ditch there is in warm weather some odor ut this is never noticeable at greater distances than 00 yd. to leeward. The broad, shallow lake with partial ilution and abundant opportunity for sedimentation and xidation effects a high degree of purification and there no odor from it except a slight marshy smell, detected especially in warm weather. The water of the lake, while inoffensive, is distinguishably green with algæ.

From a commercial standpoint the Irrigation Company appears to be successful, judging by continued improvements to the irrigation and farm structures and its solvency throughout the past 15 years.

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Government Forest Reservations in the Appalachian and White Mountain regions now aggregate 1,396,367 acres, including in this about 67,000 acres in 59 tracts whose purchase has just been approved by the National Forest Reservation Commission.

Large Mill-Refuse Burner Built of Concrete and Brick

By N. J. Blagen*

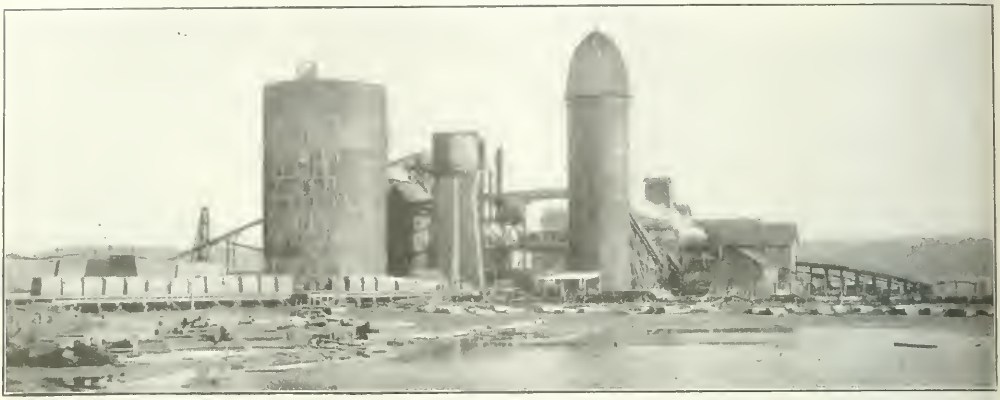

FIG. 1. CONCRETE WASTE BURNER; GRAY'S HARBOR LUMBER CO., HOQUIAM, WASH.

A concrete lumber-waste burner 63 ft. 8 in. in diameter and 104 ft. high, which has proved to be of unusual interest to engineers and mill owners, has just been completed by the Gray's Harbor Lumber Co., at Hoquiam, Wash. The structure was designed by the writer and son, Frank N. Blagen, mechanical engineer of the lumber company. We selected concrete as the material for the shell in place of steel because of our experience with the two materials under the conditions that had to be considered. Our old burner had a steel shell, and it corroded rapidly because of exposure to salt air. Moreover, the concrete shell could be put up here at half the cost of steel. We have made many successful tests of concrete subjected to much greater heat than a waste-burner shell is ordinarily subjected to; for instance, we have had in service for four years a concrete arch under the bridge-wall of a pair of boilers. It is not subjected to direct fire, but it is so hot on the outside that the hand cannot be held on it. It is still perfect. Our old steel shell has never been hot enough to melt the asphalt on the outside except at the top, where the flames could reach it. We have, however, as a special extra precaution, provided for the complete ventilation of the shell, as will be seen from the design (Fig. 3). We think the burner shell will never get warmer than the sun will make it in summer.

At first we planned building the shell with its outer wall of concrete 8 in. thick for the entire height; we were to have a 4-in. air space and then a second wall 8 in. thick and 10 ft. high, topped by brick going up the rest of the distance. Inside this was a second 4-in. air space and a third wall, this last of brick and only 12 ft. high. Before starting work, however, we changed to a single main wall outside, of 10 in. of concrete, with an inner 8-in. brick wall separated from the first by a 4-in. air space but having for stability, every 2 ft. up and across, a brick projecting out against the concrete of the wall. An 8-in. vent was left about every 4 ft. around the top and bottom, allowing a current of air to circulate up through.

The inner wall was nothing more than good common brick laid in common clay. The clay was ground, dissolved and boiled, and mixed with a very little cement and salt. It was applied thin enough so that the masons spread it with a dipper instead of a trowel; that is, they took a large dipperful and spread it over the top of one course before laying any of the next course. When the next bricks were put down in this thin clay, a joint space of not more than $\frac{1}{16}$ in. was left—just enough to form a bed. When the bricks were all laid, the entire inside was washed down with thin clay, containing no cement but with a little more salt, so that the inside would take a glaze that would protect the brick.

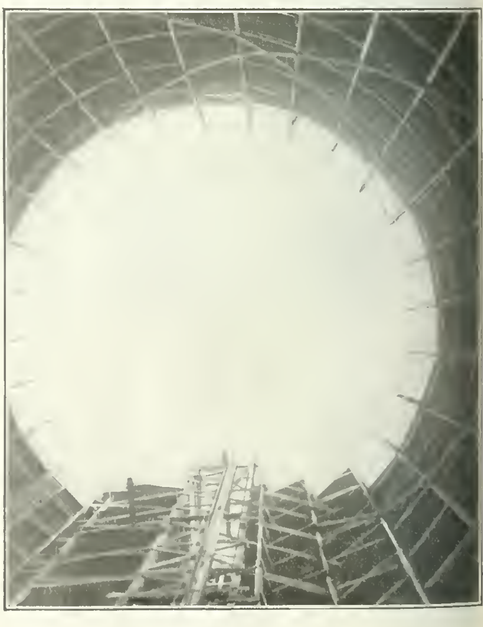

FIG. 2. LOOKING UP INSIDE THE HOQUIAM BURNER

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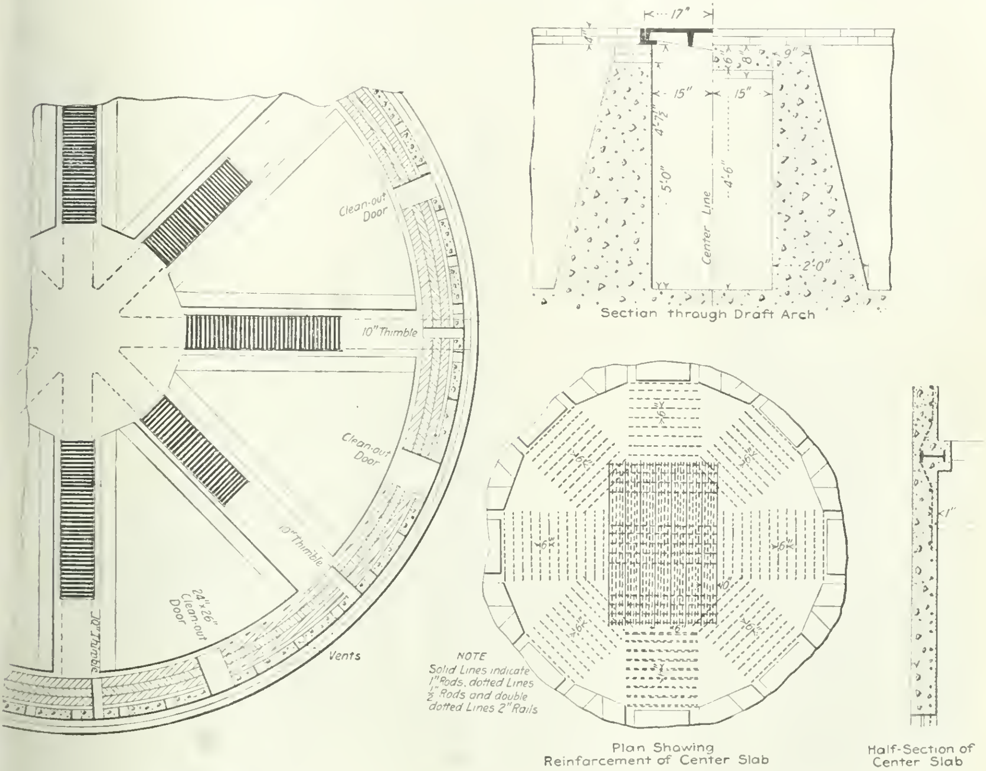
*President and Manager, Gray's Harbor Lumber Co., Hoquiam, Wash.

Laying brick in this way is not new. It has been done out here for many years. Our old steel burner has a ommon brick lining which for seven years has withstood the highest heat any burner of this sort can be subjected to.

The new burner was built on soft-mud tide flats, and it was necessary to drive piles to a depth of 40 ft. to get a firm foundation. They were driven to support 20 ons per pile, though they will not be subjected to a oad greater than 10 tons. Very large piles were selected, veraging fully 20 in. in diameter at the large end. As hey are submerged practically every day, there is no langer of decay within the lifetime of the burner.

The work was all done by day labor and therefore no pecifications were written. We gave our superintendent nstructions from time to time and also closely watched rogress. This was more satisfactory in a small out-ofhe-way place like this than it might have been in a arge city where we could have let the job to a first-class ontractor who we could have been sure would have done ood work and saved us the trouble of looking after he job so closely.

The concrete was an ordinary 1 : 2 : 4 mix, using local and and stone. Mixing was done by a drum mixer. The orms were built out of 8-ft. studding, and the scaffold vas carried up on the inside in 8-ft. lifts. Material was ifted on a platform elevator holding three wheelbarrows. We could pour an 8-ft. lift in one day, and on the next day the men built the scaffolding and forms for another 8-ft. lift. This gave an average progress of 4 ft. per day. We used 8-ft. lifts because we had a lot of 2x6's in that length that had proved a slow seller. Each scaffold was covered with plank as we went up, and we left them there for the brick masons to work on. This would not have been practical for the ordinary contractor, but it was for us with our big stock of low-value short material of the right length to reach from bracket to bracket.



NOTE Solid Lines indicate 1" Rods, dotted Lines ½" Rods and double dotted Lines 2" Rails

Section through Draft Arch

Plan Showing Reinforcement of Center Slab

Half-Section of Center Slab

FIG. 3. DETAILS OF DESIGN. WASTE BURNER OF GRAY'S HARBOR LUMBER CO.

As we laid the brick, we provided small trestles 2 ft. high to be placed next to the wall for the masons to stand on in laying the upper 2 ft. of each lift. This worked out very conveniently and economically. There was ample headroom between each scaffold for the necessary cross-brackets and for braces running under the bracket around the circle. The forms were built by the concrete gang with a few of our millwrights. The concreters not busy on the alternate (form-making) days were set to wheeling in the earth fill on top of the foundation slab. Thus we did a first-class job at a very reasonable cost. The concrete materials cost us about $2.80 per cu.yd.; the labor in concreting the main walls was approximately $1 per yd. The work on the foundations cost about 50c. per yd. of concrete. The entire cost of the structure lined was $17,000, including the top screen, or spark arrester, but not including the conveyor leading to it, which will be about $3,500.

Automatic Skip Handles Hot Ore

By H. V. Schiefer*

The handling of hot nodulized ore from kilns to storage bins by railroad cars at the plant of the Benson Mines Co., Benson Mines, N. Y., is accomplished by the use of a double automatic skip hoist. The red-hot nodulized ore is discharged from two revolving kilns into a storage hopper with two gates in the bottom. In drawing the red-hot material from this hopper a stream of water is sprayed on it, which causes the pit under the hopper to be full of steam and hot water. Any sort of conveyor or elevator was of course out of the question, so a skip hoist was built that is entirely automatic, requiring no inspection whatever in the pit.

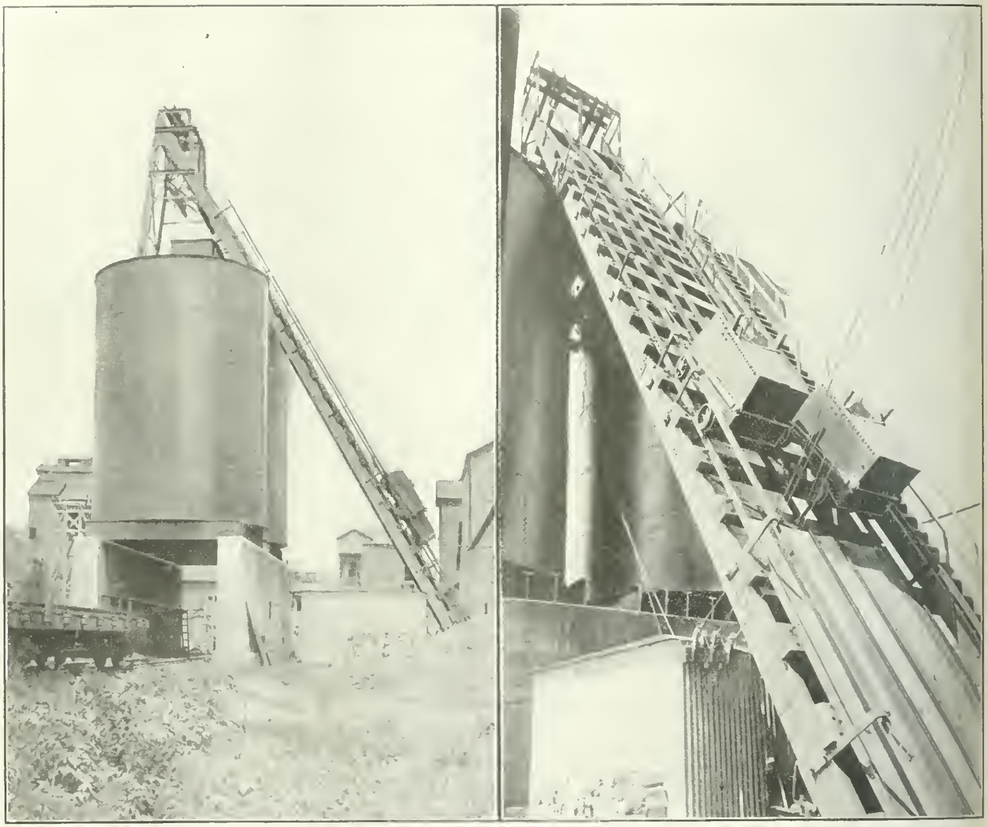


FIG. 1. AUTOMATIC SKIP HOIST FOR HOT ORE AT BENSON MINES, N. Y.

The material handled being of an extremely abrasive character, a gate of unusual and rugged design was adopted. These two gates are furnished with an outside shell of cast steel, with ribs on the inside. Between these ribs is provided a special hard-iron lining. Between the inside lining and the outside cast-steel frame is an air space to assist in the cooling of the gate. For stopping the flow of the material, there is a semicircular cutoff gate on the inside of the stationary gate, operated by a bell crank and connection to the skip-hoist bucket. The construction of this gate is shown in Fig. 4.

There are two skip buckets, in balance, which are 2½ ft. square and 3 ft. long, having a normal capacity of 1½ tons of material weighing 160 lb. per cu.ft. The bottom of the buckets is constructed of ¼-in. plate, and on three sides is provided an extra ¼-in. plate-steel lining fastened on with countersunk-head bolts so that they may be removed when the lining is worn out. The bucket is mounted on two axles of $2\frac{3}{16}$-in. diameter, with the outer ends fitted with flanged rollers, which are keyed to the axles. The axles in turn rotate in a bearing on the under side of the skip bucket. The rollers are 11 in. in diameter. The two rear rollers have special treads, so as to dump the bucket at the discharge end of the skip hoist. The buckets are provided with heavy forged-steel bale bars fastened to the lower end of the bucket.

The skip hoist is entirely automatic. When one skip bucket is in the lower position, it rests on a counterweighted lever. When sufficient weight of material is deposited in the bucket, the load raises the counterweighted lever. This lever, in rising, pulls a rope operating an electric switch, which admits current to the hoist

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*Engineer, C. O. Bartlett & Snow Co., Cleveland, Ohio.

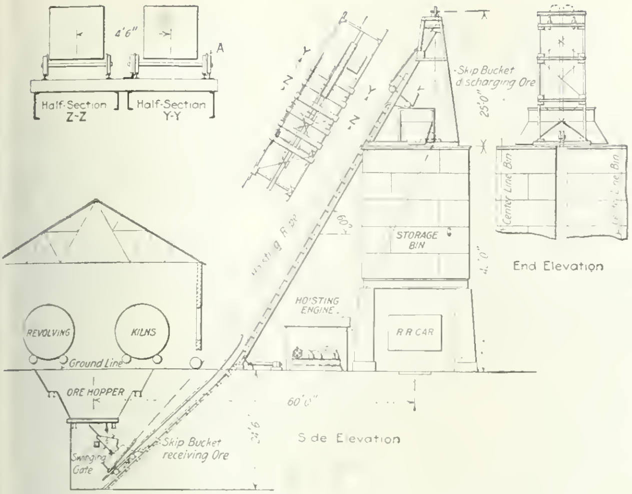

FIG. 2. DETAILS OF AUTOMATIC SKIP HOIST AT BENSON MINES

tor. The bucket then starts upward slowly allowing e counterweighted gate to close, stopping the flow of terial. After a short period of time, by means of an tomatic control system the motor is accelerated and the cket travels at full speed until it is within a few feet the top or dumping position, where it slows down and nes to a stop, at the same time discharging its load. the time one bucket is going up; the other is coming wn, and at the same speed, since both buckets are ached to the same hoisting drums. As the descending cket reaches the bottom, it pulls the gate open by means a dog engaging a lug on the gate and comes to rest on the counterweighted lever, thus completing a cycle of operation. Fig. 4 shows the detailed construction of the mechanical part of the automatic mechanism at the lower end of the skip hoist. As the skip bucket descends, the lug on the bucket *E* engages the roller *G* on the swinging part of the gate *H*; and as the bucket moves down, it pulls the gate open, allowing ore to run into the bucket. The bucket is brought to rest by means of another lug *D* on the bottom of the bucket striking the small carriage *C*, which is mounted on wheels in a guide. This carriage *C* is connected by means of a lever and bell crank to a counterweighted lever on which is mounted the counterweight *A*, which controls the amount of material to be loaded into the bucket. When the bucket receives enough material to raise this counterweight, the electric switch *B* is operated by means of a rod connection, which admits current to the hoisting-engine motor, and the bucket starts upward.

At the top of the runway two sets of rails are provided, one pair for the front wheels of the skip bucket and the other pair, of wider gage, for engaging a special tread on the rear wheels. These wheels are shown at *A*, Fig. 2. As the skip bucket reaches the top, the front wheels run on the rails *A*, Fig. 3, while the rear wheels run on the rails *B*, thus giving bucket its dumping position. As the bucket reaches the position *F*, it strikes a lever *D*, which operates an electric switch *E*, thereby cutting off current from the motor and allowing the solenoid brake on the motor to set, holding the bucket in the dumping position. A bumping block is provided at *C* to prevent over-travel of the bucket.

The ropes used are steel, ⅝ in. in diameter, composed of six strands of 19 wires each; they run over cast-iron sheaves of 24-in. diameter. The hoist consists of a heavy structural-steel base upon which is mounted a 24-in. winding drum which is direct-connected to a 15-hp. 440-volt three-phase 60-cycle induction motor by means of a train of cut spur gears. An electric solenoid brake is mounted on the armature shaft.

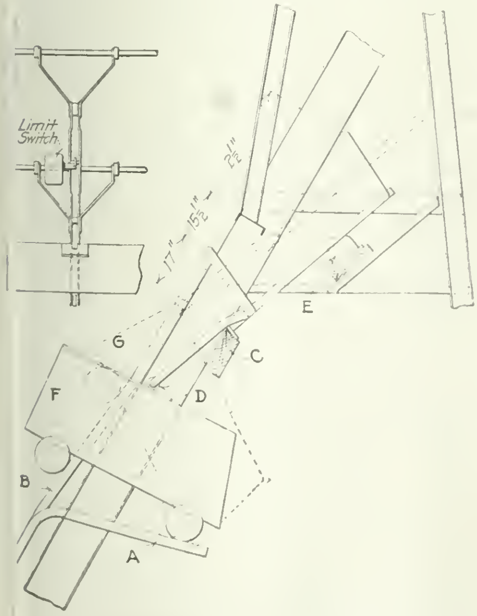

FIG. 3. DUMPING CONTROL AND LIMIT SWITCH

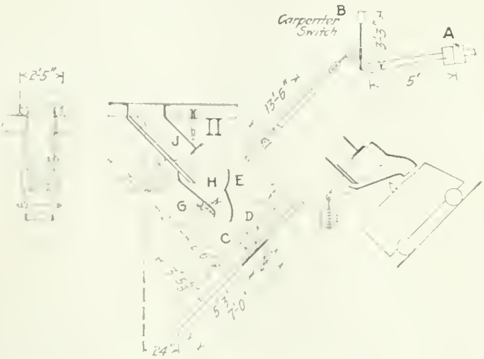

FIG. 4. ORE GATE AND CONTROL

The automatic electric control consists of a plain slate panel, supported on a steel frame on which is mounted a solenoid-operated primary reversing switch, also two solenoid-operated accelerating switches with their current relay. It is interesting to note that the primary reversing switch opens but two of three phases, this being all that is necessary to handle in order to reverse the motor. The third phase remains permanently connected to the line. The accelerating switches automatically cut resistance out of the rotor circuit under control of current relays. Th solenoid switches are so designed as to cut one step o resistance out of the three phases of the rotor circui simultaneously, thereby maintaining a proper electrica balance at all times. There is also provided an emergenc switch so that the skip hoist can be operated by hand i so desired.

The skip hoist was designed and patented by the C. O Bartlett & Snow Co., Cleveland, Ohio.

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Reinforced-Concrete Pipe Used for Railway Culverts

SYNOPSIS—Many railways are now using reinforced-concrete pipe for culverts, and some are making their own pipe. This article describes several different types adopted on Western roads.

Reinforced-concrete pipe is being used very extensively for railway culverts, many roads employing it on a large scale. It is of two different types, circular and slightly oval in section, and is made with either bell or sleeve joints, the latter giving a flush or even surface to the culvert. Of thirty-five railways using these culverts, twenty-six purchase the pipe, which is made usually to the manufacturers' specifications, though a few of the roads have it manufactured to their own specifications. Six railways make the pipe at their own plants, and three of them both manufacture and purchase the pipe. The railway plants have capacities of 40 to 250 lin.ft. per day.

The Great Northern Ry. purchases the pipe, but has it made to its own plans and specifications, though it is thought that the pipe might be cheaper if made by company forces. Both bell and sleeve joints are used, the latter being shown in Fig. 1. The pipe is slightly oval in section, and has a single course of reinforcing rings which are so bent as to lie near the inner surface at top and bottom and near the outer surface at the sides. At each end there is a wrapping of triangular-mesh wire netting; that at the socket end lies near the outer surface while that at the spigot end lies near the inner surface. To insure accuracy in placing the pipe with its longer axis vertical, the word "top" is stamped at top and bottom.

The nominal 60-in. pipe is 60 in. wide and 67 in. high, made in lengths of 6 ft., with a 4-in. socket and spigot, making an effective length of 5 ft. 1 in. It has 16 longitudinal deformed bars and 15 hoops. The latter have 15-in. laps, which are located at 45° from the vertical axis and are wrapped with wire. The pipe has 1.93 yd. of concrete and 307.6 lb. of steel; it weighs about 7,880 lb. For smaller sizes, a greater length is used, the 36-in. pipe (36x10 in.) being 8 ft. long over all. This weighs about 1,300 lb., with 1.06 yd. of concrete and 111.2 lb. of steel.

The concrete mix is 1 : 1½ : 4. The coarse aggregate may be stone passing a 1-in. and retained by a ¼-in. screen, or clean gravel that will pass a 1-in. screen. The forms are specified to be of metal or lined with metal, with all edges filleted, and the form is greased before each pipe is made. The concrete is to be mixed by machin when the amount of pipe is sufficient to warrant this and is to be spaded or puddled against the faces of th mold as it is deposited. Special care is to be taken t prevent voids and to have the reinforcement thoroughl embedded and in its proper position. The reinforcemen must be not more than 1 in. from the inner surface a top and bottom, and 1 in. from the outer surface at th sides.

The Michigan Central R.R. uses pipe of truly circula section (instead of the oval form noted above and use on several other roads). The circumferential reinforce ment also consists of two concentric sets of circular ring and longitudinal bars, instead of the single set of ring and longitudinals arranged in oval form, as in the pre vious design. This latter arrangement, however, is per mitted. The railway company purchases the pipe, bu has it made to the company's specifications.

This pipe is shown in Fig. 1. The 6-ft. pipe is 7 in. thick, 5 ft. 4 in. long over all, with an effective lengt of 5 ft. All reinforcement is of ½-in. square deforme bars of openhearth medium steel. The rings are space 4 in. c. to c. in each row (with rows staggered), and hav 9-in. laps wrapped with 24 turns of No. 16 wire. The

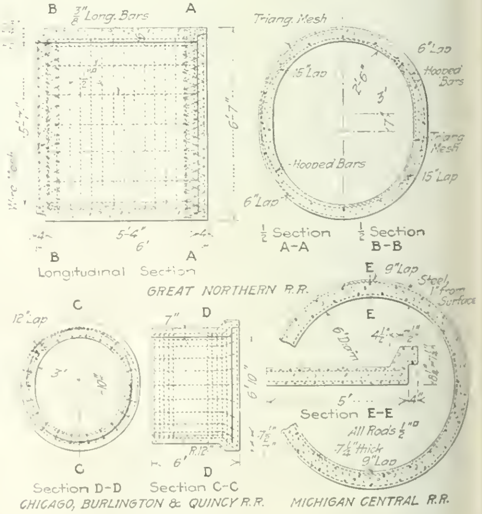

FIG. 1. THREE DESIGNS OF REINFORCED-CONCRETE PIPE FOR RAILWAY CULVERTS

ps or splices are at points 45° from the vertical and rizontal diameters. The longitudinal bars are spaced t less than 12 in. apart, and all intersections are seired with No. 16 wire drawn tight. The 3-ft. pipe is 1¼ in. thick, with ⅜-in. rods placed ¾ in. from the rfaces. This is made in lengths of 6 ft. 4 in., the fective length being 6 ft. The concrete is specified to a 1:2:4 mix, using either gravel or crushed stone hich will pass a 1-in. screen and be held on a ¼-in. reen.

The Chicago, Burlington & Quincy R.R. uses a patted pipe, but finds that it can make the pipe by its n forces cheaper than it can have it made by contract der the railway specifications. This road has two e-making plants. The pipe is of slightly oval secn with bell joints, as shown in Fig. 1. The reinforcing gs are of round steel bars bent to lie near the inner face of top and bottom and near the outer surface the sides. The longitudinal bars are bent to extend o the bell-end.

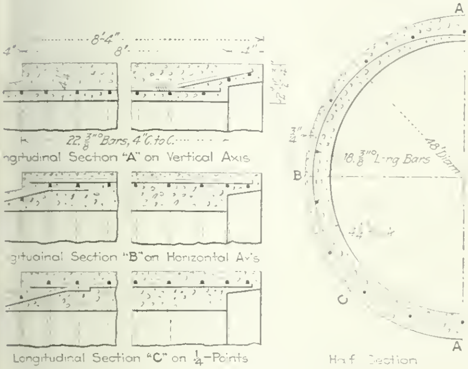
8'-4"
4"
8'
4"
12½"
22-⅜" ⊘ Bars, 4" C. to C.
ngitudinal Section "A" on Vertical Axis
gituainal Section "B" on Horizontal Axis
Longitudinal Section "C" on ¼-Points
A
B
C
A
3/4"
18-⅜" ⊘ Long Bars
48" Diam.
4½"
Half Section

FIG. 2. REINFORCED-CONCRETE CULVERT PIPE, CHICAGO & NORTHWESTERN RY.

The 6-ft. pipe is 6 ft. wide and 6 ft. 10 in. high, 7 thick, made in lengths of 6 ft., or 5 ft. 6 in. effective gth. The rings are either of ½-in. square bars 3½ c. to c., or ⅝-in. round bars 4 in. c. to c., with a gle 12-in. lap. The longitudinal bars are ½ in. square round. . Each length of pipe contains 3.5 cu.yd. of crete and 523 lb. of steel. The 4-ft. pipe is 4 ft. by t. 4 in., in 8-ft. lengths, which have an effective length 7 ft. 8 in.

The Chicago & Northwestern Ry. uses sleeve-joint conte pipe which is of true circular section (like that the Michigan Central R.R.), but in which the reinement consists of a single set of oval rings and a gle row of longitudinals as in the other pipes menned. In pipe from 18 to 30 in. in diameter the cirnferential reinforcement consists of a sheet of triangar-mesh wire netting, but in 36- to 60-in. pipe it is of l rings.

The sizes of reinforced-concrete culvert pipe range m 12 in. to 7 ft. in diameter. Some roads use a le range including both these sizes; others use a smaller ge, such as from 18 to 48 in., or 24 to 72 in. As the cost, roads which make their pipe consider that cost is less than if purchased; some roads which purse pipe consider that they could make it at lower cost provided it was made in large quantities. The approximate range of quoted cost for pipe purchased and manufactured by the railways is shown in the accompanying table.

The minimum time for curing ranges from 40 to 60 days, and some roads require that all pipe laid must be at least 90 days old. Failures and breakages seem to be so limited as to be insignificant; green pipe is an occasional cause of failure, and breakage occurs generally in handling. Practice seems to be about equally divided as to cementing the joints, and one road reports that cement is used only in the bottom of the joint. The minimum depth from the base of rail to top of pipe is 18 in. in one case, and from 2 to 6 ft. in other cases. Some roads limit this depth to a maximum of 20 ft., others have no limit, and one road uses these culverts in banks as high as 65 ft. The Rock Island lines have two classes of pipe, one for fills up to 20 ft. high and the other (of heavier construction) for greater heights.

REINFORCED-CONCRETE CULVERT PIPE

Size, In.	Cost per Lin.Ft. Purchased, Dollars	Cost per Lin.Ft. Made by Railway, Dollars	Thickness, In.	Length, Ft.	Wt. per Ft.-Lb.
24	0.95 to 2.50	0.66 to 1.78	2 to 4½	2 to 6	225 to 405
36	2.10 to 4.00	1.00 to 2.40	3 to 5	2 to 8	445 to 590
48	4.04 to 5.75	1.47 to 2.88	4 to 6	6 to 8	815 to 890
60	5.00 to 8.00	2.54	5 to 7½	6	1,200
72	10.00		7	6	1,700
84	15.00		7	6½	2,000

The thickness and length of the pipe vary widely, especially in the smaller sizes, as shown by the table. The weight is also very variable, due to the thickness and steel reinforcement. Thus in 24-in. pipe there are weights of 225 lb. per ft. for 2-in., 260 to 405 lb. for 3-in., and 395 lb. for 4½-in.; 36-in. pipe varies from 445 lb. for 3-in. to 590 lb. for 4-in.; and 48-in. pipe varies from 815 lb. for 4¼-in. to 933 lb. for 5½-in. and 980 lb. for 5-in. pipe. In the large sizes the weight is about 1,200 lb. per ft. for 60-in., 1,700 lb. for 72-in. and 2,000 lb. for 84-in.

In distributing the pipes, they are generally rolled from the cars to the roadbed, except that the larger ones are slid off by means of tackle. The largest sizes are handled by a derrick. The pipes may be hauled into place on skids with the aid of tackle. In laying them under trestles which are to be filled, however, the Fort Dodge, Des Moines & Southern Ry. uses a derrick car which picks up the pipes from the roadbed, carries it out on the trestle and lowers it into position.

The large 84-in. pipes (84x89 in.) are used for cattle-passes on the Minneapolis, St. Paul & Sault Ste. Marie Ry., and for this purpose the bottom has a flat floor for a width of 2 ft. These pipes were made by the C. F. Massey Co., of Chicago, whose standard design of pipe is made in this oval form. Their pipe is in sizes from 12x16 in. to 72x78 in., weighing 82 to 1,546 lb. per lin.ft.

The information given in the foregoing as to the use of reinforced-concrete pipe for railway culverts has been obtained from several railways and from detailed statistics prepared by a committee of the American Railway Bridge and Building Association.

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A Demand for Highway Engineers exists today, according to statistics compiled by the National Automobile Chamber of Commerce, whose headquarters are in New York City. It is claimed that nearly 1,600 engineers are now employed by the 24 state commissions, and in addition about 2,000 are employed as county and city engineers in 19 of the states; salaries of highway engineers range from $900 to $5,000 a year, the average being about $1,800.

Water-Works Service Pipes*

The committee began its investigations by requesting information in regard to the materials and methods used in service-pipe construction, the troubles experienced and other matters which appeared to the committee to be of interest in this connection.

At two meetings of the committee a number of superintendents who appeared to have had exceptional opportunities to obtain valuable experience along lines which it seemed important to investigate were invited to be present, and each of these men was in turn questioned in regard to the details of his practice and experience.

In considering the information contained in the replies received, it should be borne in mind that the returns [248] from New England included a large number of small places. The returns from outside of New England [56] are chiefly confined to larger places.

Materials Used for Service Pipes

The returns in regard to the material now used for new services may be summarized as follows: Wrought iron or steel, 13; galvanized iron, 145; lead, 48; lead lined, 13; cement lined, 37; galvanized and lead, 11; galvanized and cement lined, 4; galvanized, lead and cement lined, 2; galvanized and lead lined, 10; iron and cement lined, 2; cement lined and lead lined, 1; cement lined and lead, 2; lead and lead lined, 4; lead and wrought iron, 3; miscellaneous, 6; total, 304.

The use of plain wrought iron or steel is becoming rare, while nearly one-half of the places sending in reports now use galvanized wrought iron or steel exclusively; in 56% of the places galvanized iron is used either exclusively or in part. In 95 places lead or lead-lined pipes are used, and cement-lined pipes in 48 places. It is noticeable that the use of cement-lined pipe is largely confined to Massachusetts and New Hampshire, 46 of the 48 places using it being in these two states.

Of the new water-works systems—those constructed within the past 10 years—the following materials have been used for services: Galvanized, 24; plain wrought iron, 1; lead, 2; cement lined, 9.

The disfavor with which plain iron and steel are regarded is shown by the fact that 22 places have changed from these materials to some other, while only one place has reported as having taken up this material. Galvanized pipe, on the other hand, has lost only 17 while gaining 46. Lead and lead-lined pipes have gained 18 and 16 places respectively and lost 6 and 8. Changes to cement-lined pipes have occurred in 11 places, and changes from cement-lined pipes to some other material have occurred in 27 places.

A comparison of the number of places now using the different materials with the number of places where this material has been abandoned shows that 63% of those formerly using plain iron or steel pipes have changed to some other material. Eight per cent. have changed from galvanized iron, 19% from lead or lead lined and 12% from cement lined.

The changes from plain and galvanized pipes are almost entirely on account of rust. The changes from lead pipes are largely on account of the possibility of lead poisoning, although in some cases it has been on account of expens or because of the bursting of the pipes under pressure. Lead-lined pipe has been abandoned on account of lead poisoning and trouble from bursting and because of the difficulty in making joints which will not corrode. Of 20 places reporting the abandonment of cement-lined pipes. 8 were on account of trouble at the joints, 6 for convenience. 2 on account of expense, 1 on account of the diffi culty in getting good work, 1 because of rust. 1 becaus the cement broke off, 1 because of outside rust.

A large proportion of the places where the works hav been in operation for a sufficient time report trouble wit service pipes no matter what the material used, excep in the case of cement-lined pipes. With cement-line pipes 54% of the places heard from report little or n trouble. With galvanized pipe 36% of the places repor little or no trouble, and with lead pipe 10% so report The trouble with iron and steel pipes, both plain and galvanized, appears to be through the entire length of th pipe. The trouble with lead pipes appears largely at th corporation cock. The trouble with cement-lined pipe is very largely corrosion of the outside of the pipe jus inside the cellar walls, with some trouble at the lea gooseneck.

The main sources of trouble from corrosion are largel inside the pipes, due to the action of the water. I certain soils, however, there is a rapid corrosion of th pipes on the outside, and in case the inside is protected as in the case of cement-lined pipes, this is the main sourc of trouble. Pipes laid in salt marsh or in cinder-fill ar certain to be acted upon rapidly. Pipes in clay are muc more subject to corrosion on the outside than those in san or gravel. One of the common places where trouble occur is at the corporation cock, or where a gooseneck is use at the junction of the gooseneck with the service pip Some of the troubles at the corporation cock are due to th tuberculation of the main pipe, which tends to cover th corporation cock. This can be overcome in a large measu by inserting the corporation cock well beyond the inside o the main.

Plain Wrought Iron and Steel

The committee believes that there are very few cas where the use of either wrought iron or steel pipes wit out some protective coating for services is justifiable. The are certain to become filled with rust, and the expense cleaning or renewing them will much more than offs the extra first cost of construction. Covering the met with some protective paint seems to increase its life bu slightly.

The experience of water-works superintendents as in dicated by the returns and as shown by previous discus sions in the meetings of the association is decidedl unfavorable to steel pipe, and while, undoubtedly, man of those who argue in favor of wrought-iron pipe ma be unfamiliar with anything else and believe in it be cause they were taught to believe in it, there is certainl a large number of reliable men who have had an extende experience with both materials who are firmly convince that wrought iron is much superior to steel, and ther must be some good reason for this belief.

The feeling against steel pipe appears to be chiefl confined to New England, for it is undoubtedly a fac that a majority of pipes used in other sections of th country are of steel, and it is apparent that no mo ouble is experienced from the use of steel in these places ıan is experienced from the use of wrought iron in this cinity.

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*Portions of preliminary Report of Committee on Service Pipes, submitted to the New England Water-Works Association, Sept. 14, 1916, by W. S. Johnson, H. W. Clark, George A. Stacey, William F. Sullivan and A. E. Martin. The full report will appear in the "Journal" of the Association.

Galvanized Pipe and Lead Pipe

The chief trouble with galvanized pipe is in the joints, ıere the water gets directly at the iron, and in the im-ɪrfect covering of the iron. As pipes are manufactured, ere is a large quantity of scale left on the pipe, especially the inside. When the scale becomes loose, as it in-riably will, the metal of the pipes is exposed in spots rectly to the action of the water and corrosion begins, ıich tends to loosen still further the scale, and soon the pe is little better than an uncoated pipe. One of the ›el companies has now perfected a method of removing ıle from the pipes which would seem to be of enormous vantage both in decreasing the friction in the pipe and making it possible to obtain a much more durable ıting of zinc when galvanized.

Galvanized pipe appears to be the cheapest practical ıterial for services where the class of street surfacing not such as to make the renewal of the services a mat-· of great expense. Whether steel pipe is as durable ıen galvanized as is wrought iron, is a matter which is n to discussion. If the galvanizing is perfect, it would ıke little difference whether the metal under the zinc isted corrosion more or less. With the process for re-›ving scale above referred to, it would seem that a long p had been made toward getting a perfect galvanized ɔe.

Lead is in many respects the most satisfactory material use for service pipes. Its pliability and its compara-e freedom from corrosive action make it almost ideal m a mechanical standpoint. The cost of lead pipe of ficient thickness safely to withstand the pressure is re than the cost of many other materials used for ser-es, but in a paved street the greater duration of life ›bably more than compensates for the extra cost, and in ces where the streets are occupied by other pipes and ıduits the case of getting over and under these obstruc-ns with a flexible pipe is a great advantage.

The most serious objection to the use of lead pipe for vices is the possibility that the water may dissolve ›ugh lead from the pipe to cause lead poisoning. It certain that many cases of lead poisoning have been ısed by the use of lead services. On the other hand, d has always been used for services in most of the ge places without any unfavorable effects.

It seems to be practically impossible to determine defi-ely in advance what the effect of any water on lead ›e will be, as the laboratory results fail in many cases show the action which will occur in actual practice. sts of service pipes in use for a considerable period are only safe guides.

Lead-Lined and Cement-Lined Pipes

Lead-lined pipe as manufactured several years ago gave ıch trouble from the separation of the lead lining from iron, leaving the metal exposed to the water. The ›e as manufactured today, however, appears to be dur-e and prevents the corrosion of the iron or steel very ectively. It would seem that the life of such pipe ıuld be limited only by the corrosion of the outside the pipe. The expense of the lead-lined pipe is much than that of lead pipe.

Cement-lined pipes, if properly constructed, make ideal service pipes as far as the interior of the pipe is concerned. The cement is not acted upon by water, and the interior of the pipe will remain smooth for an indefinite time. There are many places where cement-lined pipes have been in use for many years without any trouble, and there are many others where they have given so much trouble that their use has been discontinued. The reason for the troubles which have been experienced are found to be generally the improper lining of the pipes or the use of fittings which did not prevent the water from getting to the metal.

Trouble with cement-lined service occurs most frequently from corrosion on the outside of the pipe, and especially where the pipe enters the cellar. In many cases the action on the outside of the pipe is quite rapid, and samples have been submitted to the committee where the iron has been completely eaten through and nothing but the cement remains to hold the water. This rapid corrosion is undoubtedly due to the dampness inside the cellar wall. Various methods have been suggested for remedying this. A short piece of the pipe where it passes through the cellar wall may be incased in cement. Another suggestion is that a coupling be placed just outside the wall, so that the corroded piece may be readily removed and replaced. Still another method is to put in a short section of brass pipe where it passes through the wall.

Size of Service

The standard size for services is ordinarily ¾ in., but in several cases this size has been increased to 1 in. or even to 1¼ in. for the purpose, chiefly, of lengthening the life of the service. Where plain or galvanized steel or wrought-iron pipes are used, the pipes soon fill up with rust, but the service which they render is fairly satisfactory until the pipes become nearly choked, when they must be cleaned. A 1-in. pipe has about twice the area of ¾-in. pipe and will probably last at least twice as long before it will require cleaning.

Rigid connections with the main and the omission of the goosenecks are used in a large number of places, and in some places such connections are used exclusively. Rigid connections make a considerable saving in the first cost, and are much more readily cleaned. On the other hand, the gooseneck permits the dropping of the service below the main and away from frost, and it is possible to make the service take any direction from the main.

Where rigid connections are used it is necessary to have a good soil in which the pipes will not settle, and it is necessary to have the pipes rest on a firm foundation, as any settlement in the service pipe near the main will cause the service to break. The digging up of the street near the main may also cause trouble to rigid connections. The fact that 83 of the towns reporting use rigid connections to a greater or less extent, and that 56 of these report no trouble and many others "little trouble" or "some trouble," would indicate that the use of rigid connections is thoroughly practicable.

During the past few years great advances have been made in the methods of cleaning service pipes, and it is now possible to save large sums which have heretofore been paid for digging up the services and for renewals. The committee has not discussed the merits of the different types of cleaners, but all of them seem to have some merit. The most satisfactory in many cases, and especially with lead pipes or when goosenecks are used, is the force pump and wad of paper which permits the cleaning of the gooseneck and corporation cock as well as the straight pipe.

Method of Paying for Services

Custom varies as to the method of charging for services, but in New England the general custom is for the department to pay for the service from the main to the curb cock or to the property line, the remainder being paid for by the owner. Outside of New England the custom appears to be quite different, and in the majority of places making returns the customer is obliged to pay practically all of the cost of the service from the main to the house.

The almost universal opinion among superintendents, especially in New England, is that the water department should lay and maintain all the services from the main to the stop-and-waste in the cellar whatever portion of the expense may be borne by the department. The cities and towns in which this is not now done are comparatively few, and in these places the superintendents in many cases have expressed the opinion that it would be wise for the department to take charge of the entire service.

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Building the Storm King Road

An extremely difficult piece of mountain-road construction between West Point and Cornwall Landing, N. Y., is now well under way.

This short stretch of road, only $4\frac{1}{4}$ mi. in length, is the last link needed to make a continuous highway on the west side of the Hudson River, between New York and Albany. The road has to be built along the steep rocky slopes of Storm King and Crow Nest mountains where there has never been even a footpath. These mountains slope steeply down to the river, where a narrow shelf has been blasted away for the tracks of the Wes Shore R.R.

So steep and inaccessible are some of the slopes alon which the road has to be built that in making survey for the road, cans of white paint were fired from a sma cannon against the face of the cliff to make a mark a which the surveyors could direct their instruments. Th surveys and plans for the road, made three years ago whil John S. Carlisle was Highway Commissioner of New York, were described in *Engineering News*, Oct. 1 1915, p. 721. A contract for a part of the road wa let under Mr. Carlisle, but was annulled when Commissioner Duffey took office, as the plans on which the roa was then being built promised to exceed the availabl appropriation. The work was readvertised and the contract let to the John L. Hayes Construction Co. on Jul 26, 1915, the contract price being $273,736.70 and th length of road $4\frac{1}{4}$ mi. Work started in the middle August, 1915, and continued until the severe weather December brought it to a close. It started again Ap 1 and is now being prosecuted at four points on th north division of the project.

The road starts at Bay View Ave., Cornwall, and ris gradually along the side of the mountain to an elevatio of 390 ft. above the river. About 800 ft. of this se tion has been rough-graded, and a small gang of me with a 10-ton derrick is now working. Work is also progress at three other points, the gangs amounting 120 men.

Last fall also about 2,400 ft. on the West Point en was rough-graded. The most work was done at the ravin between Storm King and Crow Nest. Here a 10x15-f stone culvert 154 ft. long was constructed. The fill ov this culvert is 60 ft. high and contains 42,000 y

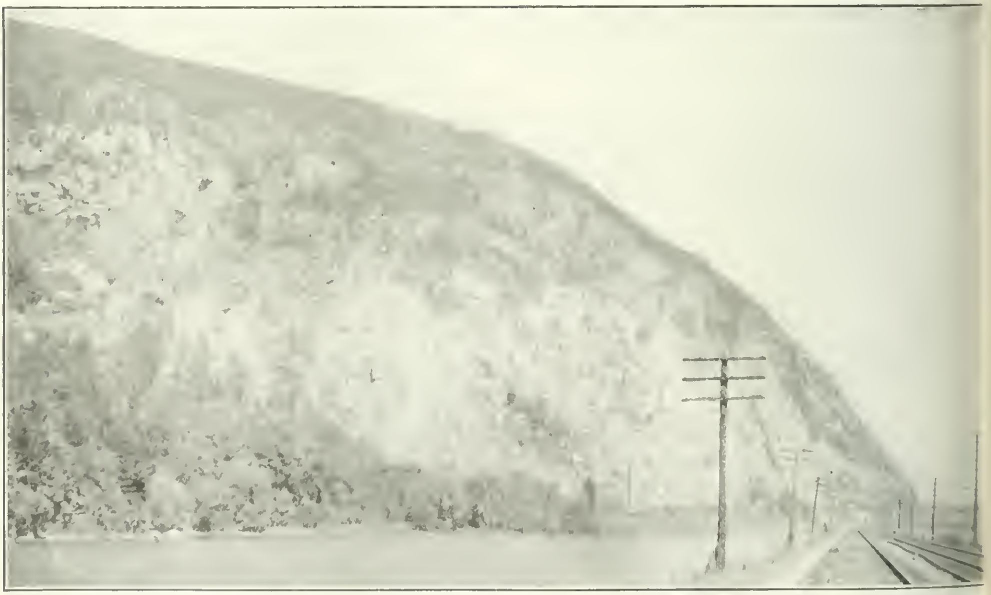
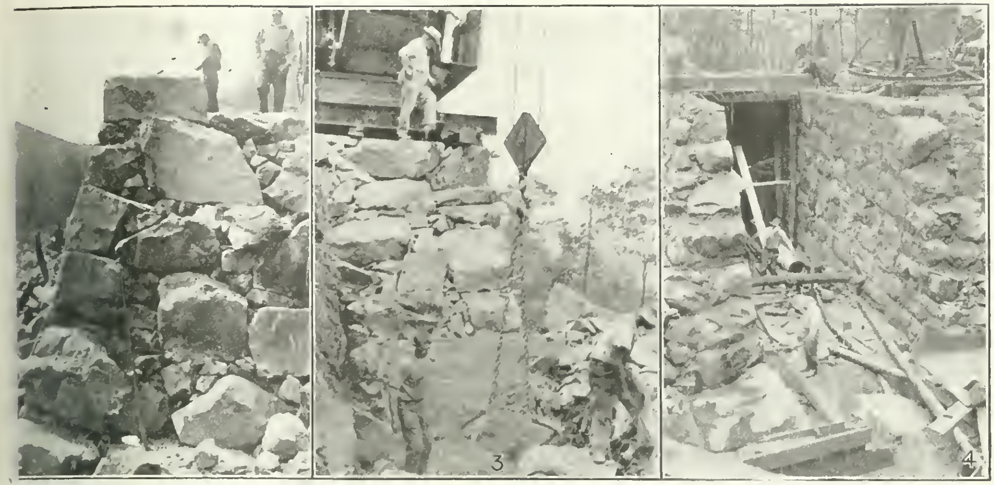


FIG. 1. STORM KING MOUNTAIN LOOKING SOUTH; ROAD LOCATED HALFWAY UP THE MOUNTAIN



FIGS 2 TO 4. TWO VIEWS OF DRY MASONRY WALL CONSTRUCTION, AND THE LARGEST CULVERT

Just above this ravine fill a gang started blasting and ilding on Storm King in the direction of Cornwall. the foot of the mountain is the abandoned Storm ng rock crusher, the quarry property of which (ex- sive of machinery) has been purchased by the state. ck from the blasting fell upon the crusher building. cause of this, about the middle of August, an injunction filed restraining the contractor from further work this location.

The most difficult portion of the work at the present e is along the slopes of Crow Nest Mountain (Sta. 112). The ground here is very precipitous and gged. Machinery can be moved forward at no faster e than the advance of the road itself. This condition, ugh aggravated here, is by no means peculiar to Crow st, but is a very general condition and one that har- s the contractor.

The roadway is 21 ft. wide and the present plan is to e it with 16 ft. of bituminous macadam. The road nearly all in side-hill cut, the fill on the lower side ng held by retaining walls, 10 to 50 ft. high. The ting courses of the retaining wall are laid up in mor- for a depth of 3 to 8 ft. and above that a dry wall laid. These dry rubble walls are laid with a batter 2 in. per ft. on the face and 1 in. per ft. on the back. stone parapet laid up in mortar, with rough coping, built on top of the wall. Weep pipes 1 in. in diam- r are provided at 10-ft. intervals.

All the excavation is done by hand. Sand and cement the footing mortar is delivered in bags by boat at eral points along the river and is transported by hand oss the West Shore R.R. tracks, and then carried up mountain side either by mule and stone boat or by a d-operated cable railroad having a maximum grade 55%.

All the machinery is air operated. The compressor nt, located at Sta. 25, was purchased from the Oscar niels Co. and is one formerly used in building the tskill Aqueduct. Mr. Hayes has not had to move the nt, having obtained a three-year lease for the ground which it stands from the Board of Water Supply. e capacity of the plant is 1,100 cu.ft. per min. It is the Ingersoll "Imperial" type and electric driven. The 4-in. air line is 3 mi. long. In colder weather no difficulty is experienced with condensation. In the summer season, however, this is something of a problem. The air is of good quality on the high line, but the condensation is troublesome on the low line and numerous blow-offs must be provided. The connected load on the air line comprises 12 Jackhamers, two cranes, three hoists, four blacksmith forges and a steel-sharpening machine.

The slope on which the work is carried on is so steep that much of the rock blasted slides down onto the railroad tracks, sometimes breaking a rail. To minimize this danger, logs of greater diameter than the height of a 105-lb. rail are placed along all rails in the immediate vicinity of a blast. The railroad permits shooting at 8, 10:50 and 11:30 a.m., and at 1:45 and 4 p.m. On the right-of-way below where the work is being prosecuted on Crow Nest, there is a dispatcher's telephone and two local telephones for flagmen. Another local telephone has been installed for the contractor on the mountain. Prior to a blast a barricade is built below the line of the road. This has some effect in checking the fall of material. Barring down has been tried instead of blasting, but much rock slid down the mountain, just the same.

On Crow Nest Mountain about 350 ft. of road has been rough graded (extremely rough) and this particular strip has required three months' work. On this section the rocks are handled by a two-drum valveless hoist built by the Dake Co. This machine weighs only 1,200 lb. and lifts one ton on a single line and three or four tons with a double block.

John L. Hayes is in personal charge of the work, his superintendent being A. C. Perkins. J. L. Wissing is county assistant and is located at Cornwall Landing.

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World's Busiest Street—On Fifth Ave. at 42nd St the heaviest traffic of any city in the world exists according to a recent count. Between 3 30 and 4 30 p.m. 1,149 vehicles were counted proceeding south. The top figure for the Strand, London, is 900 vehicles per hour, and in Paris, the record is 600 in an hour on the Boulevard de Capucines.—E. W. Stern, in Annual Report of Bureau of Highways.

Refuse Incinerator for Queens Borough, New York City

By J. C. Woodman*

SYNOPSIS—A 100-ton all-steel water-jacketed Decarie plant that at medium temperature and with forced draft burns refuse consisting largely of garbage without the use of commercial fuel.

A refuse destructor with a daily capacity of 100 tons was put into operation in April, 1916, by the Borough of Queens, New York City, and has since been consuming a very wet mixture of refuse without the use of any commercial fuel whatever and without creating any nuisance to the surrounding residence districts. The destructor is of the Decarie all-steel water-jacketed design. Kelly & Kelley, Long Island City, were the successful bidders for the installation at $98,700, and the machinery was furnished and set up by the Decarie Incinerator Co., of Minneapolis, Minn.

In the selection and installation of the destructor the Borough of Queens was represented by Daniel Ehntholt, Commissioner of Street Cleaning, and by Hans Liebau, Architect of the Borough.

The plant (Figs. 1 and 2) consists of two 50-ton units very similar in design and arrangement to a single unit of the same capacity at Roanoke, Va., described in *Engineering News* of Apr. 8, 1915. The distinctly sanitary feature of the plant is the absence of any storage bins. All material coming for destruction is dumped from the wagons on the upper floor of the building directly through a hopper opening in the floor. Each unit is capable of holding 16 cu.yd. of refuse at one time without in any way tending to smother the fire. This is possible because of the patented basket-grate construction, which is a distinctive feature of this type of plant and which was described in the article on the Roanoke plant, already mentioned.

Each unit is independent of the other, so they can be operated simultaneously or separately. Each unit has its gas-combustion chamber, preheater, induced- and forced-draft fans. The forced-draft fans are No. 110 Special American Blower Co. fans, and the induced draft fans are No. 8 Sirocco fans made by the same firm. All fans are driven by steam engines, the steam being generated in the water jacket of the furnace by the burning garbage. An electric motor drive is also provided for the

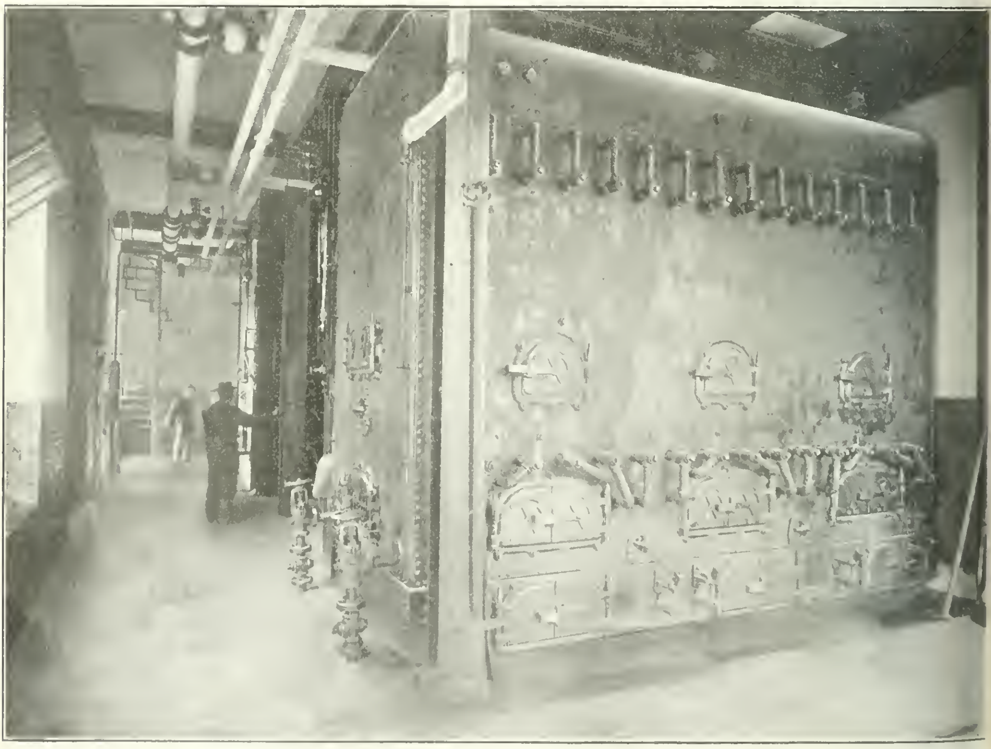

FIG. 1. VIEW OF QUEENS BOROUGH INCINERATOR, NEW YORK CITY, FROM LOWER FLOOR

rced-draft fans to be used in starting up the plant, but date (July 8. 1916) it has not been found necessary use these motors at all.

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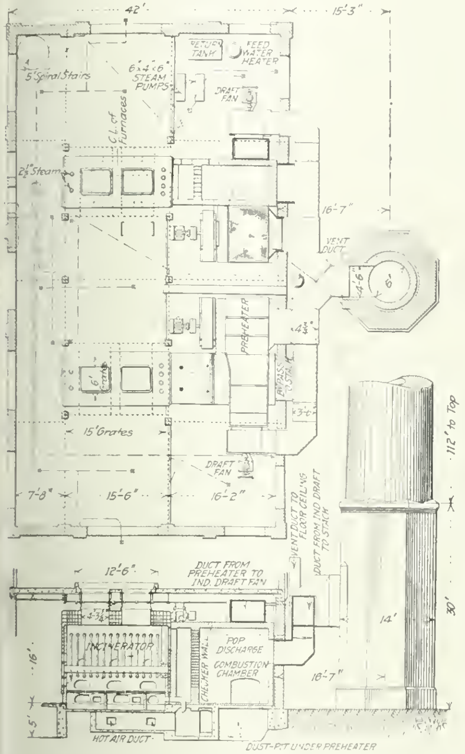
*Superintendent of Construction, Decarie Incinerator Co., Minneapolis, Minn.

The chimney is of radial brick construction, 6 ft. in ımeter by 150 ft. high; lined to the top. The build-



F . 2. GENERAL PLAN AND CROSS-SECTION OF QUEENS BOROUGH REFUSE INCINERATOR

is of heavy brick construction with concrete floors Spanish tile roof. The wagons enter from the street he upper floor over a reinforced-concrete approach 18 wide and 209 ft. long.

he most distinctive results obtained by this destructor the low cost per ton consumed, due to the small amount abor necessary, and the ability to consume the mate- without the use of fuel (see accompanying table). guarantees given by the bidders were substantially ollows:

capacity to consume at the rate of 50 tons in 24 hr in unit operating separately, or to consume 100 tons in 24 when both units were operating.

he material to be consumed to be as collected from day to by the city carts in the Ridgewood section and to be on average a mixture of about 70% wet garbage to 30% of ish.

hat all materials would be consumed to a mineral ash tically free from organic material

hat the plant in its operation would cause no nuisance ugh the escape of obnoxious odors, gases or dust from er the building or the stack.

hat the cost to operate the plant, including all labor, rvision and fuel necessary when both units were working, ld not exceed 60c. per ton, and with either single unit ating not more than 75c. per ton, labor to be figured at er 8-hr day and supervision at $1.50.

hat the cost per ton under the same conditions as above, also including the cost of electric current necessary to operate the forced-draft fans, would not exceed 80c. and 97c respectively.

These guarantees were covered by a $62,000 bond, which has been returned since the plant has been officially accepted by the city. The results of the official test made under supervision of a committee of the Board of Estimate of New York City were as follows:

RESULTS OF TEST ON DECARIE INCINERATOR PLANT AT RIDGEWOOD, BOROUGH OF QUEENS, NEW YORK CITY, MAY, 1916

Date of test	May 8	May 10	May 15
Unit tested	No. 1	No. 2	Nos. 1 and 2
Weather	Clear	Clear	Clear
Duration of test, hr.	17	15.5	17.5
Mixed refuse consumed, lb.—garbage	74,770	71,325	141,681
Mixed refuse consumed, lb.—rubbish	30,585	29,990	60,330
Total material consumed, lb.	105,355	101,315	202,011
Rated capacity of units operated, tons per 24 hr.	50	50	100
% of material, garbage	70.9	70.3	70.1
% of material, rubbish	29.1	29.7	29.9
Refuse consumed per hour, tons	3.09	3.26	5.77
Equivalent incineration in 24 hr., tons	74.16	78.24	138.48
Equivalent incineration per square foot grate per hour, lb.	69.67	72.4	64.1
Labor cost as per terms of contract	$22.31	$20.35	$36.09
Labor cost per ton as per contract	42.3c.	40.1c.	35.7c
Actual labor cost as operated by the city	$28.69	$26.16	$42.65
Actual labor cost per ton as operated by the city	54.5c.	51.6c.	42.2c.
Cost of fuel required per ton	0	0	0
Total cost of operation per ton as per terms of contract	42.3c.	40.1c.	35.7c.
Total cost of operation per ton as actually operated	54.5c.	51.6c.	42.2c.
Guaranteed cost of operation per ton	75c.	75c.	60c.
Condition and amount of smoke	Light white	Light white	Light white
% carbon in free state in the clinker	5.39*	6.58*	1.13
% of ash and clinker produced	9.3	10.7	12.3
Average temperature in combustion chamber of No. 1 unit, ° F.	1,040	....	1,290
Average temperature in combustion chamber of No. 2 unit, ° F.	....	1,161	1,340
Maximum temperature in combustion chamber of No. 1 unit, ° F.	1,580	....	1,650
Maximum temperature in combustion chamber of No. 2 unit, ° F.	....	1,600	1,810
Average temperature of forced draft beneath grates	391	496	510
Average stack draft, in. of water	0.94	0.99	0.98
Average steam pressure on No. 1 unit, lb. per sq.in.	86.2	....	96.0
Average steam pressure on No. 2 unit, lb. per sq.in.	....	93.7	90.0

*The higher percentage of carbon in these two tests was due to the fact that the units were being overloaded to far above capacity, as rate of combustion per square foot of grate will show as compared with rate of combustion in third test, May 15.

The plant exceeded its capacity by 18 to 56% with units operating separately and by 38.5% when both units were working, burning as high as 72.4 lb. of this wet mixture per square foot of grate per hour without any fuel or ashes to help maintain the temperature. The plant is capable of consuming any class of material, wet or dry, or with ashes mixed in with the other refuse.

The analysis of the gases leaving the stack from time to time showed an average of about 6 to 8% of carbon dioxide, an excess of free oxygen of about 16% (due, of course, to the fact that the plant has forced draft), together with a trace of sulphur dioxide. There was no carbon monoxide or hydrogen sulphide present—which, with the absence of any dark heavy smoke, indicated freedom from gases that could cause any nuisance.

The cost per ton to operate under the actual working conditions was from 30 to 40% under the guaranteed costs. The cost, including the electric power, was of course fully met, as no electric power has been necessary to date.

The average temperatures in the gas-combustion chambers show that this type of plant is between the so-called high-temperature class and the slow-burning low-temperature type of plant. The temperature in the furnace proper greatly exceeds this shown, as tin cans, bottles, crockery, dirt, etc., are fused into a vitreous clinker.

The [illegible] feature is that these temperatures could be maintained without having any ashes in the refuse and without using any commercial fuel whatever, even when handling material 50% wet garbage, some of which had been stored on the ground in the rain for several hours. The hot forced draft is an essential feature that helps to obtain these results and to save fuel that might otherwise be necessary.

Complete combustion of the gases is obtained in this plant by maintaining temperatures sufficiently high to ignite these gases and by introducing into the combustion chamber a small stream of hot air from the forced-draft fan so as to get a complete chemical action before the gases reach the stack. Unnecessarily high temperatures are avoided because of a greater maintenance expense that is created when these are produced. An excess of steam over that necessary to operate the plant is generated, and in this installation a small portion of it will be used to heat adjacent city buildings.

Post-Mortem Appraisal of Industrial Plant

By Charles H. Higgins*

The greatest field for post-mortem examinations is in medical science; but in engineering, accounts of them are common after a physical failure, and from them we learn much. There is another kind of failure, to which engineering construction is particularly susceptible, that is equally instructive when the remains are carefully and scientifically examined—the financial failure.

The financial failure of industrial plants is probably as common as their physical failure and may, in fact, be due to the latter. Although the failure to function properly is not so dramatic as a complete physical collapse of a structure, it is not less to be guarded against in design.

A feeling of responsibility and the consequent study of this economic side of the design are perhaps as much as anything what as a rule distinguish the design of the engineer from that of the architect. Consequently, an analysis after financial failure, while no more cheering, may be equally instructive with the analysis so common after physical collapse.

For the reasons mentioned, the analysis of the physical property of a certain industrial plant, which was closed through bankruptcy, is here presented. In common with most descriptions of failures this is not complete, but from the facts presented, suggestions made may be taken to guide the designer of other industrial plants.

The prospectus of the Traders Paper Board Co. appeared in June, 1906, and the plant was constructed during that year. Its history during the latter part of 1907 was one of difficulties not uncommon to industrial plants. But the struggle went on, and it was not until early in 1912 that the property was to be sold by the trustee in bankruptcy, and that the referee appointed appraisers to make an inventory and valuation. The author was one of the appraisers and compiled the unanimous report, the other appraisers being Frank B. Stratford and Charles Behlan.

The plant of the Traders Paper Board Co., as suggested by the name, was built for the purpose of manufacturing the material from which card-board or paste-board boxes are manufactured. The principal raw material used was waste paper.

The following paragraphs from the prospectus of the company are illuminating:

> Capital Investment—The low capital investment of the company, in proportion to its daily output, will afford it an additional advantage over all its competitors. The capital invested in all other similar plants of the country, so far as

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*Consulting Engineer, 30 Church St, New York City

TABLE 1 DETAILS OF APPRAISAL; TRADERS PAPER BOARD CO.

(1)	(2) Buildings	(3) Net Cost	(4) Net Cost plus 12%	(5) % Scrap	(6) Scrap Value	(7) Wearing Value	(8) Av Life	(9) Elapsed Life Years	(10) % of Dep.	(11) Depreciation	(12) Present Value as Going Concern	(13) Annual Dep Str Lin Basis
No. 2	Wells	7,449	8,387			8,387		5	75	6,290	2,097	
3	Reservoir	1,140	1,277			1,277		5	50	639	638	13
4	Dock	4,329	4,848			4,848	25	3	12	582	4,266	261
5, 6	Intake, drain	1,525	1,708			1,708	50	5	10	171	1,537	34
7	Concrete buildings	164,284	183,998			183,998	50	5	10	18,500	165,598	3,680
8	Frame buildings	1,741	1,950			1,950	20	8	40	780	1,170	98
9	Spec. found	9,500	10,640			10,640	25	5	20	2,128	8,512	426
10	Elevators	2,350	2,632	5	132	2,500	25	5	20	500	2,132	100
11	Fire protection	4,768	5,330	3	160	5,170	25	5	20	1,034	4,296	207
12	Air lift	7,700	8,624	6	517	8,107		5	75	6,080	2,544	102
13	Heating	8,000	8,960	5	448	8,512	25	5	20	1,702	7,258	340
14	Lighting	3,145	3,522	8	282	3,240	15	5	33⅓	1,080	2,442	216
		215,951	241,878		1,489	240,337				39,386	202,490	5,477
	Power Plant											
15	Coal machine	4,950	5,544	5	277	5,267	15	5	33⅓	1,756	3,788	385
16	Boilers	15,800	17,696	7	1,239	16,457	15	5	33⅓	5,486	12,211	1,097
17	Economizers	12,825	14,364	6	862	13,502	30	5	16⅔	2,250	12,114	450
18	Stacks	744	833	5	42	791	15	5	16⅔	132	701	26
19	Engines	18,781	21,035	7	1,472	19,563	25	5	20	3,913	17,122	783
20	Generators	2,730	3,058	10	306	2,752	20	5	25	688	2,370	138
21	Pumps	7,509	8,410	6	505	7,905	25	5	20	1,581	6,829	316
22	Motors	1,815	2,033	10	203	1,830	15	5	33⅓	610	1,423	122
23	Wiring	2,350	2,632	11	290	2,342	15	5	33⅓	781	1,851	156
24	Piping	36,742	41,151	7	2,881	38,270	25	5	20	7,654	33,497	1,531
		104,246	116,756		8,078	108,679				24,851	91,906	5,000
	Paper-Making Machinery											
25, 26												
27	Dusters, etc	1,775	1,988	3	60	1,928	15	5	33⅓	643	1,345	129
28	Beaters	14,211	15,916	4	637	15,279	15	5	33⅓	5,093	10,823	1,110
29	Jordans	4,166	4,666	6	280	4,386	25	5	20	877	3,789	175
30	Stuff pipes	800	896	2	18	878	6	3	50	438	458	6
31	Stuff chests	6,816	7,634	1	76	7,558	15	5	33⅓	2,519	5,115	504
32	Pumps	3,600	4,032	6	242	3,790	16	4	25	948	3,084	190
33	Shafting	6,002	6,722	12	807	5,915	25	5	20	1,183	5,539	237
34, 35	Cranes, scales	2,451	2,745	5	137	2,608	25	5	20	522	2,223	104
36	Screens	4,118	4,612	4	184	4,428	15	5	33⅓	1,476	3,136	295
37	Paper machine	85,745	96,034	6	5,762	90,272	25	5	20	18,054	77,980	3,611
38, 39												
40	Binder-cutter	2,500	2,800	5	140	2,660	20	1	20	532	2,268	106
41	Belts	3,279	3,672	10	367	3,305	2	1	50	1,653	2,020	1,653
		135,463	151,717		8,710	143,007				33,938	117,780	8,120
	Grand total	$455,660	$510,349		$18,277	$492,023				$98,175	$112,176	$18,601
Per ton daily capacity		9,114	10,207							1,964	8,244	372

an be ascertained, is from $10,000 to $30,000 per ton of daily utput. One of the plants most recently erected and now onducted upon a very profitable basis shows a capital inested of $10,000 per ton. The capital invested by the Traders aper Board Co. will be only $6,800 per ton, and even this is ased upon buildings and equipment designed for a larger apacity, which, when added, will reduce the capital invested $5,000 per ton of daily output.

Estimated Profits—In estimating the probable cost of manfacture, the company has based its figures upon the long nd practical experiences of Mr. Ivins, thus assuring that no nportant item of cost will be ignored or under-estimated. r. Ivins has furnished to the company the following estiate [cost of production of the cheapest and least profitable rade of paper boards]:

		Per Ton
ost of raw material		$8.00
ost of manufacture:	Per Ton	
Labor	$3.50	
Felts	.25	
Twine	10	
Insurance	.10	
Taxes	.20	
Belting	.15	
Repairs	.80	
Oils	.08	
Fuel	2 65	
		7.83
l expense of management and sales		1.40
Total, f.o.b. Bogota		$17.23

Table No. 2 is a summary of the appraisers' report, and e item "Deduct 40% for forced sale and lack of goingncern element" tells its own tale of a shut-down plant.

TABLE 2. APPRAISAL OF TRADERS PAPER BOARD PLANT, BOGOTA, N J., APRIL, 1912

Summary

nd		$13,480
ilding and appurtenances		202,490
wer plant		91,906
per-making machinery		117,780
ols		1,384
pair parts and tools		10,992
ice furniture and fixtures		992
Present value as going concern		$439,024
duct 40% for forced sale and lack of going-conern element		175,610
Actual present value at forced sale		$263,414
w materials	$8,521	
ished stock	8,300	
	$16,821	
duct 25% for forced sale	4,205	
		12,616
Total actual present value at forced sale		$276,030
ilt, except small part noted, in		1906
tal cubic feet of buildings of all kinds		2,083,000
tal square feet of buildings of all kinds		103,000
tal horsepower, engines		1,200
tal horsepower, boilers		1,600
tal capacity in tons per day of paper board		50
tual present value per ton of daily capacity		$5,528

e property sold at auction by the trustee for close to figure named as the "Total actual present value at ced sale." The view from the wash-drawing perspective blished in the prospectus, illustrates fairly well the aprance of the plant when constructed and at the time the appraisal.

Table 1, from which the principal items in Table 2 are awn, gives in condensed form the details of cost, scrap lue, life, depreciation, present value as a going concern d annual depreciation.

Numbers in the first column of Table 1 refer to secns in the appraisers' report, where the items named the second column are described and where the cost en in column 3 is arrived at through quantities and it prices. Section 2 of the appraisers' report reads as lows:

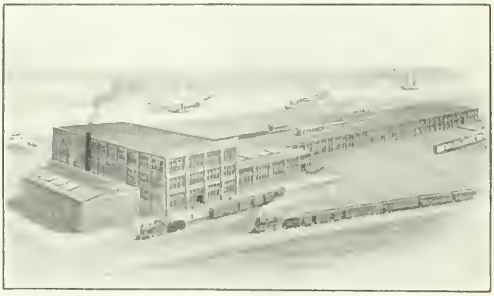
> 2. Wells—Six deep wells, said to be from 354 to 420 ft. p. and one well 128 ft. deep, with 7-ft. screen between 31 d 38 ft. Total, 2,483 lin.ft.; about 40 ft. through drift into dstone. Each of former said to have shown in test by well llers 35 to 40 gal. per min. separately, and the latter 20 gal. r min., 8-in casing. None of the wells has been in use for onsiderable time
>
> Wells, 2,483 lin.ft. @ $3, $7,449.

These wells did not meet expectations as to quantity of water and their use was discontinued. This condition is indicated in column 10 of Table 1 by the high depreciation fixed by the appraisers, to whose minds at the same time there appeared an element of value remaining, as indicated in column 12. Here we have an example of functional depreciation, which appears again in Sections 3 and 12, "Reservoir" and "Air Lift," these devices having been installed for use in connection with the wells. The other items in column 12 indicate depreciation from use—that is to say wear and tear.

Column 4 shows the cost arrived at by adding 12% to the net cost, column 3, this percentage covering overhead charges, such as design, supervision, interest, etc. The scrap values in column 6 deducted from the sums in column 4, give the wearing values in column 7. This represents the amount of investment which is fixed in the plant and can only be returned through operation.

In column 8 are set down the appraisers' estimate of the average life of each group. These simple figures will not be passed over lightly, as on them is largely dependent the final results. Varying as they do in the table from 2 to 50 years, the determination of them draws more heavily on the judgment than any other figures in the table.

The figures in columns 10, 11 and 12 follow naturally from 7, 8 and 9, and bring us to the annual depreciation of each group, shown in column 13. Now, this is the real cost to be borne annually and, taken with columns 4 or 7, is of the greatest interest to the designer in making studies for a truly efficient design. For example, "No. 24, Piping," which cost $11,151, resulted in a lower annual charge than belting, which cost $3,672—that is to say, $1,530 as against $1,653 per year.



PLANT OF TRADERS PAPER BOARD CO., BOGOTA, N. J.

It will be noticed that the plant is divided under three heads—"Buildings," "Power Plant" and "Paper-Making Machinery"; it is interesting to observe that in a plant for a highly specialized purpose the general items of "Building" and "Power Plant" amount to more than double the special item of "Paper-Making Machinery," illustrating how much of a plant for a highly specialized process is, after all, made up of general items common to industrial plants.

Nor should the last item at the foot of the table be overlooked, for here we find cost reduced to terms most clearly illuminating the purpose—namely, cost in terms of producing capacity. In the table, capacity is given in tons per day of 24 hr., while the annual depreciation charge is given in dollars per year. But if we estimate 300 working days in the year, we find a cost of $1.25 per ton of production.

It is interesting to compare this with the figures quoted from the prospectus and to notice how small the item of $1.25 per ton appears as compared with $17 per ton for other charges. The fact, however, cannot be lost sight of that this is a fixed charge, practically independent of the volume of production, and it is not, unlike the other items, to be escaped by closing down the plant. It may be noted that, when the plant was again operated, this item had been cut in half through the property having been bought at the sale for about one-half the original outlay, as mentioned at the beginning.

These are only a few of the interesting things to be gathered from a table arranged in such fashion; and any person, whether designer or owner, with such a table before him for the plant he is proposing to build, will appreciate much better the difference between cheapness and economy and may design for true saving of expense instead of either running into extravagance on the one hand or parsimony on the other. Between them lies the path to the truly efficient design of industrial plants.

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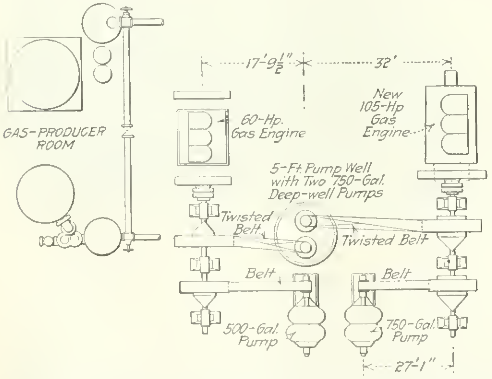
Producer-Gas Engines Drive Water-Works Pumps

The City of Wheaton, Ill. (population 4,000), is making improvements in its water-works system so as to give both increased supply and greater pressure. The city is mainly of a residential character, and is about 25 mi. west of Chicago. Its average daily consumption is 300,000 gal., with a maximum record of 510,000 gal.

The water is obtained from two 10-in. wells, 175 ft. deep, the bottom being in rock for about 65 ft. These wells penetrate a local deposit of glacial drift about 100 ft. deep which constitutes a natural reservoir. This drift is underlaid by Niagara limestone, which contains numerous fissures and cavities that are filled with water from the overlying sand and gravel. Neighboring cities which are not on this body of drift require wells about 2,000 ft. deep.



PLAN OF PRODUCER-GAS PUMPING PLANT FOR THE WATER-WORKS AT WHEATON, ILL. (NOT TO SCALE)

The water level in the drift is about 26 ft. below the surface, and when the pumps are working the water in the wells is about 66 ft. below the surface. The water level has had the same elevation for several years, but it was feared that with increased pumping it might be lowered. At several cities in the northern part of the state, where the water is drawn from deep wells, such a depression of the water table has been observed due to increased pumpage. In these cases, however, the supply is taken from the St. Peters and Potsdam sandstones.

Investigation indicates that there is no liability of serious depression of water level at the Wheaton water-works, since the comparatively shallow wells have such a large body of water to draw upon. If deep wells were sunk, as had been proposed before the investigation was made, these would have probably a much lower water level, while draft on the supply in the lower water-bearing formations which they would tap will be steadily increased in future by additional deep wells in adjoining communities. It was recommended therefore that the city should continue to draw from the wells in the drift rather than sink deeper wells in the underlying rock strata.

The two 175-ft. wells are 20 ft. apart, and about midway between them is a brick-lined pump well 5 ft. in diameter and 34 ft. deep. In this well is an American Well Works vertical-shaft centrifugal pump with a capacity of 600 gal. per min., and having 6-in. connections to the two supply wells. This pump discharges into a covered concrete surface reservoir approximately 32 ft. square and 17 ft. deep, having a capacity of about 116,000 gal.

The total head is only 65 ft., against which the pump delivers about 680 gal. per min. The pump was designed, however, for a capacity of 520 gal. against a total head of 200 ft. in order to enable it to pump directly into the mains under 215 ft. head if necessary. This would give about 30 to 35 lb. fire pressure. The pump is driven from a Nash vertical three-cylinder gas engine of 60 hp., which is supplied with gas from a 75-hp. producer of the suction type, built by R. D. Wood & Co. The producer burns pea-anthracite coal, costing about $5.50 per ton in the bin at the plant. A twisted belt runs over pulleys on the horizontal shaft of the engine and the vertical shaft of the pump.

A service pump, belted to the gas engine, delivers water from the reservoir to a standpipe, 14 ft. in diameter and 120 ft. high, having its top 130 ft. above the mains. This reservoir has a capacity of 138,000 gal. It was built in 1890. The pump can deliver 650 gal. per min. with the standpipe full.

With only one engine and pump there is a risk of trouble from breakdown, and the pumping plant is now being enlarged so as to provide two separate units. For this purpose an additional Nash gas engine (with its own producer) is to be installed, and the present well pump will be replaced with two larger vertical-shaft pumps built by the American Well Works. The new engine, built by the National Meter Co., of New York will be of 105 hp., having three vertical cylinders 13x1 in., and running at 250 r.p.m. It will be served by a gas producer of 125-hp. capacity, of the Sharpe-Bassett type, built by the Reliance Boiler Works, of Milwaukee Wis. The well pumps will be driven by twisted belts as formerly, and the plant is so arranged that either engine can drive one of the pumps. The accompanying drawing shows the layout of the new plant.

Each of the new well pumps will have a capacity of 50 gal. per min. against 70 ft. total head. They will ave 8-in. suction connections to the supply wells and -in. discharge pipes. There will be also two service umps, one of 500 gal. and the other of 750 gal. per nin. capacity. Each gas engine will drive a well pump nd a service pump, the new engine driving the larger ump. This arrangement will give a total pumping ca- acity of 1,250 gal. per min. when necessary, and the ead will deliver four 70-ft. fire streams of 250 gal. per nin. at the center of the city. An electric sump pump ill be provided for keeping the pump well dry.

A water tower with elevated steel tank of 200,000-gal. apacity is to replace the present standpipe, the latter eing located on low ground while the base of the tower ill be 19.2 ft. higher than the base of the standpipe. he tower is 138 ft. high from the piers to the circular irder around the base of the tank. The tank itself is s ft. in diameter and 34 ft. high in the cylindrical ortion, with a segmental bottom 11 ft. deep and a nical steel roof. The Memphis Steel Construction Co., f Greensburg, Penn., has the contract for the tank.

The purchase of electric current for pumping was pro- osed, but was not adopted for reasons of cost and the ar of possible interruption of the supply at some crit- al time. A new brick pumping station is to be built, x90 ft. Its floor will be about 12 ft. above the present oor level, with concrete piers for the two engines. The uilding will have a curved roof carried on McKeown ood lattice trusses.

When the present 34-ft. pump well was put down, a w years ago, the water from the supply wells broke in d caused considerable trouble before the well could be mpleted and sealed. The bottom of the well is plugged ith concrete. In trying to keep this well pumped out, rge quantities of sand were discharged by the pump, using surface settlement which threatened to be serious. he cavity was filled up later, but as its extent is not own definitely it was considered inadvisable to put lumns on this fill, and part of the pumping station ill be carried by girders spanning the fill.

The cost of the improvements will be about $35,120, portioned as follows: Water tower, $8,843; founda- ons for tower, $1,071; gas engine and producer, $8,237; mps, belting, etc., $4,695; 1,700 ft. of 12-in. main to nnect with new water tower (including pipe laying), ,518; pumping station, $9,056. The engineer's esti- ate was $35,000, but between the making of the esti- ate and the letting of contracts there were important creases in market prices. The cost will be paid out of bond issue. The water-works improvements were de- gned by L. J. Ruddock, City Engineer, and are being rried out under his direction.

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perating Results of Cleveland Municipal Lighting Plant

The municipal electric lighting plant of Cleveland, hio, furnishes current at a maximum rate of 3c. per .-hr. and has now been in operation for over two ars. A description of the plant was published in the sue of July 30, 1914, and a brief review of the finan- al results obtained during its first year of operation, ct. 28, 1915, p. 859.

In the *Utilities Magazine* for July, Frederick W. Bal- rd, the former Commissioner of the Cleveland Light Department, who designed and built the plant and was in charge of its operations up to Jan. 1, 1916, reviews the financial results of operation and shows that at present the plant is earning a large profit over and above its fixed charges. Mr. Ballard is this year President of the Cleveland Engineering Society.

During the first year of its operation, as usually happens in starting a new public utility, the profits of the Cleveland plant were insufficient to meet the fixed charges, owing to the length of time required to take on customers sufficient to give the station a paying load. The results for the entire year 1915, however, were very satisfactory. They are summarized by Mr. Ballard as follows:

Gross revenues		$528,856
Operating expenses		
Generation of current	$112,578	
General office expense	33,786	
Distribution of current	139,391	
Damage claims paid	7,340	
Overhead charges from city administration	13,000	
Interest to Water Department for use of land	5,040	
Total operating expenses		311,135
Net revenue		$217,721

Mr. Ballard states that the investment in the plant is just about $3,000,000. He estimates fixed charges on this investment as follows:

Taxes at 1½% on $3,000,000	$45,000
Interest on bonds	119,850
Depreciation at 3%	90,000
Total fixed charges	$254,850

While the net earnings for the year 1915, as shown, are somewhat below the fixed charges, there has been a great increase in the revenues in the past year, the earnings for January, 1916, being nearly double those of January, 1915, and the plant is now earning a handsome surplus. The financial results for the first quarter of 1916 were:

Revenue	$188,045
Operating expenses	21,919
Net revenue	$166,126

It will be seen from these figures that for the first quarter of 1916 the Cleveland municipal lighting plant made net earnings over operating expenses at the rate of $665,000 per annum and showed profits at the rate of $210,000 per annum after paying the fixed charges on the capital invested in the plant. It should be noted that these fixed charges include a 3% charge for depreciation and a tax rate at 1½% on the full value of the property, which is probably a larger tax than the city would actually receive if the plant were owned by a private company instead of by the city.

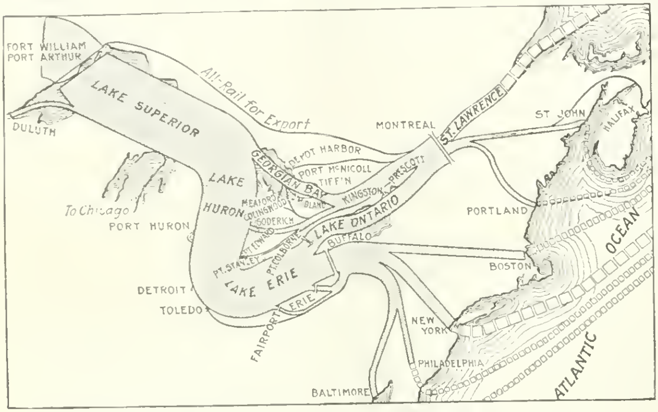
Mr. Ballard's estimate of fixed charges, moreover, errs if anything on the side of unfairness to the plant. The outstanding bonds issued against the plant are only $2,770,000, and of this amount $200,000 was applied to the construction of an ornamental street-lighting system that was not a necessary part of the municipal lighting plant.

Mr. Ballard states that the competition of the municipal lighting plant with the Cleveland Electric Illuminating Co. has reduced the rate charged by the company on street lamps by about $20 per year, and has also reduced the rate charged by the company to users of current for power and lighting, so that the total saving to the citizens of Cleveland resulting from the building and operation of their municipal electric light plant he computes to be $1,085,209 per annum.

Traffic Routes from the Lakes to the Seaboard

For more than 75 years one of the big problems of the engineering profession in America has been that of economic transportation between the Great Lakes and the Atlantic seaboard. The first great engineering achievement in this field was the completion of the Erie Canal in 1825. A generation later came the building of the trunk-line railways and, on the Canadian side of the boundary, the construction of the Welland and St. Lawrence canals, which enabled Lake vessels of moderate size to pass from the upper Lakes to tidewater at Montreal.

Near the close of the last century there was general discussion of larger water routes from the Lakes to the seaboard. The United States expended nearly a million dollars making surveys for a deep waterway from Lake Erie to tidewater at New York, some of the routes being across New York State to the Hudson at Albany, and others down the St. Lawrence, thence by canal to Lake Champlain and southward to the Hudson. This project was abandoned, however, when the State of New York undertook the construction of the New York Barge Canal, now nearing completion.



MAP SHOWING EASTWARD MOVEMENT OF CANADIAN WHEAT IN 1913 AND A STATEMENT OF DISTRIBUTION THROUGH OCEAN PORTS

Canadian Ports	Bushels	United States Ports	Bushels
Montreal	26,834,373	Portland	8,223,463
St. John	7,666,998	Boston	14,334,932
Halifax	554,712	New York	22,616,905
		Philadelphia	12,797,843
Total	35,056,083	Baltimore	12,690,009
		Total	70,663,152

STATEMENT OF DISTRIBUTION TO INTERIOR PORTS

	Bushels
From Fort William and Port Arthur via Great Lakes	130,181,954
From Duluth via Great Lakes	7,830,740
Total	138,012,694

	Bushels		Bushels
To Chicago	374,967	To Detroit	15,000
To Depot Harbour	2,963,915	To Toledo	950,525
To Port McNicoll	7,774,110	To Port Stanley	340,302
To Tiffin	11,639,728	To Fairport	5,198,205
To Midland	630,000	To Erie	7,628,824
To Collingwood	337,869	To Port Colborne	20,806,527
To Meaford	110,000	To Buffalo	54,643,639
To Goderich	6,608,085	To Kingston direct by water	1,972,473
To Port Huron	3,992,137	To Prescott	80,059
To Port Edward	386,142	To Montreal	11,559,887

	Bushels
Total Canadian ports	65,209,097
Total United States ports	72,803,597
Total Canadian and United States ports	138,012,694
By all-rail for export via Canadian Pacific Ry.	1,030,000

At about the same time a project was developed in Canada for building the Georgian Bay canal, a waterway from the northern portion of Lake Huron to the headwaters of the Ottawa River, and following down that stream by a system of slack-water navigation to Montreal. The surveys for this canal, completed in 1908, provided for a waterway 22 ft. deep and 440 mi. long, the estimated cost of which was $125,000,000. No action was taken by the Canadian parliament upon this project at the time the report of these surveys was presented; but five years later, in 1911, a commission was appointed to investigate the question whether or not it would pay Canada t spend $125,000,000 upon this work.

The chairman of this commission was W. Sanford Evans, of Winnipeg. A progress report just presented by Mr. Evans contains the most complete investigation of traffic conditions between the Canadian Northwest and the seaboard that has ever been made. While some studies in the same field were undertaken by the United States Deep Waterways Commission in 1898 and by the New York State Barge Canal Commission in 1900, the figures then obtained do not apply to present-day conditions. Mr. Evans' report is one that will be in general demand for engineering reference libraries. The full title of Mr. Evans' report is, "Statistical Examination of Certain General Conditions of Transportation Bearing on the Economic Problem of the Proposed Georgian Bay Canal." These "general conditions of transportation" are of interest not only as bearing on the question whether a Georgian Bay canal would be a paying enterprise, but because they have direct relation to the conditions in other transportation routes, existing and proposed. The investigations of waterways from the Lakes to the seaboard made 20 years ago developed the fact that at that time the export-grain traffic from the Lakes eastward was rapidly decreasing. When the upper Mississippi Valley was first settled and began pouring its vast crops of grain to market, there was a huge surplus of this grain available for export. The rapid growth of population in eastern cities, however, with the opening of new outlets for export grain at New Orleans and Galveston, materially reduced the volume of Western grain flowing eastward by way of the Great Lakes and was undoubtedly one reason why the United States lost interest in its projected deep waterway.

Conditions have again been radically altered by the enormous development of wheat-growing in the Canadian Northwest, since the beginning of the present century and especially in the last half-dozen years. Mr. Evans' statistics show that in 1913 there were 145,000,000 bushels of Canadian wheat brought to elevators at Port Arthur and Fort Williams as against 66,000,000 bushels in 1909.

As to the future increase in the production of wheat in the Canadian Northwest, Mr. Evans says it is impossible to set a limitation. "There is more wheat-growing land in western Canada that can by any stretch of probability be turned to account within a generation or two. The amount of wheat produced in that region, therefore, will simply depend on the market demands. In the past, out of every seven bushels of flour shipped by all exporting countries, Europe has absorbed a little over six bushels."

The great bulk of this Canadian wheat crop must find its final market across the ocean. The less the cost of transportation between the farms in the Canadian Northwest and the final purchaser in Europe the higher will be the price the Canadian growers will receive and the better the chance for the Canadian wheat in competition with wheat from Argentina, India and Russia. Canada is further interested in having as much as possible of this wheat carried to the seaboard over Canadian transportation lines and shipped through Canadian ports. The question that most interests Canada, therefore, is whether the proposed Georgian Bay canal would reduce the total cost of transport and whether it would restore to Canadian ports some of the Canadian wheat that is now diverted to routes through the United States.

Flow of Wheat to the Seaboard

There is reproduced herewith from Mr. Evans' report a map on which the flow of Canadian grain from the western end of Lake Superior to the seaboard is shown graphically. It will be seen that while very little grain is carried all-rail eastward from Fort William, a large amount is carried by rail from the ports on Georgian Bay to Montreal. Most of the grain, however, goes by water to the eastern end of Lake Erie and there divides into two streams, one turning south to United States ports and the other, considerably smaller, going through the Welland Canal, Lake Ontario and the St. Lawrence to Montreal. No attempt has been made to show on the map the division of traffic between competing trunk-line railways following various routes between the eastern end of the Lakes and Atlantic seaports, but only the proportions finally delivered at each port.

There is sharp competition for this traffic, not only among the various water and rail transportation lines, but among the several ports. Montreal, Boston and Philadelphia have been particularly active in the development of their port facilities with a view to increasing their proportion of this and other competitive traffic. It is of great interest in connection with this competition to note the investigations by Mr. Evans of the causes for the diversion of Canadian grain to ports south of the international boundary line. The route from the grain-growing districts of Canada to northern Europe via the St. Lawrence is far shorter than the route via United States ports; and yet in 1913 more Canadian wheat was shipped from United States ports than from Canada.

Mr. Evans investigates this problem and finds that the diversion was not due to the physical inability of the Canadian routes to handle more traffic. The St. Lawrence and Welland canals have never carried more than a moderate fraction of the traffic that could be passed through them. Difference in inland freight rates does not explain the diversion. On the whole, Canadian wheat diverted to United States ports appears to have paid higher rates to the seaboard than wheat shipped to Montreal. Mr. Evans then inquires whether conditions of ocean transportation and not the relative facilities of competing seaports or of inland transportation routes are not after all the determining influence that governs the routing of export shipments. He then presents the results of an extended investigation, which indicates that ocean freight rates are the controlling factor in the routing of this traffic.

Ocean Freight Rates Control Inland Traffic

It is commonly supposed that the rate fixed by tramp steamers determines the cost of ocean transportation. This is true on many classes of cheap bulk freight. In the transport of grain, however, the regular liners and not the tramp steamers fix the rate. A liner secures its chief revenue from the carriage of passengers and high-class merchandise. Whatever space it has left available it will fill with grain at whatever freight rate it can get. The amount of grain exported from Montreal in 1913 appears to have been substantially that which the regular liners at that port had room for. Any grain in excess of that capacity had to be diverted to other ports for shipment. The amount of grain carried by tramps from Montreal was very small.

Here is the probable explanation, also, why New York still holds first place among United States ports in the export-grain traffic, notwithstanding the well-known heavy expense involved in handling grain there. New York, because of its enormous trade in high-class imports, has a far larger number of regular steamer lines running to it than any other American port. These liners are willing to take wheat and other grain at a very low rate in order to fill up surplus cargo space. This will doubtless continue to be the case no matter what superior port facilities may be provided at other Atlantic ports.

The bearing of this investigation on the Georgian Bay canal project is obvious. If ocean transportation and not inland transportation is the governing factor in the competition among Atlantic seaports, then Canada might build the Georgian Bay canal and gain no benefit whatever in the restoration of grain traffic to Canadian routes.

Other Benefits of a Deep Waterway

On the other hand, there are possibilities not touched upon by Mr. Evans in the through shipment of grain from Lake ports to Europe without transshipment at the seaboard, if a deep waterway were available. The engineers who have made investigations of deep waterways from the Lakes to the seaboard have hitherto assumed that the Lake vessels were unfit for ocean service and hence that if a deep waterway were built by which Lake vessels could reach a seaport, transfer of their cargo would have to be made there.

Conditions have materially changed, however, in the past 20 years. The Lake steamers have attained an average tonnage much exceeding that of the average ocean freight steamer. The cost of transshipping has been increasing. Again, the war conditions of the past two years have produced unprecedented conditions in ocean traffic. Had it been possible during the past two winters for the shipping of the Great Lakes to have engaged in ocean freight carrying, instead of remaining idle during the winter months, the vessels would have earned enough, in all probability, to have paid the entire cost of a ship canal from the Lakes to the Atlantic.

Field and Office

Engineer talks on night work—Crude diving helmets that worked and are still working—Old well relined with precast rings—Home-made pile hammer replaced steam hammers—Expansion joints placed only when concrete-road work stopped for 30 minutes—Sheetpile coffer-dam driven as unit by use of templet—Hair is pumped without difficulty

Cost of Night and Day Work

By A. M. Shaw[*]

It will be generally conceded that all construction work can be carried through more economically under favorable light conditions than when only an indifferent light is available. Special conditions may exist—such as those mentioned in the *Engineering News* editorial of Aug. 27—under which heavy traffic or the weather may be a deciding factor; but ordinarily the contractor or the engineer is not called on to decide as to which is to be preferred, day or night work, but the question is: "Will it pay to run both a day and a night crew?"

Judged solely by the net cost of operation, it is not usually economical to do night work on jobs that require a relatively large amount of hand labor. This is especially true on work of a varied nature, scattered over a considerable area and not provided with an ample supply of artificial light. Such conditions entail inefficient work, poor supervision and often are the cause of numerous injuries to employees. The urgency of the case frequently demands that night work be done under these unfavorable conditions, an example of which may be found in the repairs following railroad wrecks and washouts. On such jobs every recurrence presents a new set of conditions; the lighting is usually poor and the men frequently are unfamiliar with the duties required of them. Night work is undertaken most advantageously under a combination of the following conditions:

1. When a considerable proportion of the cost of the job is represented by overhead expenses, such as interest on the investment, insurance, office force, etc., which items are little affected (if at all) by increasing the working force so as to work at night.
2. When the nature and location of the work make it practicable to provide an ample supply of artificial light at small expense.
3. When a relatively small number of men is employed, and these men perform routine duties with which they are familiar.

In the field of earth-handling contracts the two extreme conditions may be illustrated by team-and-scraper work, which can seldom be handled to advantage at night, and the operation of a large modern dredging plant constructing a canal and wasting the earth at the sides of the canal. In the former case, proper illumination at a reasonable cost is impracticable, and both men and animals work at a greater disadvantage at night. In the case of the dredge, practically all the conditions enumerated as being favorable to night work are found. We have here a heavy investment in equipment, a small crew engaged in work with which they become familiar, and it is practicable to provide a liberal amount of artificial light at small expense.

Another advantage is the saving in fuel resulting from the practically continuous operation of a steam plant. Under single-crew operation a considerable amount of fuel is lost in firing up each day and in laying by at night. This saving in fuel and the saving in night watchmen may easily more than offset the cost of furnishing light and even cover the possible reduction in efficiency due to night work.

Siesta Better Than Night Work in the Tropics

It is doubtful if any permanent gain is made by working men at night rather than in the day time on account of hot weather. A better plan would be to follow the Mexican custom and provide for a siesta during the hottest part of the day, say from twelve to three o'clock. On jobs not requiring continuous operation this may often be done to good advantage. This custom is also common on sugar plantations. Laborers employed in construction camps are more adaptable to such a change of hours than those living at home, as the latter class do not take kindly to a change that breaks in on their accustomed hours for rest and recreation. By working men all night the natural order is upset, and in very hot weather they seldom get a proper amount of restful sleep in the day. A visit to the homes of city laboring men discloses the fact that if they work at night, they are compelled to seek their rest in hot, stuffy rooms, often with a horde of children romping about and with interruptions from the usual day noises, making normal, refreshing sleep impossible for the average man. Even in large camps equipped with a special view to the comfort of the men who sleep during the day the rest secured in very hot weather cannot be compared to that obtained in the comparatively cooler nights. Men working continuously at night in hot weather will usually be found to be lacking in energy and initiative.

A good plan of handling double crews is to have them alternate weekly, making the change on Sunday. On dredging jobs a considerable amount of Sunday work is necessary. This is done by the Saturday-night crew, making their "long shift" about 16 hr. On the following week they are let off on Saturday night and do not come back to duty until Monday night.

Repairing What the Night Crew Breaks

On a land-excavator job on which the writer was engaged a number of years ago it was practicable to operate the machine with a crew of only two men, an additional ground force being required to lay track, bring up fuel, etc. This outfit was operated on double shift. Sufficient track material was provided so that the day men could lay up track for the night crew. One of the crews expressed a preference for night work, so this crew vas not alternated. It soon became apparent that the)utput of the night crew was consistently in excess of hat of the day men. An explanation was requested of he day operator, which was promptly given as follows: 'It takes us half a day to fix up the things that the)ther fellows bust." An investigation proved this to be ubstantially correct. Owing to the nature of the equipnent it was impracticable to keep up a proper system f inspection and repairs during the night, and the night ork was discontinued.

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[*] Consulting Engineer, Hibernia Buildings, New Orleans, La.

The placing of lights so as to avoid objectionable hadows deserves more careful thought than is given to t on the average construction job. Men cannot work to dvantage in semi-darkness or where bewildering and noving shadows interfere with a proper view of their ork.

Electric lighting is not always feasible, but is usally preferred when practicable. On many construction obs independent lighting plants may be installed to dvantage, if current is not available from local sources. f a steam supply is not available, internal-combustion ngines may be used for driving the generator. Owing the present high price of gasoline, engines equipped operate on a low grade of kerosene are preferred to asoline engines, and they are now made so that they ill operate for hours with very little attention.

Electric-lighting outfits may be transferred from one ob to another with practically no loss in material and quipment, beyond a small amount of wire that may be asted in making the change. So far as practicable, ghts should be stationary and protected from the eather and from unnecessary vibration. Carbon lamps hould be employed only when absolutely demanded by he character of the service, the higher-efficiency lamps eing used wherever it is possible to give them protecon from excessive vibration.

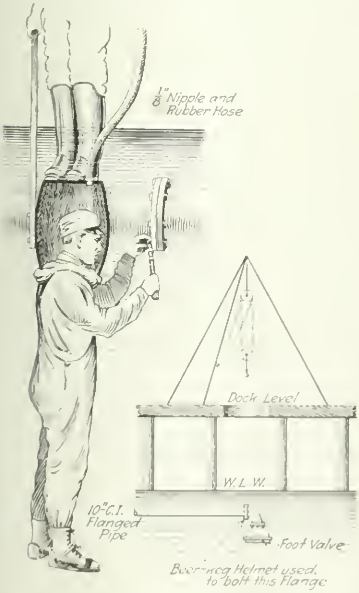

1/8" Nipple and Rubber Hose
Dock Level
W.L.W.
10" C.I. Flanged Pipe
Foot Valve
Beer-keg Helmet used to bolt this Flange

FIG. 1. DETAILS OF THE BEER-KEG HELMET AND THE WORK IT DID

Beer Keg and Kitchen Boiler Serve as Diving Helmets

Two remarkable home-made diving helmets were used in emergency underwater work by J. J. Grafflin, Engineer-Superintendent of the New York Dock Co., foot of Montague St., Brooklyn, N. Y. Fig. 1 shows the first of these and explains the work on which it was employed.

It was necessary under one of the wharves to connect up a 10-in. fire line—under water and in a limited time. It was impossible to do this from the wharf or from a boat, and a diving helmet was not available. A satisfactory helmet was obtained, however, by knocking one head from an empty beer keg. To steady the keg when submerged, a man stood on top, holding to a strip of wood that was nailed to the keg. With this extremely rough outfit it was possible for a man to stay down 1½ min., using only the air imprisoned in the keg. The pipe was bolted to the elbow successfully.

For later work on this same fire line a ⅛-in. brass nipple was fitted into the head of the keg, and to this was attached a rubber tube, through which air was forced by means of a common foot pump. With this arrangement—which was used only in shallow water—a man could stay down about 8 min.

Fig. 2 shows the next step in home-made diving helmets instituted by Mr. Grafflin. This arrangement is one end of an ordinary kitchen boiler notched to fit the shoulders and weighted with chain, as shown. With this rig and an ordinary duplex automobile pump it was

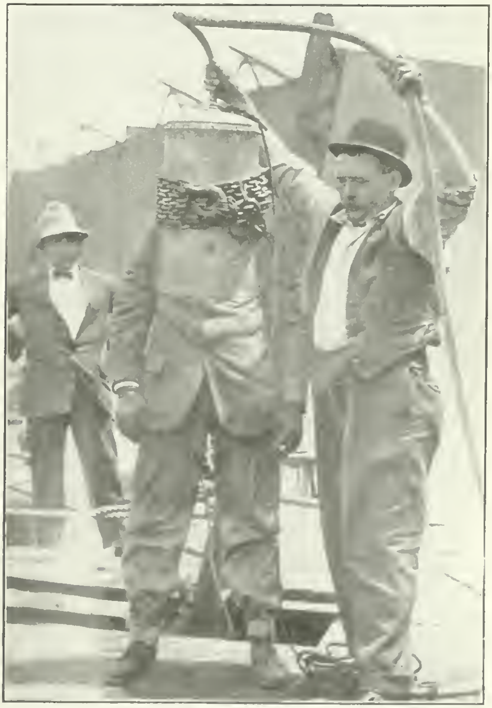
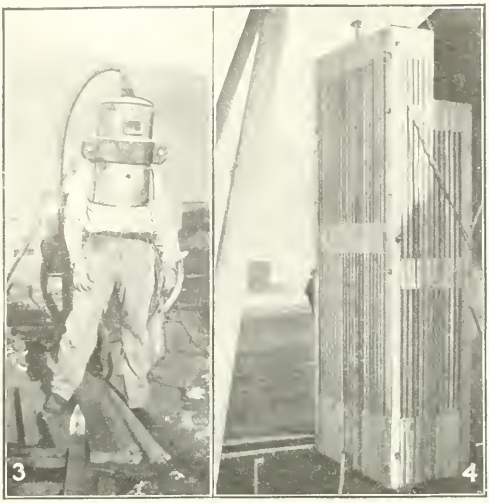


FIG. 2. DIVING HELMET MADE FROM A KITCHEN BOILER



FIGS. 3 AND 4. IMPROVED "BOILER" HELMET USED TO INSTALL PUMP-INTAKE. SCREEN SHOWN

possible to stay down 15 min. at a depth of 30 ft. The contrivance was used in the summer of 1914 to clear out in front of the intake to a 1,500-gal. per min. centrifugal fire pump located at the New York Dock Co.'s German-American stores.

In this outfit, as in the case of the keg, there was no window. This omission was not an item of importance, inasmuch as the sense of sight is of no service under the East River. Diving work there must ordinarily be done in the dark. As a general convenience, however, the boiler helmet was ultimately provided with a window, which was merely an oblong glass paperweight cemented to a hole cut in the front of the helmet. With the present rig (Fig. 3) and a regular deep-sea pump Mr. Grafflin has stayed down 1½ hr. This helmet was used in the summer of 1915 to excavate about 1½ yd. of silt and rock in 10 ft. of water, in a space not over 3x4 ft. in plan. The excavation was at the intake of the same centrifugal fire pump before mentioned and was to permit the installation of the screen in front of the intake (Fig. 4). Fig. 5 shows the screen in place and indicates the service it performs.

The rough helmet described has the advantage of occupying only about one-half the space of a regular helmet. The sandals were made by the company blacksmith from ¾x4-in. iron. They are provided with a ⅛x1½-in. strap across the toe and tied above the instep with sash cord.

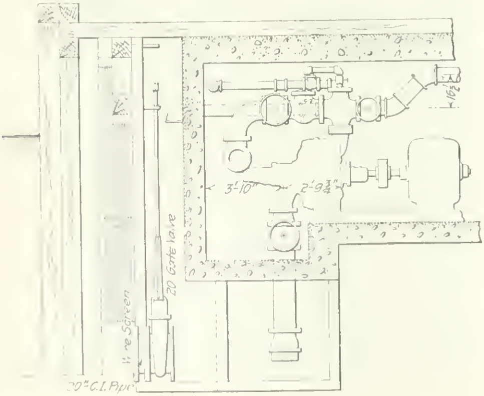


FIG. 5. SHOWING SCREEN IN PLACE AND THE RESTRICTED WORKING QUARTERS

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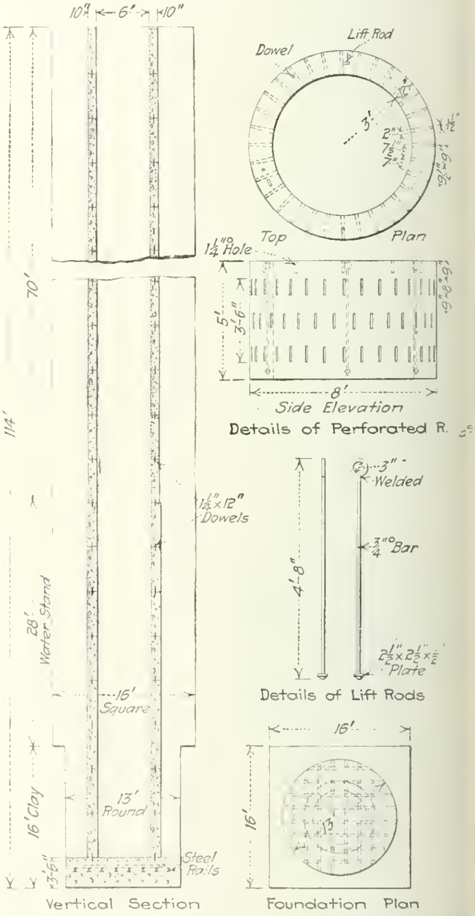
Lining a 114-Ft. Well with Precast Concrete Rings

Following the drought in northwestern Texas in 1909 and 1910, the Fort Worth & Denver City Ry. increas its water-supply at Clarendon by sinking a second wel the first being 100 ft. deep and the new one 114 ft.



A 114-FT. WELL LINING OF PRECAST CONCRETE RINGS

This well was made 16 ft. square and was lined wit 8x16-in. timbers. It was in use for about four years when pumphouse, wellcover and pump suddenly disappeared one morning, leaving only a cone-shaped crater to mark the spot.

As the well was dependable as a water-producer, it was decided to rebuild it. There was no suitable stone to use for curbing or lining, and it was decided to do the relining with precast concrete rings. A railway lerrick car with a 40-ft. boom handling a dump bucket was used to clean out the well, remove the remains of he wooden curbing and place the concrete rings.

These rings were 6 ft. inside diameter, 5 ft. high, 12 in. thick from the bottom to 44 ft. above, and 10 n. thick from there to the top. They were not reinforced.

The mix was 1 : 3 : 5, using crushed stone for the coarse ggregate. The concrete was placed by hand in steel orms. After three days, when the forms were removed, he rings were thoroughly wetted three times a day for wo weeks. The rings were then allowed to cure for t least two months before use.

Through the water-bearing sand six special rings were ised, perforated with three rows of 32 slots each, these lots being 8 in. in length and 1½ in. in width on he outside.

Six 1¼x12-in. dowels at each horizontal joint, set in ¾x6-in. sockets molded in the rings, took care of lateral novement.

The work of cleaning out the well presented no articular difficulties, except that two pumps had to be ept continuously in operation to keep it unwatered. On he bottom a slab of concrete 3½ ft. thick, reinforced ith steel rails, was laid. This was allowed to set for wo weeks before building up the well lining on it.

Behind the perforated rings screened crushed rock was laced by hand and well tamped, and above the water-earing sand earth well puddled was used for backfilling. ll of the rings were set without accident, and so far s could be determined by inspection there has been no ettlement or displacement of any of them, and the flow f water is fully equal to what it was prior to the cave-in.

A cost table is given herewith. The work was done y the railway company under the supervision of R. C. owdy, chief engineer. The steel forms were made in ie railway company's shops: the cost of their material not included, as it was used over.

COST OF CLARENDON WELL LINING

aterial:		
70 cu.yd. crushed stone	$45.50	
35 cu.yd. sand	35.00	
440 sacks cement	189.60	
92 lift rods	23.90	
210 pieces pipe, 2x12 in.	17.40	
20 wood blocks, 2 ft. by 12x12 in	9.04	
105 pieces round iron, 1¼x12 in.	5.56	
		$326.00
abor:		
Building forms; 2 men 12 days each @ $2.75	$66.00	
Filling forms; 1 foreman 10 days @ $3	30.00	
Filling forms; 10 men 10 days each @ $2.75	275.00	
		371.00
Total material and labor		$697.00
abor setting 23 concrete pipes in well:		
1 foreman 5 days @ $3	$15.00	
10 men 5 days each @ $2.75	137.50	
		152.50
Total labor and material making blocks and placing in well		$849.50

Pile Hammer for Steel Piles

By D. A. Watt*

In the construction of the lock and dam in the Hudson iver at Troy, N. Y., recently completed, several thousand eel sheetpiles were driven in the coffer-dams. Steam ammers were employed almost entirely, as they could used from a derrick boom and thus reach places accessible to the ordinary fixed-lead piledriver. However, their constant breakdowns caused much expense and delay, and in addition they lacked the driving power of a drop hammer. Piles driven on adjacent work with a drop hammer went down deep in heavy gravel ¼ in. at a blow, while those driven a few feet away with a steam hammer would come to absolute refusal at a considerably less depth of penetration.

In an attempt to remedy these defects a home-made drop hammer was devised by E. C. Quinlivan, Shop Superintendent. It consisted of steel bars bent as shown in Fig. 1 and having a total weight of about 1,500 lb. The bars straddled the pile and were raised by a single line, from a derrick boom, the legs of the hammer moving on each side of the pile, acting as leads and guiding the blow. The anvil (Fig. 2) was made of a piece of steel pile, surmounted by a steel block that received the direct blow and riveted to two channel irons that kept the anvil from falling off the pile and at the same time acted as guides for the legs of the hammer.

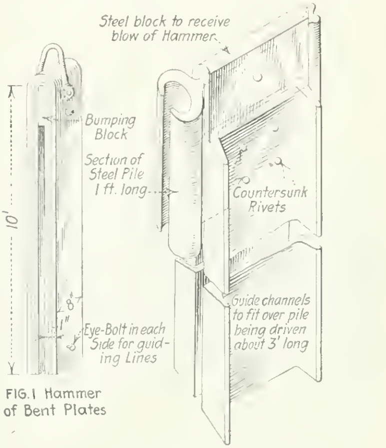

Steel block to receive blow of Hammer
Bumping Block
Section of Steel Pile 1 ft. long
Countersunk Rivets
10'
8"
1"
Eye-Bolt in each Side for guiding Lines
Guide channels to fit over pile being driven about 3' long

FIG. 1 Hammer of Bent Plates

FIG. 2 Anvil Block

HAMMER AND ANVIL USED IN DRIVING SHEETPILES

As the design was not worked out until toward the end of the construction it was tested only to a limited extent, but as far as used proved very satisfactory. About the only defect in the hammer itself was due to the tendency of the legs to spring gradually apart from the shock of succeeding blows and thus eventually wedge on the anvil. With a cast-steel hammer of suitable design this tendency could be removed. The short piece of pile in the anvil, resting directly on the pile being driven, should preferably be of cast steel with its web not less than 1 in. in thickness, so as to give ample bearing surface.

Michigan Omits Joints in Concrete Pavements

By D. A. Thomas*

The revised specifications for concrete roads recently issued by the Michigan State Highway Department provide for expansion joints only at points where the work is stopped for more than 30 min. The clause relating to expansion joints reads as follows:

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*Principal Assistant Engineer, United States Engineer llice, Albany, N. Y.

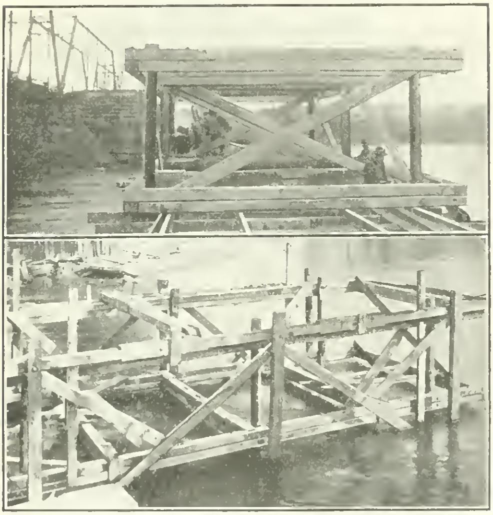
*Michigan State Highway Department, Lansing, Mich.

Vertical transverse expansion joints shall be placed across the entire width of the concrete roadway perpendicular to the center line where work is stopped for more than 30 min. All joints shall extend through the entire thickness of the pavement and shall be perpendicular to the surface.

Heretofore joints were required at 33-ft. intervals. The value of expansion joints in concrete roads, except at sections where the work is stopped long enough for the cement to acquire its initial set, has often been debated among engineers. It is the belief of the Michigan State Highway Department that, if expansion joints are omitted, cracks will form at approximately the same points at which the joints are customarily placed and that such cracks can then be maintained in the same manner as joints. The early maintenance cost and the construction costs are thereby reduced to no small extent.

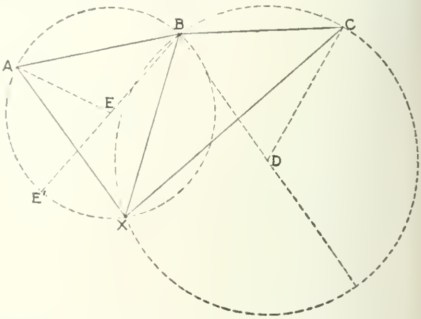
NOTES

A Coffer-Dam Frame, or templet, for holding sheetpiles was used in putting down the coffer-dams for the new Milton (Penn.), bridge of the Philadelphia & Reading Ry. over the Susquehanna River. The templet was moved from one pier location to another along the timber service trestle, as shown in Fig. 1. The coffer-dams were 20x40 ft. in plan. The piling was 38 ft. long, penetrating to rock through about 10 ft. of sand. In accordance with the best practice at the present time, F. P. Kemon set up all the 94 piles of a coffer-dam before driving any. The No. 3 Union sheetpile hammer was swung around the piling, on the end of a crane arm, so that the coffer-dam was driven as a whole.



TEMPLET FOR SHEETPILE COFFER-DAM, MILTON, PENN.

Simple Geometrical Solution of Three-Point Problem—The following method of solving the three-point problem does not seem to be given in any of the textbooks, yet a simpler graphical solution would be hard to find. The rule may be stated thus: Connect the known points A, B and C by straight lines. At each two points lay off from the line connecting them the complement of the measured angle between the points from the unknown point. Continue each pair of lines to their intersection. Check by noting that the two lines of each pair must be of equal length. The two intersections are the centers of two circles each passing through two of the known points and intersecting at the required or unknown point. In plotting transit notes the rule is literally followed by use of straight-edge, triangle and compass. The geometrical proof can be seen from the accompanying figure at a glance: $ABE + AXB = \tfrac{1}{2}$ arc $BAE' = 90^\circ$. With the plane table the method is fully as simple: First, erect perpendiculars at A and B, and B and C, respectively. With the table set at X, set the alidade on A; with its straight-edge lying along the perpendicular erected at A, orient on signal B; clamp the table, swing the straight-edge so as to sight on signal A, and draw AE. This reproduces from the perpendicular at A the

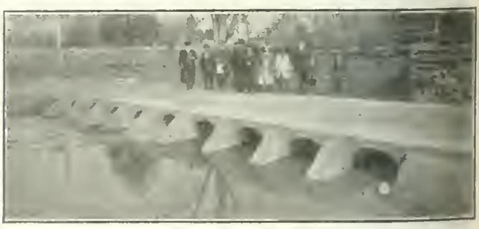


angle AXB and therefore its supplement EAB. In a similar manner BE, BD and CD are obtained and the centers of the two circles E and D graphically determined. Their intersection is the required station of the plane table.—H. K. Higgins, Jackson, Mich.

A 40,000-Gal. Steel Flour Bag on the top of a steel tower contains the water necessary for the operation of an automatic-sprinkler system recently installed at the Campbell Flour Mills Co., Ltd., Toronto. The top of the tank is 152 ft. above ground. The tank is 37 ft. deep by 18 ft. wide and has an oval cross-section. The Chicago Bridge and Iron Works built the tank.

Pumping Hair is done by a No. 2 Nye steam pump at the plant of the Wilder-Manning Tanning Co., Waukegan, Ill. The pump is located between two hidescraping machines that take all the hair off the hides. The hair is washed down by small jets of water to a sloping runway at the back of the scrapers, and down this runway to the pump sump. The mixture is pumped vertically about 30 ft. and horizontally along under the second floor about 100 ft., where it is discharged into a washer and later dried and baled. The pump replaced an elevating conveyor that is said to have had a tendency toward freezing up in the cold months. Another pump of this type will shortly be installed here.

A Culvert Intended To Be Overflowed during times of extreme high water is shown in the accompanying view. This culvert is on the Shelbyville turnpike between Shelbyville and Wartrace in Bedford County, Tennessee. The waterway consists of 10 semicircular arches of 36-in. span. The crown thickness of the arches is 5 in. of plain concrete. The whole structure is 60 ft. long, 14 ft. wide and cost $175. When the culvert and pavement are submerged, wires are strung along one side so that the traveler will have little difficulty in "following the trail." This culvert was designed and built by C. L. Shoffner, general manager of the Shelbyville turnpike. It is obviously a variation of the arroyo crossings of the arid West, described in "Engineering News," Sept. 14, 1916



OVERFLOW CULVERT ACROSS BUTLERS CREEK

Editorials

Selection and Use of Cars for Construction Work

The review of various types of cars used in construction nd improvement work, which is given elsewhere in this sue, suggests a consideration of the classes of work for hich different types of cars are adapted.

The selection of equipment for any one piece of work ill depend largely upon the local conditions and upon the uipment already owned by the contractor, railway or ther party doing the work. Among the local conditions be taken into account will be the general character of e work; whether the work is convenient to or distant om railway or other means of communication: hether cuts and fills are heavy or light; the kind and tal quantity of material to be handled; the length of aul, duration of work, etc. For work that is difficult access the cars must be of such size and weight as to lmit of being transported to the site by wagons or other eans.

In selecting equipment for railway work to be done by mpany force, the question may be whether to buy cars at can be used in work-train service only or those that n be assigned to ordinary freight service in winter or at her times when not required on construction. Cars of e latter class offer advantages in the fact that they ay be kept practically in continual use instead of lying le at times. On the other hand, they might be needed both kinds of service at the same time, and the car itable for one kind of service might be less suitable (and ss economical) for service of another kind.

Where a railway has extensive and costly construction improvement work to be done, it will often be both lvantageous and economical for the engineering or construction department to have its own equipment and not required to rely upon some other department for its pply. Narrow-gage construction equipment is rarely vned by railways, as it is of special class and its use is restricted availability. Such cars are frequently found, wever, in railway contract work and are of particular rvice in widening roadbed and cuts, where they can be erated very often without interfering with running acks and regular traffic. In this way the occupation of ain track by work trains may be avoided.

It must be borne in mind that it is not always advisable even possible to adopt the equipment that theoretically est suited to the work and conditions of a particular b. Both contractors and railway departments are comlled sometimes to work under conditions not favorable the lowest cost, because they have to use equipment uch is in hand, and they cannot—or do not wish to—vest capital in additional equipment that might not be of uch service for future work.

This is true especially of jobs of the smaller class. On large piece of work (contract or otherwise) it is not visable or economical to attempt to carry it on with sufficient equipment; but even here the use of such uipment may be obligatory. Thus expediency and arbitrary limitations are often important factors in the selection of equipment.

There is another side to this investment phase of the question, however, and that is the possibility of leasing or renting cars. Under such an arrangement the contractor or other user can obtain the equipment best suited to the work without the possible objection of having it idle on his hands later, on account of its being unsuitable for other jobs. The leasing plan is adopted by a number of firms that build or supply cars, and it covers practically every class of car for construction work.

An important point in relation to the efficient and economical operation of the cars is the maintenance of the temporary or construction tracks in good running condition. This need is not always recognized, and men in charge are apt to assume that almost any kind of track is good enough for dump-car trains. But the weight of train hauled and the efficient progress of the work are affected materially by track conditions. Derailments also are likely to be frequent on poor track, and these cause delay and interruption, extra repairs, etc., or perhaps the loss of a load of concrete. All these adverse conditions are reflected in an increased total cost of work.

Good track, substantially built and well maintained, is highly desirable for economic reasons. It may increase the hauling capacity, enable trains to be run safely at higher speed, reduce delay and expense due to derailments, minimize various other troubles and thus facilitate the progress of the work and tend to reduce its cost. The importance of good construction track increases rapidly with the weight and capacity of the cars employed. The object of using large cars is to reduce unit cost by speed and economy in handling material, and this cannot be attained where trains are stalled and cars are derailed frequently.

A corollary to the proposition of good track maintenance is the proposition of keeping the cars in proper repair and good running condition. Delays in transportation and dumping due to bad-order cars are quite as serious as those due to track in poor condition. These are matters for the special attention and watchfulness of the engineer or superintendent in charge of construction work.

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Effect of Heat on Rate of Flow of Fluids

The paper by W. L. Butcher, published in *Engineering News* of Aug. 17, reviewing experiments which indicate that the rate of flow of water is materially increased by rising temperature, has brought us several letters from correspondents who appreciate the importance of this matter. It has, of course, long been well known that the heating of oils has a great effect on their viscosity and consequent rate of flow. Many engineers, from practical experience with automobile carburetors, have become familiar with the very great influence a change in temperature has upon the rate of flow of gasoline through the narrow passage of a carburetor nozzle. It is reasonable to believe that if a liquid which has so little apparent viscosity as gasoline will nevertheless have its rate of flow materially affected by heat, then the same thing may be true of water.

The limited amount of data which Mr. Butcher was able to unearth in technical literature indicates that this may be the case; but as various correspondents point out, there ought to be available for the use of engineers accurate and complete information and data showing what corrections should be used in computations for the flow of liquid where large variations in temperature are involved.

There would seem to be an opportunity here for useful work by post-graduate students in some of the engineering schools which have suitable hydraulic laboratory facilities. Possibly the Bureau of Standards might take the matter up, although we believe the work of original investigation already accumulated by that bureau is sufficient to keep it busy for a long time to come.

It may be worth while inquiring, too, whether any similar effect occurs in the flow of gases. The present formulas for the flow of gases take into account, of course, variations in flow due to the change in volume of the gas as a result of heating. It is quite possible that there may be some variation in the internal friction of a gas due to its heating corresponding to what takes place in the case of liquids. If so, it should be possible to discover this by accurate experiments and apply suitable corrections in the formulas.

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Mechanical Engineers Society Pays Off Its Debt

In a bulletin just issued to the membership, the officers of the American Society of Mechanical Engineers state that the last of the bonds issued by the society to finance its part of the Engineering Societies' Building enterprise were paid off on July 1, and the society is now out of debt. Many will recall that when, a dozen years ago, Andrew Carnegie electrified the engineering profession with his generous offer of $1,500,000 to erect a great building in New York City as a home for the national engineering societies, he coupled with it the stipulation that the societies themselves should purchase the land on which the building was to be erected.

The cost of this land was about $540,000, and this investment in itself seemed to many a large burden to be assumed by the three societies that accepted the offer. The immediate financing was made easy, however, by Mr. Carnegie, who advanced the money for the land purchase. For a number of years this loan was continued, the societies paying interest upon it. Each of the societies made energetic efforts to raise the money to pay off this debt by circulating subscription papers. It was hardly to be expected, however, that so large a sum would be raised by direct subscription, and there was a general opinion that the societies themselves should bear the burden. Principally through the efforts of the late Charles Wallace Hunt, who was for many years active in the council of the American Society of Mechanical Engineers, a plan was devised by which the money was raised to pay off the balance of the debt for the land in the following manner: The society issued interest-bearing bonds equal in face value to the amount of the debt, announced that the portion of its income derived from initiation fees would be segregated each year to pay off an installment of these bonds and invited subscriptions from the members of the society. The sum desired was promptly secured and, as announced above, the last of these bonds has now been paid off.

Another announcement in the bulletin issued to the society members is of general interest. There is a more or less general impression among the members of the national engineering societies that a large part of the money they pay in for their annual dues is expended in maintaining the expensive offices and headquarters in the big building in New York City.

To those who may have held such an opinion, it will be of interest to note the statement issued by Calvin W. Rice, Secretary of the American Society of Mechanical Engineers, that at the present time less than 5% of that society's annual income from dues is absorbed in paying its share of maintaining the building in New York City. If the society owned no property whatever and merely rented the space absolutely necessary for the clerical force required to carry on its work at its headquarters, in New York or any other large city, the annual rental would amount to more than 5% of its income from dues.

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Recovering Steel Sheetpiling

Steel sheetpiling is worth recovering because unlike most second-hand steel it can be used repeatedly. A few years ago the feeling was quite general that steel sheetpiling—even though driven in structures of temporary service only—was a dead loss and therefore expensive and of an emergency nature. Since then a number of schemes have been devised for recovering the piles economically, and it is now unusual not to attempt, at least, to recover piling used in temporary structures such as coffer-dams.

About two years ago a machine designed especially for pulling piling was developed in England and was described in *Engineering News* of June 11, 1914. This machine was practically an inverted steam hammer. Since, ordinary steam hammers have been used inverted, one manufacturer making a special point of this. This method has been successful in many cases and is now a matter of general knowledge and fairly extensive experience. A large and successful operation of this kind was the pulling of the coffer-dam construction for the land connection of the Harlem River crossing of the new Lexington Ave. subway, New York City. The extractor consisted of an ordinary steam hammer with a few minor additions suggested by the contractor's superintendent. According to the latter, this tool pulled piles which three derricks working together were unable to budge. The inverted hammer weighed 1,500 lb. and withdrew piles that had been put down by a 5,000-lb. hammer. This same scheme has been tried—but not with remarkable success—in pulling the piling for the coffer-dams used in building the municipal piers at 47th St. in the North River, New York City. This is an extremely difficult job and other methods than the inverted hammer have proved inadequate on it.

Hydraulic jacks have been used in several instances with more or less success. One of the first instances of this kind was at one of the shafts of the Newark Bay tunnel of the Passaic Valley sewer. Blocking was placed lose against both sides of the piles to be pulled and a 0-ton jack was mounted on each set of blocks. This iethod was not noted for its speed. A crew of five men nd a foreman sometimes required eight hours to pull ne pile. In pulling the sheetpiles from the earth-filled offer-dam at Troy, N. Y. (*Engineering News* of Aug. 1), 150-ton hydraulic jacks were employed. To jack it a key-pile required one to two days. An inverted eam hammer was tried here, but breakages were ex-ssive and the method was not certain.

A novel expedient was tried recently in recovering a rge tonnage of 60-ft. steel sheetpiling driven in the rm of a series of arcs. A combination of water and r jets was used to loosen the material about the pile be pulled. The method was eminently successful.

It is evident from the foregoing that a number of meth-s have been developed for recovering sheetpiling. Not ly does this indicate that the operation has a tendency be difficult, but it also shows that the desire to recover is piling is quite general. In view of conditions in the el market at the present time, steel piling is worth covering for its scrap value, even though it be not used ain in a structural capacity. The method adopted on specific job is usually dependent not only on the char-ter of the piling—size, penetration, soil, etc.—but o upon the machinery available.

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urbing City and County Debts

New Jersey has come to the front with a notable act verning municipal and county debts. The act estab-ies a relationship between the life of bonds and the rks they are to pay for and limits bonded debt in portion to the assessed valuation of real property. e first is a new departure in the United States, so as we are aware, and both features of the act are only worked out logically but means are provided to that they are enforced.

There has been no lack heretofore of limitations on life of bond issues, but the limits have been arbitrary have meant but little. Moreover, there has been often no adequate provision to make certain the re-nption of the bonds at maturity, although of late there been a strong and commendable tendency to pay off d issues in installments instead of relying on that eat against sound municipal finance, a poorly guarded king fund.

The New Jersey act of 1916, abstracted elsewhere in s issue, compels city and county officials to face two stions whenever a bond issue is authorized and to write answers boldly in the bond ordinance. The first ques-n is, How long may these proposed works be expected to form useful service? The second question is, What l be the net debt of the city if these bonds are ied? More wholesome questions could not be pressed ne whenever an increase in the municipal debt is templated.

Not content with forcing city and county fathers to ask mselves what the life of the proposed works will be, New Jersey act sets limits beyond which too san-ne authorities cannot go. In like manner it fixes a nicipal debt limit and tells how it must be com-ed. The particular limit set on the life of the bonds on the amount of net debt a city, town or county may ur may or may not be wise. The main point is that cardinal principles in sound public finance have not only been recognized, but that a well-considered law to put them in force has been worked out in considerable detail and placed on the statute books of an American commonwealth.

Fortunately, these sound principles of public finance can be widely adopted in other states without specific legislation. Hundreds of cities are free to make the life of their bonds come within the probable life of the works for which they are to pay; the majority can perhaps choose serial bonds in place of sinking funds; few if any can be forced against their judgment and will to pile up municipal debts faster than sound municipal finance warrants.

But while any municipality may go far along these lines if it desires to do so, many will make no move in that direction unless compelled. Engineers should therefore use voice and pen to create both local and state public opinion against piling bond issue on bond issue for public works worn out before the first bonds are redeemed and public debts out of proportion to financial resources.

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British Engineers in Canada

The following remarks appeared in the London "Surveyor" of Aug. 25, 1916, under the heading "The Outlook for British Engineers in Canada":

> Is it not possible that when the Great Crisis is over many of our returned engineers may look to Canada as a fertile field for the exercise of their professional skill? If so, our advice to them would be, emphatically, Don't! We have it on excellent authority that most of the towns and cities there have spent so much in the past, and the war has caused such a great setback, that it will take a long time for them to revive the stage when the services of consulting engineers will be needed frequently. Moreover, practically all the plums in this line are given to American engineers. For many reasons there is a strong tendency to select them, while the next choice falls to Canadian-born engineers. It is generally held that American methods and ideas are best suited for Canada, and no doubt this belief is sedulously fostered by interested Americans. Anyhow, men from the Old Country are not encouraged, and it is well this should be put plainly.

It may be well to warn British engineers not to look to Canada as a field for employment; but the reasons might have been more accurately stated. Although some of the cities in Western Canada went too fast and far in municipal expenditure and particularly in real estate booming before the War, and while all of them have been sacrificing men and money and curtailing municipal and other civil expenditures during the War, it is probable that Canadian municipalities as a whole will resume the construction of public improvements on a large scale soon after the War ends. By far the larger part of the engineering work involved will naturally and properly be done by Canadian engineers. These men are destined to harvest most of the plums—and the lemons also. A few consulting engagements will doubtless come to engineers in the United States, but our British contemporary is far afield in its supposition that all the best engagements and large fees go across the international boundary.

What is more natural than that engineers of Canada and of the United States should be given preference over those of Great Britain, when the first are on the spot where the work is to be done; the second are next at hand while the third are a long ocean journey away?

As to it being "generally held that American methods and ideas are best suited for Canada," this is so obviously in accord with the facts as to leave no need whatever that the "belief" should be "sedulously fostered by interested Americans."

Letters to the Editor

Careful Design Needed for Wall-Bearing Flat Slabs

Sir—The report on the "Flat-Slab Floor Failure Due to Poor Brick Wall Columns," appearing in your issue of Aug. 10, 1916, should do much toward the abolition and suppression of the criminal practice of designing flat-slab floors resting on exterior brick piers in practically the same manner as if they were carried on reinforced-concrete columns capable of taking the bending moment induced in them by the eccentric application of the loads. Some engineers have become so enthusiastic over flat-slab construction that they seem to think it will do the impossible. That any designer can so lose himself in the mathematics of the problem as to ignore the broad principles of commonsense is almost beyond comprehension. Picture a building three bays wide, having spans of 22x20 ft. 3 in. with reinforced "pipe-stems" 12x12 in. in cross-section forming the interior supports of a flat-slab roof resting on exterior brick piers 13 in. thick. Such was the shop building of the Boys' Industrial School at Roxbury, Mass. If that can be called "good practice," then the work of our various joint committees, engineering societies and city building departments has been an utter waste.

It is now generally conceded by designers that, owing to the monolithic nature of the construction, bending moments of considerable magnitude may be induced in the exterior columns and those adjacent to the exterior by unequal distribution of loads. That a 12x12-in. column reinforced with four ⅞-in. rods is good for a relatively small moment, and much less so a brick pier 12 or 13 in. thick, can be readily appreciated by an engineer without much computing. The direct load on the column may warrant the use of one very small cross-section, which when investigated for its resistance to bending may be wholly inadequate. Some of the more prominent city building ordinances and rulings on flat-slab design take this into account by specifying minimum sizes of columns or the amount of bending which the columns must resist in addition to the direct load.

The Chicago ruling says: "The least dimension of any concrete column shall be not less than one-twelfth of the panel length, or one-twelfth of the clear height of the column." The Cleveland, Ohio, code limits the diameter of interior spirally reinforced columns to one-thirteenth of the span for floors and one-fourteenth for roofs. An exterior column supporting a roof the Philadelphia code requires to be figured as taking 80% of the negative moment developed in the roof slab at the edge of the column head, and other wall columns as taking 10% of the negative moment developed at the edge of the column head, above and below the floor considered.

The interior roof columns in the building in question had dimensions of one-twenty-first of the average span, while to conform with the Chicago code, instead of being 12 in. square they would have been 21 in. square, an increase in section which no doubt would have enabled them to resist the additional moments coming upon them, due to the inability of the brick piers to take bending, and possibly might have avoided the failure. The framers of the codes mentioned are to be commended on placing limitations on the minimum sizes of concrete columns allowable in flat-slab buildings, based on the span of slab as well as the unsupported length of column. Such failures as the one in question, demonstrate the absolute need of such requirements. The largest columns in the Roxbury building were only 18 in. square, which was smaller by several inches than the minimum or top-story column should have been. Combined with the uncertain action of brick piers as exterior supports, the results are not at all surprising.

For the best interests of all concerned and for the advancement of good construction, flat-slab floors with brick walls as exterior supports should be absolutely prohibited by law, unless designed in accordance with the most conservative assumptions as to spans and moments and the bearing walls stiffened by projecting pilasters o piers at frequent intervals, preferably to line up with interior columns, which should have a sufficient cross section to withstand bending moments induced in them by unbalanced loadings on slabs.

ALBERT M. WOLF.

Chicago, Ill., Aug. 11, 1916.

Sir—Sanford E. Thompson is quoted, in your articl on the Boys' Industrial School at Roxbury, as havin stated, "My criticism of the design relates chiefly to th improper combination of the reinforced-concrete flat slab with the brick walls. This combination is a poor construction at best." With this statement of Mr. Thompson's we thoroughly agree. By tests, deflection measurements, theoretical analyses, and practical experience, during the last few years, it has been proved beyond doub that the combination of brick wall bearings and an reinforced-concrete construction depending upon continuous action in its members is not to be considered as goo engineering practice.

Even provided that the walls and wall piers ar brilt of first grade material, and that first-class workmanship is applied, a difference in the settlemen of the walls as compared to the settlement of th construction at the best. In fact, we would consider i as an impossible construction from the viewpoint of goo engineering practice. Even provided that the walls an wall piers are built of first grade material, and that first class workmanship is applied, a difference in the settl ment of the walls as compared to the settlement of th interior columns can hardly be avoided, and it is a we known fact that uneven settlement of these support generates very excessive moments over the interior co umns, and also negative moments in the center portio of the interior panels. Although the positive momen in the exterior panels may be designed with the assum tion of a free support on the walls, the elastic deforma tion in the slab will cause a negative moment of son magnitude in the walls, since no provision can be made, from a practical standpoint, for hinges at the wall support. The eccentric conditions of loading thus generated in the walls will cause an increase in the compressive stresses, and, possibly, tensile stresses over a part of the wall section, which stresses are more safely taken care of by reinforced-concrete wall columns. From a viewpoint of economy also, we have found, in our experience, that a combination of wall columns, lintels and curtain walls s more advisable than bearing walls and piers, when the atter are designed and constructed at their best.

In addition to the apparent carelessness in the de-ign and construction of the exterior walls, it seems to us that, according to the information given in the article, the methods of choosing the dimensions of the other structural members were just as hazardous.

From the column schedule we learn that the interior columns in the higher portion of the building are 12 in. quare, reinforced with four 7/8-in. round rods. It is a igidly enforced law, required by most of the well known building ordinances, that the smallest diameter of the column shall not be less than 1/12 of the clear span of the slab, for flat-slab construction, and not less than ½ of the clear story height for any reinforced-concrete construction. This minimum is entirely justified from he viewpoint of good engineering practice, since an unbalanced distribution of loads, or an excessive ratio of lenderness, is apt to cause bending stresses in the columns. It is true that the bending moments in the columns will be reduced, due to the fact that the columns re restrained vertically by the columns above and below, nd laterally by the adjoining slabs, thus forming a rigid rame with the adjacent panels as well as the stories above nd beneath. No matter how small this moment may be, however, it is there just the same, and the conscientious esigner will take it into consideration. This building would require columns at least 21 in. in diameter, with a cross sectional area of 346.4 sq.in.

With respect to direct load, we find that the columns used in the building are barely able to withstand the uperimposed dead-load. Considering the relative large mportance of a column, a factor of safety of 5 is not oo conservative. Moreover, it is a generally accepted ule not to use the fireproofing portion of a column for he direct load. Using these principles as a basis, the llowable safe unit stresses for a mixture of 1 : 2 : 4 con-rete would be 400 lb. per sq.in.; for a mixture of : 1½ : 3, 480 lb. per sq.in. on the net sectional area of the columns, using an *n* of 15 and of 12 respectively, or the allowable safe unit stresses in the vertical reinforcing steel. Refiguring, on this basis, the total loads which the columns are able to withstand, we find, as already stated, that there is no permissible live load.

Making the unsound assumption of a factor of safety of 3½, for concrete in direct compression, and using he gross area of the column, the largest possible live-load the columns are able to withstand, according to our investigations, would be 25 lb. per sq.ft. on the roof and about 75 lb. per sq.ft. on the first and second floors. We wish to emphasize, however, that this load, considering he bending moments in the columns, would seriously impair the safety of the structure, and we used this basis of design only in order to find the live-load which the man aying out the building might have had in mind while assuming the dimensions.

The same inconsistency with respect to relative strengths appears in the flat-slab designing. Making the most favorable assumption, that all the slab rods are bent up over the columns, thus being effective in the top portion of the slab, we find that the resisting moment over the column would be able to carry safely a uniformly distributed live-load of only 60 lb. per sq.ft. in addition to its dead weight, while the slab at the center of the panel is strong enough to withstand a load of 600 lb., or ten times as much as the other portion. It is one of the fundamental principles of engineering design that each member of a structure shall have a degree of safety in proportion to its relative importance, giving the structure an even strength throughout. Using 100 lb. per sq.ft. live-load as a basis for designing the building, a saving of about 15 to 25% could have been obtained in addition to the 100% of cost due to rebuilding the entire structure.

Failures of this kind do not only reflect upon the responsible party, but upon the entire engineering profession, jeopardizing its reputation and integrity; also discrediting a type of construction and structural material that has proven its merit for many years. The engineering profession *in corpore* should apply strict and energetic methods to prevent repetitions of a similar character, not only for our own sake but primarily for the protection of our clients and for the safety of the general public.

CURT VON MUELLER,
Concrete Steel Products Co.

Chicago, Ill., Aug. 25, 1916.

Opportunities for Civilians To Become Engineer Officers

Sir—It is expected that the next examination of candidates from civil life for appointment as second lieutenants in the Corps of Engineers, U. S. A., will be held on or about Jan. 29, 1917. There will probably be about 30 vacancies, which it is desired to fill from that examination. Candidates to take this examination must be (a) unmarried, (b) between 21 and 29 years of age, (c) graduates of approved technical schools, (d) eligible for appointment as junior engineer in the Engineer Bureau of the War Department.

It is believed that there are a large number of well-qualified young engineers who comply with the conditions (a), (b) and (c) above and who will desire to take this examination. *In order to qualify under item (d) above, it will be necessary for all such young men, who are not already so qualified, to take the Civil Service Commission's examination for junior engineer, civil, to be held at numerous points throughout the country Oct. 11 and 12, 1916.* The Civil Service Commission informs me that the results of the October examination will be determined in ample time to allow the successful candidates to take the War Department examination for second lieutenant on or about Jan. 29, 1917.

Applications from persons along the Atlantic Coast to take the examination Oct. 11 and 12 should be submitted so as to reach the United States Civil Service Commission, Washington, D. C., at the very latest by Oct. 8. For other parts of the country applications must be submitted earlier. In every case applications should be submitted as soon as possible to insure the receipt of the approved application at the place of examination by Oct. 11. Application blanks may be secured by addressing the Civil Service Commission, Washington, D. C., or by addressing or calling upon the secretary of any of the civil-service districts. These districts with their headquarters are as follows:

First	Boston, Mass.	Post Office Building
Second	New York, N. Y.	Custom House
Third	Philadelphia, Penn.	Post Office Building
Fourth	Washington, D. C.	
Fifth	Atlanta, Ga.	Post Office Building
Sixth	Cincinnati, Ohio	Post Office Building
Seventh	Chicago, Ill.	Post Office Building
Eighth	St. Paul, Minn.	Post Office Building
Ninth	St. Louis, Mo.	Post Office Building
Tenth	New Orleans, La.	Custom House
Eleventh	Seattle, Wash.	Post Office Building
Twelfth	San Francisco, Calif.	Custom House

It may be stated that while the examination papers from the recent examination for second lieutenant, held Aug. 21 to 25 of this year, have not yet been completely marked, a preliminary report received from the board marking the papers shows that several of the candidates will probably receive marks of over 90%, from which it would appear that the examinations are not too difficult for the class of men desired. W. M. BLACK,

Chief of Engineers, U. S. A.

Washington, D. C., Sept. 23, 1916.

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Wanted: Contractors

Sir—I find that this state (Kentucky) has not enough road contractors, or contractors who are capable of doing good reinforced-concrete work. I think it would be well for contractors to investigate prospects in Kentucky.

R. WILEY,

State Commissioner of Public Roads.

Frankfort, Ky., Sept. 21, 1916.

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Concrete Road Pavements on Sandy Soils

Sir—A piece of road under improvement near here crosses some hills of fine shifting sand, and most of us doubt whether the surfacing will last. The sand gives very poor footing and is considered a treacherous foundation material. Will a concrete slab laid on such sand, without reinforcement, be able to last without cracking and breaking up?

This subject of roads on unreliable sand soils is not thoroughly discussed in the few books available here. The town officials have asked me whether some kind of clay or stone or mixed surfacing, or anything cheaper than a hard pavement, can be used successfully on this sand. Improvement of several roads besides the one mentioned is planned, and they also cross sand stretches in part.

You would do a service if you could give a brief outline of the subject of road construction on bad sand soils, especially in the direction of indicating cheap types of construction for light-weight traffic.

HENRY D. JOHNSON.

——, Long Island, Sept. 7, 1916.

[A member of the editorial staff of *Engineering News* visited the road in question, and he believes that the doubt as to the durability of the concrete pavement under construction is well founded, but not on account of the sandy soil under it.

An adjoining stretch of pavement on the same road, which was completed last season, shows wheel-track ruts and other evidences of very poor concrete, but no evidences of foundation failure. There seems no good re son for believing that a sandy soil makes other than a excellent foundation for concrete pavements.

The road in question does not appear to be a heavi traveled highway, and were clay available a sand-cl surfaced road might have answered. On the other han the conditions are almost identical with those on Ca Cod, where the Massachusetts State Highway Commi sion has been very successful in constructing oiled-sa roads by both the penetration and the mixing methods.—Editor.]

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Gravel Cover on Concrete Highway Bridges

Sir—I notice in *Engineering News* of Sept. 7 a co munication from C. E. V., Syracuse, N. Y., entitle "Why Put a Gravel Cover on a Concrete Floor of Bridge?" While I agree with C. E. V. that the avera country bridge is in danger of overloading from th cause, there is a very good reason for carrying the ro metal across the bridge floor.

Anyone familiar with road maintenance knows t difficulty of keeping the gravel or macadam up to t level of the bridge floor. The wheels of vehicles comi off the concrete onto the road metal are sure to cause depression. This depression is not only annoying to aut ists, but becomes a source of real danger to traffic. The is but one satisfactory method of avoiding this—namel carrying the road metal across the bridge so that the will be no break in the road surface.

Decatur, Ind., Sept. 11, 1916. R. L. LONGSHORE.

NOTES AND QUERIES

The Pumping Station at Shrewsbury, Mass., illustrated p. 433, of the issue of Sept. 7 was designed by E. Worthingt Consulting Engineer, Dedham, Mass. The view shown is t rear of the station.

The Effect of Bichloride of Mercury in a very diluted fo on cast-iron pipe or on monolithic concrete is the subj of an inquiry. If anyone has any data on the subject "Eng neering News" would be glad to give publicity to them.

The Soil Pressure Test Device, described in "Engineeri News," Aug. 24, 1916, was devised by E. B. Smith and A Goldbeck, of the United States Office of Public Roads. Smith was inadvertently referred to in that note as T. Smith.

The Electric-Car Ferry at Oakland, Calif., mentioned "Engineering News," Sept. 7, is not the first of its kind. T Evansville Railways Co. operates a car ferry across the Oh River at Evansville, Ind., on its interurban line betwe Evansville and Henderson, Ky. The boat is a "side-wheel 120 ft. long, with each wheel driven by a 54-hp. gasoline e gine. This ferry was described and illustrated in "Eng neering News," Nov. 21, 1912.

Concrete for Brick-Pavement Base—W. H. W. writes fro Pennsylvania:

> In laying brick paving is concrete made of slag prefera to concrete made from hard stone? The specifications we a using for brick paving call for a concrete base 6 in. thic using a good hard rock in the mix. The brick is to be la on a sand cushion. The question has arisen whether it wou not be better to use a slag-concrete base 5 in. thick, with 1-in. mortar cushion. Recent tests seem to show that in m cases the slag concrete is stronger than the stone.

The variations in test results on different samples of co crete are often so great that figures may seem to show superiority of concrete made from one material over anoth when no such superiority exists. It is doubtful whether a change in the aggregate used would justify reducing thickness of a pavement foundation from 6 in. to 5 in. R garding the change in the cushion used under the brick, wh most brick paving is still laid on a sand cushion, recent pra tice favors the use of the mortar bed.

ntermittent Excess Coagulant at Springfield, Mass.*

By Elbert E. Lochridge†

Coagulation by sulphate of alumina prior to slow sand ltration has been the practice at the West Parish filter lant of Springfield, Mass., since its construction. Records are now available covering six full years. During ne last four years of this time the method of application as been so altered that materially reduced amounts of agulant are necessary, although at all times it has been ssible to produce satisfactory water. This method has en the application of overdoses of sulphate of alumina the water intermittently. The filters, six in number, e of the slow sand type and of one-half acre area each. he water of Little River as it comes to the filters is that a mountain stream usually clear, of low alkalinity, but ith a varying color, which with the rise of the stream ay increase several fold within a few hours. This lor in the river water may be low enough for use witht any reduction for a long period of time, when sudnly a rise in the stream will cause a large increase of lor which makes the water objectionable for use.

The Little River at the point of diversion has a catchnt area of 48 sq.mi. The water is diverted from the eam in a deep and narrow gorge and sent through a ile of tunnel to a sedimentation basin eight acres in a with a capacity of 40,000,000 gal., or between three d four days' supply. From this small reservoir the ter is drawn to the filters. The water from the tunnel carried by a concrete conduit to an arm at the greatest tance from the outlet. There are no baffles or other ificial obstructions in this reservoir. The coagulant is plied in solution to the water in transit in the concrete nduit at a point which causes it to travel with the curt 510 ft., permitting some mixing before its submerged livery into the basin. Water is constantly flowing from river to this basin through the conduit and is drawn iformly from this basin to the filters.

Determination of Amount of Chemical

The determination of the amount of aluminum sulate necessary for complete reaction is made in a series 2-gal. bottles from fifteen to twenty in number, which filled each day with the river water. To these are led, in uniformly varying increments, definite amounts sulphate of alumina. Within a few hours all of the tles with amounts of coagulant in excess of the "reacn point" will indicate complete color removal, and the cipitation of foreign matter will be complete, while bottles containing less coagulant than this amount l be in a cloudy or murky condition, indicating incomte reaction. The determination is made in this man each day, permitting a study of the effects of the rise l fall of the stream, the effect of storms, melting ws, etc. The amount of coagulant actually applied to water is always a little in excess of the reaction point ermined, and during the period of application this is t as nearly constant as possible.

With the amount or rate of coagulant application per r thus known, it is still necessary to determine the number of hours per day during which it shall be added. Throughout most of the year from 4 to 6 hr. per day is sufficient, but at a time of flood, resulting in a very material increase in color, this period may be lengthened to 12 hr.

Generally speaking, the standard set for filtered water is that of no coagulation if the color does not exceed 25. Before the filtered water reaches this figure, coagulant is resorted to, and during such application the color is to be kept at 20 or below. Under the old method of constant coagulant use, it was found impossible, especially at times of low alkalinity or sudden changes, to add sufficient sulphate of alumina to reduce the water to a satisfactory color at all times. The addition of soda ash or lime was necessary for restoring alkalinity at such times. This is entirely unnecessary with the intermittent application, as but a small portion of the alkalinity is used in the formation of the floc.

Steps in the Coagulation Process

The first coagulation in the conduit and basin results in a water of substantially zero color, with at least a theoretically slightly acidic reaction. This treated portion of the water, which has entered the basin chemically active, with the precipitate or floc forming rapidly, is then followed by untreated water in a quantity, because of the longer period of time, in excess of the treated water. The thorough mixing of this raw water with the treated water is brought about at the outlet of the submerged conduit as it displaces the basin water at this point. The second reaction begins at once and is carried to completion with a restoration of alkalinity to the entire supply, this action probably being consummated during the period which elapses before the next application of coagulated water.

The floc of the treated water has not had an opportunity to settle when the raw water is admitted, and readily furnishes a base about which the additional precipitation resulting from this secondary reaction forms, and serves to carry down color, sediment and bacteria mechanically, as well as through the chemical reaction which is taking place in every part of the untreated water as it mixes with the overdosed water. The resultant reduction of color is therefore due to the effect of dilution of the higher-colored water with water of no color; to the second reaction, which is in reality the completion of a reaction started under favorable conditions of overdosing, and which reaction chemically is always complete, as the excess of the applied coagulant is taken up by the alkalinity of the untreated water, resulting in the completion of the mass reaction; and also to the mixing of the floc of the fully treated portion with the mass of the entire day's water-supply, before it has the opportunity to settle. The precipitate thus formed in large part settles before it is carried to the filters.

In conclusion it may be said that the use of intermittent coagulation results in a saving in expense, uniform results of satisfactory quality, coagulation without exhausting alkalinities in soft waters and coagulation without excessive overloading of the precipitated hydrate on the filter beds.

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Holders of Activated-Sludge Patents are requested to correspond with Adams-Hydraulics, Ltd., manufacturer of sewage-disposal appliances, York, England.

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*Abstract of a paper read before the New England Waterrks Association at Portland, Maine, Sept. 13, 1916. The er will be printed in full in the "Journal" of the assotion.

†Chief Engineer, Springfield Water-Works.

Big Stack Falling from Broken Boom Tests Concrete Floor

By Henry Blood*

On Aug. 30 a section of steel boiler stack weighing 6,700 lb. was dropped 145 ft. to the roof of a two-story wing of the Pittock Block in Portland, Ore., by the breaking of the derrick that was hoisting it. The accident not only was interesting as a structural failure of a timber derrick, but it affords an exceptional example of the ability of a good concrete floor to stand up under a most severe test.

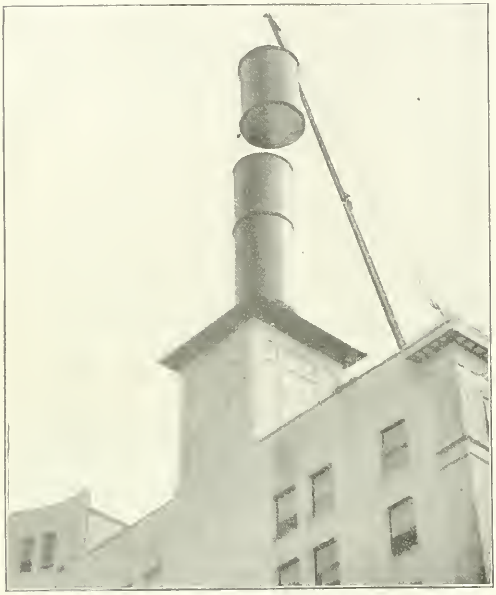
FIG. 1. BOILER STACK ON THE DERRICK A FEW MINUTES BEFORE IT FELL

The Pittock Block is a reinforced-concrete office building, erected in 1913. It is 200x200 ft. The south half is eight stories in height; the north half was designed for eight stories, but constructed only to the third floor on which a temporary wooden roof, covered with ta and gravel, was placed. The roof framing consists o 4x4-in. caps and sills, and 4x4-in. posts spaced 5 o 6 ft. on centers in both directions. The third floor i a reinforced-concrete slab with girders and intermediat beams, and it was designed for a superimposed load of 9 lb. per sq.ft., using the stresses allowed by the Portlan code.

The auxiliary steam plant of the Northwestern Electri Co. is located in the basement. It has a stack 10 ft. in. in diameter, inclosed by two separated tile partition and extending about 35 ft. above the roof of the eigh story wing before the new work was started. At tim when the boilers were being forced to take on a hea load, a considerable volume of smoke was emitted. Th annoyed the tenants of a neighboring office buildin and in an effort to abate the nuisance the company w adding 50 ft. to the height of the stack. This was three sections; the lower one was 20 ft., weighing a proximately 8,400 lb., and the upper two were 15 f long, weighing 6,700 lb. each. The first and second se tions had been raised and riveted in place. The upp section was within 1 ft. 6 in. or 2 ft. of the top when t accident occurred. Fig. 1 is a view taken from t street, looking southeast, a few moments before the se tion fell.

The derrick had an A-frame composed of 14x14-i Douglas fir timbers, with a vertical height of 45 ft. a a spread of 50 ft. It had no stiff-legs, but was guy to the roof with two sets of steel cables, making a angle of 60° or 70° with each other, extending back abo 50 ft. from the derrick and fastened through holes in the slab, around concrete girders. The base had timber under each leg, connected by poorly made join to a short girder built up from I-beams, with top a bottom plates, to form a seat for the boom. Back of t sill there were two diagonal timbers, and a center str 12 ft. long. The boom was a single stick of Dougl fir 106 ft. long, 14 in. in diameter at the top and 22 at the bottom. It worked on a vertical pin $4\frac{1}{8}$ in. diameter. Its weight with fittings was about 6,600

The legs of the A-frame were connected at the top two wide steel plates, 4 ft. 9 in. long. The front pla was $\frac{3}{8}$ in. and the back plate $\frac{5}{16}$ in. thick. The low corners of the back plate were cut off, so that they d not extend as far down the legs as the front plate.

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*Engineer, Bureau of Buildings, Portland, Ore.

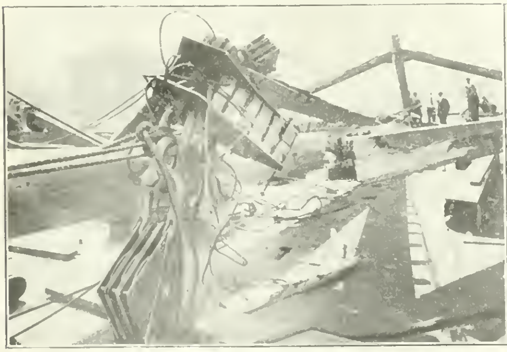
FIG. 2. CLOSE VIEW OF BREAK IN DERRICK

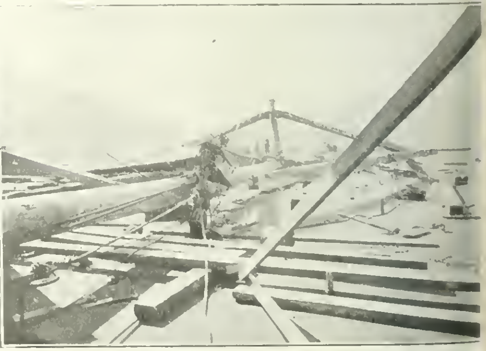
FIG. 3. THE COLLAPSED DERRICK ON THE ROOF

arge number of bolts, mostly ¾ in., joined the plates nd legs, some being below the back plate. A heavy orging passed through the plates near the top. It had n eye in each end. The center of the front eye was ·1½ in. from the face of the plate; that of the back eye bout 5 in. The boom guy was fastened by a link and levis of 2¼-in. metal to the front eye. It was a six-art ¾-in. steel cable. The back stays were attached y a horizontal pin and shackle. The running line from he boom guy passed through a block held by a U-bolt ear the bottom of the front plate. The derrick was set acing north on large timbers laid on the roof. A side uy ran from the end of the back shackle to the east all, to take the strain when hoisting from the street ver the west wall. The position of the derrick was ot changed in doing this. Each stack section was set own on the roof before raising it to the stack.

All cables and connections appeared amply strong for he loads. The superintendent stated that the derrick as designed to handle 36 tons at an elevation of 30°. t was used in erecting the Broadway bridge and had een lying outside quite a while.

Two engineers of the Northwestern Electric Co. were n the roof watching the work, and they observed all teps of the failure. It was caused by the west leg of he A-frame twisting or tearing off just below the top onnection. The boom fell in a vertical plane toward he north, struck on the firewall and broke off a few feet utside. The broken end, which was about 40 ft. long, ll close to the wall, the top end punching a hole through he wooden roof about 25 ft. from the wall and the roken end leaning against the wall at a window. The locks swung violently against the wall, smashing windows at the fifth, sixth and seventh floors in the second ow from the west corner. Several workmen, and employees in two or three offices, had narrow escapes.

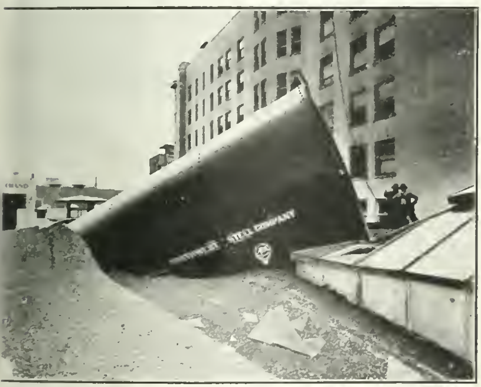

FIG. 4. THE FALLEN SECTION OF STACK STUCK IN THE TIMBER ROOF

The stack section struck with its nearer side about 0 ft. from the wall. It crushed the wooden roof to the oncrete slab, but stopped on the latter and apparently lid not seriously damage it. The frame of a skylight n which the upper end of the stack struck was bent at ne corner, and some pieces of wire glass were broken ose. The well of another skylight a few feet away had horizontal crack all around, 2 or 3 ft. below the top. The stack was flattened, and its angle rings were badly twisted. It had to be returned to the shop. A couple of small holes were cut through the main roof by sheave blocks, the firewall was slightly crushed, and pieces of brick were knocked from several window jambs.

The derrick kicked backward, not being fastened to the roof, struck a corner of the firewall and was turned toward the west. The base timber broke off near the east leg. No cables or connections were broken. Fig. 2 shows a close view of the top connection and primary break. Fig. 3 is a view of the stack as it lay on the roof. The photographs were taken the next morning.

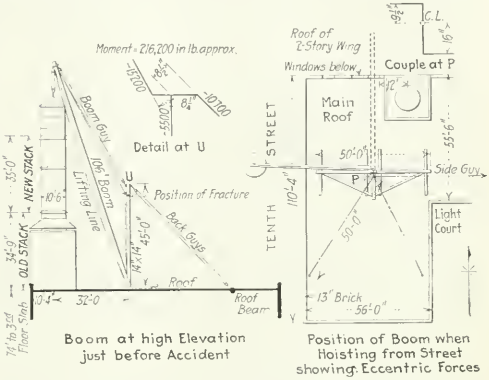

FIG. 5. DETAILS OF DERRICK WHICH COLLAPSED

Cause of Failure

The timber was not entirely sound, but no real decay was visible. It was seriously weakened by the bolt holes. There were three ¾-in. holes in a transverse row and two more only 2½ in. from them at the point of failure. The wood broke through all five.

There was an old crack or check about 2 in. from the outer face, extending for some distance along the fibers. It may have been caused by some previous strain. But even with these defects the stick was safe for a much larger direct load than it had.

In my opinion the break was due to a twisting moment on the derrick head produced by eccentricity of the guy connections. This was not nearly as large when the boom was at a moderate elevation as when it was in a high position. It was elevated at an angle of 70° or 72° from the horizontal at the time of the failure. An examination of the photograph shows that there would be considerable twisting in this position, which would cause tension in the front face of the legs. The connection of the boom lifting line to the bottom of the front plate added to this eccentric action. The direct stress in the leg was tension also.

But the heaviest twisting moment could have occurred when the boom was swung to the west to hoist from the street. It was then nearly parallel to the front of the A-frame, and its guy formed with the side guy from the east wall a couple having a lever arm of 26 in. or 27 in. The leg may have been slightly cracked by this strain and so weakened that when the boom was in its unusually high position it easily failed.

It is quite unlikely that there would have been a failure, if the top connection had been designed to avoid eccentricity with the load in any position and if the side guy had not been attached to the back shackle. This is a detail that should receive more careful consideration. Derricks, hoists, scaffolding and other erection equipment should have proper design and inspection, as well as more permanent structures. They need not necessarily have the same factor of safety; this depends upon the importance and place of use. They should be sufficiently strong to avoid risk, and the details should not be weaker than the members they connect. This is not a criticism of anyone connected with the work.

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Test of New Type Reinforced-Concrete Bridge

The Minnesota Highway Commission has developed a new standard design of reinforced-concrete bridge for short spans in which the volume of concrete is reduced by cells in the under side of the slab so as to form six longitudinal beams and also three transverse beams to distribute the concentrated load. This design saves about one-third of the volume of concrete required in the flat-slab type for the same load and using the same unit stresses.

In order to test this design and also to demonstrate the strength of reinforced concrete when built properly and under engineering inspection, the Commission constructed a model bridge from the plan shown in Fig. 1 as a part of their exhibit at the Minnesota State Fair, at St. Paul, Sept. 4 to 9, and arranged with the Experimental Engineering division of the State University to conduct a series of public tests.

This model was one-half size of a 23-ft. span, 18-ft. roadway bridge built under standard specifications of the Highway Commission by men in the bridge department acting as laborers. The slab mixture was one part cement, two and one-half parts sand and four parts gravel, hand mixed, and the reinforcement plain, square bars. Th bridge was designed for a 20-ton traction engine with 1 tons on the rear axle. The unit stresses used were ste in tension 16,000 lb., in shear 10,000 lb., concrete i compression 650 lb., in bearing 400 lb. and in shear 50 ll The forms for the cells are made of arched corrugate No. 26 iron with wood bulkheads which may be taken ou nested, moved to another bridge site and used again.

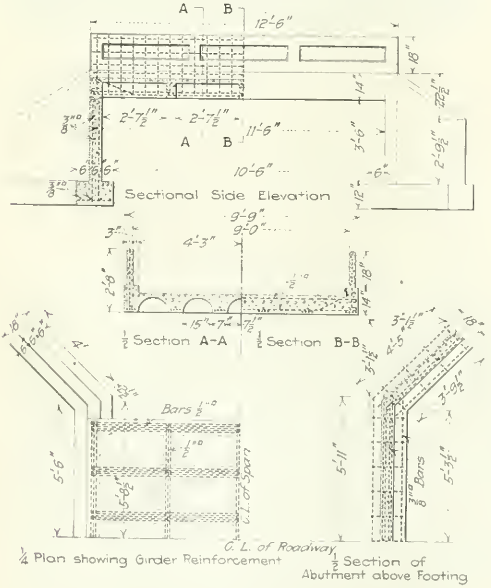

FIG. 1. DETAILS OF REINFORCED-CONCRETE BRIDGE TESTED BY MINNESOTA HIGHWAY COMMISSION

The bridge was cast June 19. Wooden plugs in contac with the steel were placed with the forms, to be pulle out later, and permit of strain-gage readings on the stee and steel plugs were set in the top of the slab for compre sion readings in the bottom of the girder for defle tion readings. Tests for shrinkage stresses were made a intervals between June 19 and Sept. 4, the opening da of the Fair.

A stone wagon was then placed on the bridge, pig iro being loaded on it over the rear axle in increments 2½ tons until the normal calculated load of 7½ tons wa on, equivalent to a 20-ton traction engine on the ful size bridge. These loads were moved around to differen positions, and readings extending over four days wer taken at each position. The wagon was then remove and replaced by a platform support on two 6x42-in timbers on which pig iron was piled at intervals until th calculated breaking load, 30 tons, was reached, equivalen to 60 tons on the full-size bridge.

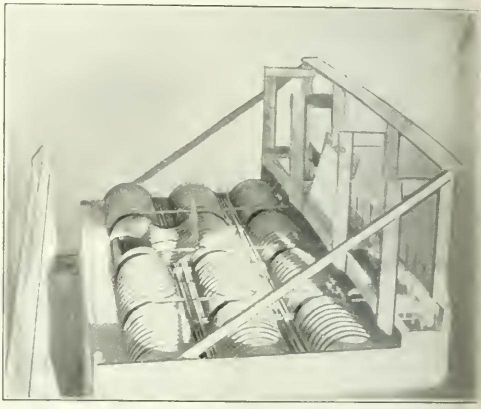

FIG. 2. MODEL OF FORMS FOR BRIDGE AS EXHIBITED AT STATE FAIR

The maximum longitudinal steel strains under th designed live-load was 3,800 lb. per sq.in. and the defle tion 0.022 in. Under 20 tons concentrated on two 6x42 in. timbers the deflection was 0.06 in. at first and afte 24 hr. 0.08 in. and the steel stress 1,800 lb. Under th breaking load after 4 hr. the longitudinal steel strain wa 12,000 to 15,000 lb. per sq.in. and the maximum deflectio 0.3 in.

As no cracks appeared anywhere in the bridge under th breaking load, excepting a cleavage crack along the ba of the abutment indicating the bottom and side lines of th slab, on the afternoon of Sept. 9 the reinforced-concret railings were broken down with sledge hammers. Th girder effect of the railings, which were not figured i the design, was apparent in the slight deflection of th outside girder (0.1 in. as compared to 0.3 in. at th center). After their removal a hair crack appeared i

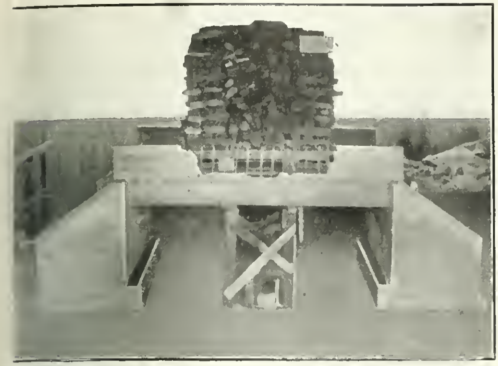

FIG. 3. TEST BRIDGE UNDER LOAD

he bottom edges of the outside girders at their center and heir deflection was 0.35 in. Slight transverse cracks also ppeared in the bottom of the cross girders. The bridge vill be allowed to stand under this load for further levelopments.

A complete analysis of stresses as determined by the ests must be made before many deductions can be drawn, ut in general the tests indicated that a safe and less ostly type of bridge has been developed by the Minnesota Iighway Commission; also that with insured engineering nspection higher unit stresses might be used in concrete ighway bridges with perfect safety, with a still greater aving in cost resulting in the construction of more ermanent highway bridges. The Highway Commission s now allowed 3% for drawing plans, supervision and nspection.

The bridge was designed and built under the supervision of C. E. Nagel, Bridge Engineer of the Highway ommission, and the tests were made by F. R. McMillan, Engineer of Tests, Experimental Engineering Department, University of Minnesota. A complete analysis will e made by Professor McMillan and published in a ulletin later.

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Thacher Bridge Patent Loses in Iowa District Court

In the United States District Court, Southern District of Iowa, Central Division, Judge Martin J. Wade on Sept. 12, 1916, handed down a decision against the Thacher reinforced-concrete bridge patent (No. 617,15). The suit was by Edwin Thacher against the authorities of Polk County, Iowa, and was defended by he Department of Justice of the State of Iowa. The lecision is by far the broadest of the three which have recently been made against the patent, inasmuch as it holds, first, that Thacher's swearing back of his invention before the von Emperger patent which it obviously nfringes was not valid; second, that the "independence" of the reinforcement specified in the Thacher patent must be rigidly construed and third, that Thacher should be estopped from maintaining his patent because of laches in defending it through the first fifteen years of its existence.

Judge Wade's decision in the main, is as follows:

I do not pass upon the validity of the patent in so far as the same was affected by the prior art, or previous publication, except as the same is affected by the von Emperger patent. The patent to von Emperger embodies the idea upon which the plaintiff procured his patent, and I hold that the von Emperger patent was an anticipation of the patent granted to the plaintiff.

I also hold that the proof furnished to the patent office to establish the fact that the plaintiff's invention antedated the von Emperger patent, is not, in view of the evidence in this case, sufficient to justify a court in sustaining the claim of the plaintiff. Such proof must be at least "satisfactory and convincing." The proof in this case is not "satisfactory," nor "convincing." It is too uncertain to justify a court in setting aside letters patent.

So that in my view, the patent to plaintiff is invalid because anticipated by the von Emperger patent. In truth I am convinced that the only invention upon which the plaintiff procured a patent, was developed by him—not prior to the von Emperger patent, nor even at the time he filed application for his own patent, but that it really was invented by him, if at all, under the spur of repeated rejections by the patent office, of his application for a patent upon inventions entirely different from the one for which patent finally issued.

I agree with Judge Thomas in Thacher vs. Transit Construction Co., 228 Fed. 906, that the Thacher patent is specifically limited by the language "each bar of a pair being independent of the other." The proceedings in the patent office, and the proof as to the prior art, clearly convince me that it was only by reducing his claims to this specific description, that plaintiff ever procured a patent; in fact, a broader construction would in my judgment render the patent void because of the prior art, aside from the von Emperger patent. But whether it would or not, the proceedings in the patent office clearly makes effective the self-imposed limitation, that the bars to come within the scope of the patent must be each "independent of the other."

Under this construction of the plaintiff's patent, even if it were valid, there was no infringement in this case. The bars used in the construction in issue are not "each independent of the other." The bars are a part of a rigid or semirigid structure, consisting of longitudinal and cross-bars and lattice bars, all firmly bound together by wire ties at intersections.

I am convinced upon the whole testimony that the cross-bars and lattice bars and ties have functions to perform. I cannot agree with the apparent theory of Mr. Thacher as a witness that these serve only the purpose of maintaining the independent bars in place during the construction. If anything were necessary to convince me that the construction used by the defendants does not consist of pairs of bars each bar "being independent of the other," I find it in the letters written by Thacher himself through many years. These appeals by Thacher for use of the Melan and von Emperger types in preference to his own, and the failure to use the strictly independent bar system in any construction, so far as the record discloses, convinces me that Thacher himself recognizes that cross-bars and ties and lattice bars used with longitudinal bars have a function and a purpose in concrete construction; in fact it is quite apparent from the record in this case, that limited strictly to the bars independent of each other, in no manner connected, or held together, or held apart, the Thacher invention is not, and has not been, of practical use. Without further discussion of the evidence, I am convinced that there is no infringement in this case.

I am also of the opinion that the plaintiff is estopped by laches from asserting any such construction of his patent as would bring the structure involved in this case within its meaning.

This patent was issued in 1899; it expired before this case was tried. During all the years from the issuance of the patent up to the present, the plaintiff has been in close touch with concrete construction all over the United States. For years, bridges and other structures have been erected which come as near infringing the plaintiff's patent as does the structures in controversy and no action was ever brought by the plaintiff until 1913 or 1914—fourteen or fifteen years after the issue of his patent. The plaintiff permitted individuals and municipalities to proceed apparently in good faith, with private and public work, and made no protest until a comparatively short time before his patent expired. In fact I am convinced that the plaintiff's present view of the construction of his patent as including structures such as those in controversy, is a discovery made by him or some one else within recent years. I do not believe, during all these years when he quietly allowed those he now claims to be infringers to proceed without asserting any right, that he understood or believed that these structures came within the claims of his patent.

There will be a decree dismissing the plaintiff's Bill and judgment against the plaintiff for costs.

Prominent Bridge Engineers Express Regret

The editors of *Engineering News*, after the publication of the issue of Sept. 14 with the account of the accident at Quebec, invited a number of prominent engineers to comment on the disaster. The following replies were unfortunately crowded out of the issue of Sept. 21:

The accident proves again the fallibility of the human mind even where highest qualifications are in commission. The failure seems to be chargeable to an erection plan containing a casting that failed, thus producing eccentricity and the kicking out of the supporting girder.

The first Quebec Bridge failure was due to an erroneous compression formula and too small a purse. Engineers who have studied the present design and seen the work now standing have been profoundly impressed with the great advances represented over the old design. Engineering follows the rules of evolution the same as every other art; only in engineering the inexorable laws of nature expose our troubles where other professions do not reveal them. The shoulders of the engineering profession are strong and courageous, and this failure will be translated, I am sure, into a fine success by the very men whose responsible souls have been so severely tried by this accident.

Some engineers will say, "Of course, the design at this point was bad," and so on, but such critics have done little in life but criticize.

I am sure that the engineering profession will be strengthened by the accident and that the present organization will carry to complete success this very bold undertaking. The general public, often indifferent to the multitude of responsibilities that have to be absolutely solved in every detail, may be here awakened to the extent of the exactions of our profession, for it is quite likely the casting was only one of ten thousand problems in this structure of equal importance to final success.
HUGH L. COOPER.
101 Park Ave., New York City, Sept. 14, 1916.

I did not have the benefit of first-hand observation, but have had the report of two other experienced eye-witnesses. It was evident to all observers that the contractors, the St. Lawrence Bridge Co., had spared no care or expense to make a perfect success of this unprecedented operation, and they should receive every sympathy, particularly from the engineering profession, which profession appreciates that, in the great strides made from time to time, the pioneers are called upon to pay the toll of advance experience. There is no reason to be discouraged in the slightest degree; the contractors will ultimately complete the work promptly and successfully.

I think it is plain there was no defect in the design of the main structure, either in the cantilevers or in the suspended span, that contributed to the disaster. It would be presumptuous on the part of any member of the profession to make any suggestion as to the cause of the disaster in advance of the report of the contractor, whose engineers and field forces are entirely competent and are the only ones in a position to know the sequence of events that actually led up to the trouble. I well know they may be depended upon to enlighten the profession fully and completely.
JOHN STERLING DEANS,
Vice-President and Chief Engineer, Phœnix Bridge Co
Phœnixville, Penn , Sept. 15, 1916.

The second failure seems to have originated like the first—from a cause which would be apparent to the mechanic.

As the shopman questioned the make-up and lacing of the chords of the first ill-fated design, so in like manner the mechanic familiar with the use of jacks and the trouble incident to "kick" would be inclined to expect more than the usual difficulty owing to the carefully hinged bolster support built up high upon the stirrup girder.

A safe and cheaper support would have been secured had a low flat shoe well bolted to the top of the girder been employed with stiff chords in the end panels.

There is no new lesson apparent in the collapse further than to emphasize to us all the ease with which some of the best of us may overlook the simplest and most obvious things.

The unsurpassed skill exhibited in floating and swinging the great span has unfortunately gone for naught because of the insufficiency of a mere trifling detail.
C. A. P. TURNER.
Minneapolis, Minn., Sept 15, 1916

Temporary Rock-Fill Dam on Colorado River

During the past August a temporary rock-fill dam was built across the Colorado River by the Imperial Irrigation District under the direction of C. R. Rockwood, chief engineer. The purpose of the dam was to divert the low-water flow of the river into the main irrigation canal of the district and thus save irrigated crops in the Imperial Valley. During June, it is explained by Mr. Rockwood, the flood flow of the river leaves an enormous deposit of silt, building up the canal bottom, while at the same time erosion of the river channel causes the river bed to fall. When the peak of the flood is past, the river generally falls very rapidly, resulting in a low river bed and a high canal bottom. Several months are required for the gradual filling up of the channel and erosion of the canal bottom to establish an equilibrium.

In 1910 a rock-fill dam or weir was placed in the Colorado River under the direction of Mr. Clark, then Chief Engineer of the California Development Co., at that time the owner of the canal. From 1910 until this year the Government has refused repeated requests for permission to construct another rock-fill weir. In 1915, however, permission was granted by the Government for a temporary hydraulic-fill dam across the Colorado River. The construction of this dam was described in *Engineering News* of June 22, 1916, pp. 1170-71.[1]

The construction of a hydraulic-fill dam in the Colorado is not possible, except at times of very low flow. Such a flow did not occur this year, and consequently permission to construct the rock-fill dam was a godsend. It should be understood that these dams, whether hydraulic fill or rock fill, have to be removed before the river again goes into flood.

The construction of the rock-fill dam this year has been thus described for *Engineering News* by Mr. Rockwood:

We have had for years a standard-gage railroad track running from our quarries at Andrade to our intake at the river. From this track we threw a spur across the river at right angles to the direction of flow. The river channel at this point is 650 ft. wide, and the trestle was 700 ft. long. The trestle was an ordinary four-pile bent, 15-ft. span structure. From the trestle we dumped rock on either side, carrying first a thin blanket of rock across the channel, gradually raising it until we had a sufficient amount of rock in the channel to divert the required amount of water to the canal. We used no rock exceeding ½-cu.yd. capacity. All of it was loaded with steam shovels.

We used for hauling rock 12- and 16-yd. air-dump cars and have placed a total of 1,146 cars to date (Aug. 28). The weir was completed 10 days ago, and the only rock that is now being used is for repair work where some slight breach occurs in the top of the dam.

We shall remove the trestle in October and before the approach of next summer's floods will remove the rock, or as much of it as may be necessary to avoid seriously obstructing the channel during flood.

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Electrification of the St. Gothard Ry. in Switzerland has been undertaken by the Swiss Government, which is spending about $600,000 on the work this year and will eventually spend about $7,500,000. The length of line to be electrified is about 68 mi. Two power stations are being built, one at Amsteg where the water of the river Reuss is utilized under a head of 900 ft. and the other at Piotta where the head of water is 2,642 ft. and 39,000 hp. will be developed. The commission appointed to investigate as to the system of electrification to be adopted has recommended a single-phase system similar to that used on the Lötschberg tunnel line.

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[1] The description mentioned was taken from a paper by J. C. Allison, of Calexico, Calif., Chief Engineer of the California Development Co., printed in the May "Proceedings" of the American Society of Civil Engineers. The paper was read before the society on Sept. 6, 1916.

News of the Engineering World

Railway Roadmasters Meet

The thirty-fourth annual convention of the Road- sters' and Maintenance of Way Association, held in ·w York City, Sept. 19 to 22, was the best attended on ·ord. Over 250 members were registered, and there ·re 57 exhibitors of track appliances and appurtenances. The committee reports on the "Seasonal Distribution of aintenance Work and Forces," on "Recommended actice for Anchoring Track, Uniform Spacing of Ties d Elimination of Slot Spiking," and on "Equating ack Values" were the principal features of the meeting.

The committee on seasonal distribution of maintenance rk reported in favor of a monthly payroll allowance d a yearly material allowance. That monthly payroll owance gives greater elasticity in labor hire and that arly material allowance results in greater economy in rchases were the contention.

The discussion showed much difference of opinion on th these heads, some favoring a permanent section force e year round and others expressing themselves against e maintenance of a considerable labor force during the mparatively idle winter months. The experience of the ng Island R.R., described by Coleman King, supervisor, s shown that the gain in efficiency resulting from perma- nt employment pays the railroad for the unproductive ne during the winter. Moreover, it has assured the ilroad of plenty of labor at a time when other roads re suffering from shortage of labor. The experience the Buffalo, Rochester & Pittsburgh Ry. has been much e same.

The report of the committee on anchoring track outlined e damage done by creeping rails and strongly advocated e economy of rail anchors, which it was estimated, save proximately $250 to $400 per mi. in tie renewals, driv- g back rails, squaring up slewed ties, surfacing track, . In the discussion it developed that some thought is too high an estimate of saving. It was stated that th the New York Central and the Canadian Pacific lines e using track anchors on single- as well as on multiple- ack lines.

The spacing of ties, the committee reported, should be uniform distance between edges instead of a uniform stance center to center. The recommended method gave iform bearing for the rail irrespective of the width of e tie, although the time honored method is to place so any ties per rail length. The committee reported against int fastenings slotted for spiking, which were held to be ineffective method of preventing rail creeping and only nded to weaken the track and increase maintenance ex- nses.

The committee on equating track values outlined the llowing course to be pursued: (1) Classification of rail- ads on basis of traffic handled; (2) determination of roper standard of maintenance for main track, sidings, vitches, etc.; (3) the selection of special test sections of ack from which accurate records of labor distribution, c., could be compiled.

From available data the committee prepared the following table of recommendations:

Class		Force: 1 Foreman and	Equiv. Mileage or Sect.	Men per Mile with Foreman	Men per Mile without Foreman	Miles per Man with Foreman	Miles per Man without Foreman
A. Double-track lines	S	6 men	9	0.78	0.67	1.29	1.50
	W	3 men		0.44	0.33	2.25	3.00
A. Single-track lines	S	4 men	6	0.83	0.66	1.20	1.50
	W	3 men		0.66	0.50	1.50	2.00
B. Single-track lines	S	4 men	7	0.71	0.57	1.40	1.75
	W	2 men		0.57	0.43	1.75	2.33
C. Single-track lines	S	3 men	8	0.50	0.37	2.00	2.67
	W	2 men		0.37	0.25	2.67	4.00

The following officers were elected: President, M. Burke, roadmaster, Chicago, Milwaukee & St. Paul Ry., Chicago; first vice-president, A. Grills, superintendent of track, Grand Trunk Ry., St. Thomas, Ont.; second vice-president, J. B. Oatman, Buffalo, Rochester & Pittsburgh Ry.; secretary, P. J. McAndrews, roadmaster, Chicago & Northwestern Ry., Sterling, Ill.; treasurer, W. H. Kosmehl, Elgin, Ill. The newly elected officers of the Railway Supply Association are: President, R. A. Van Houton, Sellers Manufacturing Co., Chicago; vice-president, E. T. Howson, engineering editor, *Railway Age Gazette*, Chicago; secretary-treasurer, W. C. Kidd, Ramapo Iron Works, Hillburn, N. Y.

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Port Authorities Meeting Held at Montreal

The fifth annual convention of the American Association of Port Authorities was held at Montreal, Sept. 13 to 15, with a large and representative attendance from all parts of the United States and Canada. W. G. Ross, President of the Montreal Harbor Board, spoke of the advantages of annual gatherings as productive of harmonious international coöperation and dealt at length with the benefits of the public as compared with private control of harbor facilities. Until recent years organization in American ports has been in the hands of interests or railroads vying with each other to capture freight and secure the best competitive terminals. Of late, however, public control is being instituted for private ownership, and almost every seaport of note will presently be organized in this manner. Mr. Ross explained conditions in Montreal, where there are no wharves under private ownership and the jurisdiction of the Harbor Commissioners extends over a distance of 17 mi., including both sides of the River St. Lawrence. Thomas R. Williams, of the Board of State Harbor Commissioners, San Francisco, read a paper on concrete wharf supports.

Robert Bridges, President of the Seattle Port Commission, read a paper on the British policy of national control of ports, as exemplified in Canada at Montreal and Vancouver, where the Harbor Boards are appointed by the Canadian Government. This policy keeps public control of access to the ocean; and if private individuals construct wharves out to deep water or become squatters on tide lands. the Government has only to pay the value of any improvements and order them off. The American attitude as regards public control of ports is changing and the completion of the Panama Canal is a great stimulus to port improvement.

F. W. Cowie, Chief Engineer of the Harbor of Montreal, gave an address on "Canadian Ports," pointing out the difficulties of the problem of providing transportation facilities for Canadian produce, owing to the climate and the great distances to be traversed through a sparsely settled country. That this problem has not been solved may be judged from the fact that of 312,000,000 bushels of wheat shipped from the head of the lakes during 12 months, 161,000,000 bushels were diverted to American ports.

The delegates were entertained at luncheon by Mayor Martin and in the evening were banqueted by the Montreal Harbor Commission. The delegates inspected the railway terminals, elevators and other facilities of the harbor and were entertained at luncheon by the Shipping Federation of Canada.

The following principal officers were elected: President, W. G. Ross, Montreal; Secretary, W. J. Barney, New York; Treasurer, Harry C. Gahn, Cleveland. It was decided to hold the next convention in Cleveland, Ohio.

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Activated Sludge in India

Activated-sludge studies at three points in India, with particular attention to fertilizer possibilities, are to be made by Dr. Gilbert J. Fowler, who was for many years chemist and superintendent and then consulting chemist of the sewage works of Manchester, England, and whose pioneer activated-sludge work is well known by sanitary engineers. Some months ago Dr. Fowler became Professor of Applied Chemistry at the Indian Institute of Science, Hebbal, Bangalore, India. Under date of July 28, 1916, Dr. Fowler wrote *Engineering News* that he expected experimental activated-sludge plants would be installed in connection with the Institute at Hebbal, and also at Calcutta and Hyderabad.

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New Chicago Railway Terminal To Cost $20,000,000

Tentative plans for the new terminal station of the Illinois Central R.R. at Chicago have been submitted to the City Council committee on railway terminals. These plans provide for the use of the new station, not only by the roads now entering the present station, but also by those using the Dearborn Station and possibly by those using the La Salle Station. The location will be at the southeast corner of 12th St. and Indiana Ave. Both of these thoroughfares are blocked by the present station, but will be continued past the new station. The headhouse will be about 700x200 ft., four stories high, and in architectural design it will harmonize with the neighboring Field Museum. The trainshed and platforms will extend nearly to 16th St. A Bush type of trainshed will be used.

A special feature of the design is that it is to be a three-level terminal. The top deck, level with the new 12th St. viaduct, will have the main passenger floor, with 24 tracks. At the street level will be the express and mail han ling platforms, while below this will be the suburb tracks. These last tracks will be depressed in a subw beginning at about 22nd St., and (as at present) w extend beyond the main-line terminal station to t suburban terminal at Randolph St. The lower platfor may later be developed for through passenger traffic.

Electrification of the suburban lines is proposed as pa of the project. The total cost is estimated at $25,000,00 More complete plans have been called for by the city, i cluding plans for such a station as would be required the other railways continue to use their present termina

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Opinions on Building Vibratio Collected by Contractors

An inquiry on the seriousness and injurious effects vibration in buildings containing machinery is sum marized by the Aberthaw Construction Co., 27 School S Boston, in a little pamphlet just issued under the tit "The Effect of Vibration in Structures; Prelimina Report of the Aberthaw Investigation." The summary based on several hundred replies.

Concerning the effect on workers, this citation is ty cal: "Under certain conditions it was impossible for o employees to stand it for a very long time. . . . the case of women it seemed impossible for them to sta the vibration even temporarily on account of its nervo effect." In another plant a case of paralysis of the le was attributed to vibration.

The amount of vibration involved in severe cases unstable buildings appears to be rather indefinite. O descriptive remark, which may be exaggerated for effe relates to an extraordinarily bad case: "I have seen m buildings vibrating so much from the movement machinery that a half-filled pail of water placed upon t upper floor would spill over."

A few cases are reported of vibrations due to machine so severe in character as to injure the structural streng or stability of the building. In the case of a set of belt grinding machines the machines when set on the fl vibrated badly; the vibration "was so severe that it wou be only a question of a short time until we would ha had to repair the brickwork." In another case shafti was thrown out of alignment, owing to the distortion the building. In another case: "We have often be obliged to reline shafting, and also after adopting high rates of speed we found it necessary to install ad tional posts supporting several floors."

Taking repairs as evidence of structural injury, a ve decided statement says: "In all cases the loading of t floors is within the safe limits of the floor constructio but we have found that the vibrations in many instanc have caused the loosening of the floor-joist supports in t walls and have in some cases made repairs necessary to t building."

Increase of output, possibility of doing more delica work, and greater freedom from stoppage of work on su machines as looms and spinning frames are reported in considerable number of cases. By putting a machine on solid foundation "the increased output by making th change was almost 40%, owing to the fact that the ope ator could take measurements with the machine runni when there was no vibration, but was unable to do so wh vibration was so great. The quality of the work was al greatly improved." Putting grinding machines on a solid foundation "increased the grinding capacity of the machines possibly 10% without using any more wheels." In textile mills before stiffening up the building by pilasters and new flooring "there was a great deal more repairs on looms and therefore necessarily less production." Also "a rigid loom placed on a firm foundation will turn out better work and more of it than one of ighter frame subject in itself to vibration and standing on a vibrating floor. The same is true of carding nachines." Foreign fabrics are thought to be better than some of the American fabrics because of more attention abroad to building construction and solid setting of the nachines. It has been estimated that about 10% increase n output may be effected by eliminating vibrations in extile mills.

A printing concern reports that since moving into a rigid modern building from an old brick and wooden building it can run its presses 20% faster. A chemical aboratory reported much difficulty in weighing on the aboratory balances, owing to vibration, and cure of this rouble by moving into another building. A machine-ool manufacturer says: "We have difficulty in taking fine neasurements where very sensitive indicating mechan-sms, both mechanical and optical, are used."

There is comment from a few in the direction of indicating rapid "crystallization of machines and machine parts where they rest on concrete floors or otherwise have ibration transmitted directly to them by rigid connec-ions." This testimony is of uncertain tenor, however. n other cases there is trouble from breakage of machines here they are set on very rigid supports; and in general is evident that the question of flexibility or cushion ffect is bound up with the question of vibration nfluences.

ENGINEERING SCHOOLS

University of Arizona

The University of Arizona has added to its curricula four year course in architectural engineering, which ork will be offered beginning in September of this year.

University of Texas

A four-year course leading to the degree of B. S. in Iechanical Engineering will be offered this fall for the rst time. The new work offered will include machine esign and operation, steam- and gas-power engineering, frigeration, and manufacturing methods. Additional ecture rooms, laboratories, offices shops and drafting oms have been secured by the erection of a new power uilding on the campus. A larger amount of new equipment has been secured.

University of Iowa

This institution has abandoned its four-year course chemical engineering and substituted a five-year course hich it has aimed to make as complete as any offered the country. Besides the formal course of study, the tudents will be required to make at least two inspection rips and spend two six-week periods in employment at ome industrial plant.

Two combined business and technical courses have een established jointly by the College of Applied Science nd the Department of Economics of the Liberal Arts College. One is for the business end of chemical industries and one for work when the fundamentals of engineering practice must be known. The latter course has been established to meet the demand for city and industrial-plant managers, engineering salesmen, etc. The number of electives in this course allows the student to lean toward mechanical, electrical or civil engineering fields.

Oglethorpe University

The President and Board of Directors have just announced the formal opening of Oglethorpe University, at Atlanta, Ga., on Sept. 20. The announcement goes on to say that:

> The total subscription in the present campaign for the founding of Oglethorpe as a great Presbyterian university in the South is rapidly approaching $1,000,000, the goal set being $3,000,000. Ground will soon be broken for additional buildings. The University includes the following schools: Liberal Arts, Literature and Journalism, Commerce, and the School of Science leading to B. S., M. S., and Ph. D. degrees.

NOTES

City Manager Wanted by Portsmouth, Va.—Applications accompanied by recommendations will be received by L. P. Slater, City Clerk, until Oct. 20, 1916, at noon, marked "Application for position of City Manager, Portsmouth, Va." The population of Portsmouth by the 1910 census was about 33,000.

The Slide on the Panama Canal, which tied up traffic from Aug. 30 to Sept. 7 inclusive, for ships drawing over 17 ft. of water, was due to the sudden movement into the canal prism of a large rock in the base of the Cucaracha slide. This rock mass was very hard and compact, and it was necessary to drill and blast it before the dredges could remove it.

Employment Agencies in Pennsylvania which furnish laborers for engineering and construction work, and all other private labor agencies, must obtain from the State Department of Labor and Industry before Oct. 1 new licenses, for which a fee of $50 and a bond to the amount of $1,000 are required. Receipts on standard forms must hereafter be issued by the labor agencies to every person who pays them for the purpose of obtaining employment.

Pennsylvania Turnpike Ordered Paved—Following a joint complaint by the motor clubs of Harrisburg and Lebanon, Penn., the Public Service Commission of Pennsylvania has ordered the Berks and Dauphin County Turnpike Co., which operates a toll road between Hummelstown and Wernersville, a distance of 35 mi., to rebuild a section of the road between Palmyra and Myerstown, a distance of 17 mi., before July 1, 1917. The other parts of the road must be put in repair before that date. The commission has specified a concrete base for the part to be rebuilt. This order of the Public Service Commission is looked upon as a sweeping precedent and a number of similar complaints are expected.

The Engineering Foundation, founded a year ago by Ambrose Swasey, of Cleveland, has elected as its first Secretary Dr. Cary T. Hutchinson, of New York City. Dr. Hutchinson's name was selected from a list of 16 candidates considered by the board of trustees. Dr. Hutchinson was born in St Louis in 1866, where he graduated at Washington University. He tooks a post-graduate course in physics at Johns Hopkins University under Professor Rowland. He is widely known for his work in electrical engineering and his contributions to engineering literature. For some time he was a member of the firm of Sprague, Duncan & Hutchinson, but has in recent years been in independent practice in connection with electric railway construction and hydro-electric development. He was Chief Engineer of the McCall Ferry Power Co. and Consulting Engineer for the Great Northern Ry. in the electrification of the Cascade Tunnel. Dr. Hutchinson has also been selected as the Secretary of the National Research Council, recently organized under the auspices of the National Academy of Sciences. In addition to the funds available from the original endowment by Mr. Swasey, an additional contribution of $5,000 for the current year has been made by Mr. Swasey, to meet the expenses incident to the organization of the Foundation's work.

A Barge Built of Concrete recently completed in Norway has been widely heralded in newspaper dispatches as the first vessel of this kind to be built in the world. Many engineers will recall that previous vessels of this type have been built in the United States. Some reinforced-concrete barges were built at Panama and were used to support the hydraulic pumping machinery used for lifting excavated material in some of the dam construction. Two concrete barges were also built in 1912 and 1913 at Fairfield, Md., by the Arundel Sand and Gravel Co., of Baltimore, Md. The boats were about 112 ft. long and 28 ft. beam. One of them was abandoned early in the present year but the other is still in service.

The Mississippi River Bridge or Tunnel projected by the City of New Orleans must be begun by May 1, 1920, and completed within five years thereafter, according to the terms of the constitutional amendment on which the electors of Louisiana are to vote on Nov. 7. As stated in the note referring to this projected bridge or tunnel in "Engineering News," of Sept. 7, 1916, p. 477, the project is in charge of the Public Belt Railroad Commission of New Orleans. The Commission has received applications from a number of engineers for appointment as chief engineer of the work and announces that it is desirous of hearing from any other firm of engineers whose record of work performed and general reputation as bridge or tunnel engineers will warrant their consideration for so large and important an undertaking. Wm. B. Bloomfield, of New Orleans, is the Chairman of the Commission.

Coke-Oven Byproducts of the plants of the United States amounted to nearly $30,000,000 in 1915. The manufacture of coke is an industry that is on the increase, as evidenced by the fact that last year's income for byproducts was greater than the previous record by $17,500,000. Numerous plants are being erected at the present time. One of special interest on account of its location is on the Hackensack meadows, Jersey City, N. J., that is designed to work up in the New York district an interest in domestic coke. Although there were material increases in the output and value of gas, tar and ammonia—as was to be expected in view of the greater output of byproduct coke—the increase in benzol products presented the most interesting feature of the year. The value of these products rose from less than $1,000,000 in 1914 to more than $7,760,000 in 1915, according to the United States Geological Survey. In 1914 there were 14 benzol plants in the United States, all controlled by one company. Last year 16 additional coke plants were equipped with benzol apparatus. The benzol products obtained in 1915 amounted to 16,600,657 gal. More than 13,000,000 gal. of the total output was crude light oil, having an average value of 33c. per gal.

The High-Pressure Fire-Service System of Boston, on which work has been delayed many times by the failure of the authorities to agree upon a pumping-station site, may not be completed as originally planned, as a cheaper layout has been recommended by Joseph Rourke, engineer in charge of the project. The design included a station with electrically driven pumps of 18,000 gal. per min. capacity at 300-lb. pressure and with provision for additional units at some later time. Owing to a dispute with the Edison Electric Illuminating Co. regarding rates to be charged for power, studies have been made for a smaller station to contain pumps of 6,500 gal. per min. capacity at 240-lb. pressure, driven by gas engines. The remarkable increase in the amount of sprinkler equipment in hazardous-risk buildings and the enactment of new and strict fire-prevention laws have made the larger capacity unnecessary in the opinion of the engineer, and the saving in cost at the station would enable the city to build about 11½ mi. of pipe system instead of the 6½ mi. contemplated with the original appropriation. An objection to the proposition is that the city contracted for a pump with electric equipment at a cost of about $176,000 over two years ago, and it would be necessary to obtain release from this obligation.

A Water-Storage Project in Connecticut, to increase the flow of water in the Naugatuck River, during low-water periods, is being promoted by a number of the principal manufacturing concerns in the Naugatuck Valley. The Naugatuck River drains an area of 326 sq.mi. above its junction with the Housatonic. There are many dams and mill ponds on the river and its tributaries, and during the four dry months of the year there is very little water flowing in considerable stretches of the river. The population discharging sewage into the river is estimated at 140,000, and it receives a large amount of manufacturing waste in addition. The banks of the river are coated with a heavy layer of decomposing sludge and other deposits. Two years ago the principal manufacturing concerns in the cities along the course of the river held meetings and raised funds for the purpose of investigating the possibilities of water storage to supplement the dry-weather flow. Chas. H. Preston, Jr., Waterbury, Conn., was engaged as engineer, and has made plans for a storage reservoir on Lead Mine Brook. After investigating various possible sites for the dam, one was chosen which permits t storage of about 3½ billion gallons of water, or 10,477 acre-f at a cost of $914,500 or $87.29 per acre-ft. The dam w be 1,300 ft. in length and 142 ft. in maximum height. A suming that this reservoir were emptied at a uniform ra beginning June 1, it would provide a stream 125 ft. in wid with a velocity of 3 mi. per hr., 2½ in. deep, for 12 hr. ea day and 6 days each week, for the period from June 1 Oct. 1. The dam will be a gravity dam of cyclopean mason The foundation conditions are very favorable. A solid led extends across the valley the entire length of the dam, w only 5 to 6 ft. of earth covering. Plans for the dam ha been approved by the State Board of Engineers. Furth prosecution of the enterprise is to be considered at a meeti of the manufacturers interested on Sept. 14.

PERSONALS

R. R. Feller has been made County Engineer of Wo County, West Virginia, to succeed Burdette Woodyard, r signed, as noted elsewhere.

R. P. Boyd has resigned as Assistant State Highway E gineer of Alabama to take charge of a half million dollar ro improvement project at Monroe, La.

W. F. Fourrier has been appointed Assistant Engineer the Atchison, Topeka & Santa Fe Ry., Coast Lines, at Needl Calif., to succeed B. H. Quinham, resigned.

C. W. Hays, formerly with Boyts, Porter & Co., Co nellsville, Penn., is now in charge of the pump departme of the Ross Mechanical Supply Co., Pittsburgh, Penn.

H. E. Stevens, M. Am. Soc. C. E., Bridge Engineer of t Northern Pacific Ry., has been promoted to be Chief Engine succeeding William E. Darling, resigned, as noted elsewhere.

T. F. Malloy has been appointed Engineer of the Falls a Sewell Mountain road districts of Fayette County, West V ginia, where highway improvement involving the expenditu of $350,000 is to be done.

Edward St. C. Smith, Assoc. M. Am. Soc. C. E., Consultin Engineer, Boise, Idaho, has been appointed Engineer in char of highway construction of the Piedmont road district of Mi eral County, West Virginia.

John Martin, former chief bookkeeper of the Clevelan Ohio, Water Department has been appointed Deputy Con missioner to succeed Charles P. Jaeger, resigned, as noted these columns of last week.

Harold E. Ketchum, Superintendent of Construction on t Detroit-Superior High Level bridge for the Hunkin-Conk Construction Co., has accepted a position with the Graff Co struction Co., Seattle, Wash.

Henry R. Beebe, Assoc. M. Am. Soc. C. E., of Utica, N. Y., the candidate for State Engineer of New York on the Dem cratic ticket. The Republican candidate is the present Sta Engineer, Frank M. Williams.

George S. Wheatley, Jun. Am. Soc. M. E., formerly I structor in Mechanical Engineering at the University of Pen sylvania, has accepted a position with the engineering depar ment of the Cambria Steel Co., Johnstown, Penn.

William A. Bartlett, Jun. Am. Soc. C. E., of Colora Springs, Colo., has been appointed Resident Engineer on t construction of a coal unloading station to be construct for the American Brass Co., at Stratford, Conn.

J. H. Converse, of Selma, Ala., for several years Reside Engineer of the Alabama State Highway Department, h been promoted to be Assistant State Highway Engineer, su ceeding R. P. Boyd, resigned, as noted elsewhere.

Norman F. Strachan, of Dallas, Tex., has been appointed A sistant Engineer of the Kansas State Board of Health. He a graduate of the University of Kansas and has been e ployed by Myers and Noyes, Consulting Engineers, Dallas.

Burdette Woodyard, former County Engineer of Wo County, West Virginia, has been appointed Engineer of t Walton and Spencer road districts, Roane County, West V ginia, where nearly half a million dollars is to be expende

R. J. Parker, General Superintendent of the Eastern line Atchison, Topeka & Santa Fe Ry., has been promoted to b General Manager of the Western lines, with headquarters a Amarillo, Tex., succeeding Fred C. Fox, promoted as note elsewhere. He began his railway work in 1872 as a brak man.

Fred C. Fox, General Manager of the Western lines of th Atchison, Topeka & Santa Fe Ry. at Amarillo, Tex., has bee promoted to be General Manager of the Eastern lines at T peka, succeeding the late Charles W. Kouns. He began his railway experience in 1880 as a telegraph operator.

James M. Herbert, former President of the Colorado, Wyoming & Eastern Ry., Laramie, Wyo., has been elected President of the Missouri Bridge and Terminal Co., St. Louis, Mo., succeeding the late F H. Britton. He was recently elected First Vice-President of the St. Louis Southwestern Ry.

H. A. Lane, M. Am. Soc. C. E., Assistant Engineer of Surveys of the Baltimore & Ohio R.R., has been promoted to be Assistant to the Chief Engineer, with headquarters at Balimore, Md. He has been with the Baltimore & Ohio since 902 and has been Assistant Engineer of Surveys since 1910.

Henry Welles Durham, M. Am. Soc. C. E., County Engineer of Bergen County, Hackensack, N. J., and former Chief Engineer of the Bureau of Highways, Borough of Manhattan, N. Y., is a corporal in the Seventh New York Regiment on the Mexican border. He has recently returned to his regiment in Texas after two months' furlough to attend to his other public duties.

Edward Raymond, who was recently appointed General Superintendent of the Eastern district, Eastern Lines, Atchison, Topeka & Santa Fe Ry., has the distinction of being one of the few high operating officials who has come up from he track department as section foreman and roadmaster to rainmaster and superintendent. He has been continuously with the Santa Fe since 1877.

George B. Dusinberre, M. Am. Inst. E. E., Consulting Engineer of Wellsboro, Penn., formerly Manager of the Westinghouse Electric and Manufacturing Co at Cleveland, Ohio, has been appointed Commissioner of the Cleveland Water Department. He is a mechanical engineering graduate of Cornell University and for many years was with the Westinghouse companies in this country and in England.

F. H. Tillinghast, M. Am. Soc. C. E. and **W. Parker Ireland** have formed the engineering firm of Tillinghast and Ireland, Consulting and Constructing Engineers, with offices in the Forum Bldg., Sacramento, Calif., and the Nixon Bldg., Reno, Nev. They will specialize in irrigation, drainage, hydraulic and sanitary engineering. Mr. Tillinghast has been in the employ of the United States Reclamation Service for the past ten years in charge of construction of irrigation works, the most recent of which is the Lahontan dam of the Truckee-Carson Project in Nevada. Mr. Ireland was formerly in the Water Department of Chicago, later Hydraulic Engineer with the Chicago, Milwaukee & Puget Sound Ry., and until recently was Constructing Engineer with the State Engineering Department of California.

Matthew C. Brush has been elected President of the Boston Elevated Railway Co., succeeding William A. Bancroft. Mr. Brush has been Vice-President of the company since 1910. He is a native of Minnesota and was educated at the Armour Institute of Technology, Chicago, and Massachusetts Institute of Technology at Boston, where he was graduated in mechanical engineering in 1901. His first engineering experience was with the motive power department of the Union Pacific R.R. at Omaha, Neb. Later he was with the Chicago, Rock Island & Pacific Ry. From 1903 to 1909 he was Vice-President and General Manager of the properties operated by the Boston Suburban Electric Co. From 1909 to 1910 he was General Manager of the Jamestown, Chautauqua & Lake Erie R.R. and the Chautauqua Steamship Co

William L. Darling, M. Am. Soc. C. E., Chief Engineer of the Northern Pacific Ry. for many years, has resigned, effective Oct. 1. He was graduated from Worcester Polytechnic Institute in 1877 and entered the railway service in 1879 as a Resident Engineer on the old Northern Pacific R.R. Later he was Locating Engineer of the Chicago, Burlington & Quincy R.R. and of the Florida Ry. In 1885 he had charge of much construction work as Engineer in charge of terminals of the Chicago, Burlington & Northern R.R. He was Assistant Engineer and Chief Engineer of lines which subsequently became part of the Northern Pacific Ry. until 1898, when he became Assistant Chief Engineer of the entire system He was Chief Engineer from 1901 to 1903, when he resigned to become Chief Engineer of the Rock Island System, but in 1905 was recalled to his old position with the Northern Pacific and took charge of many extensions in the Northwest

OBITUARY

Eckley B. Coxe, Jr., of Hazleton, Penn., a member of a pioneer family of anthracite coal operators, died Sept. 20, aged 43 years. He was known to engineering students and instructors as the translator of Weisbach's "Mechanics." In recent years he was much interested in Egyptian archaeological explorations.

Frank E. Shedd, M. Am. Soc. C. E., a mill and hydraulic engineer and vice-president of Lockwood, Greene & Co., of Boston, died at his home in Dorchester, Mass., on Sept. 22. He was born in Sharon, N. H., in 1856 and was graduated from Dartmouth College in 1880. Mr. Shedd was a member of the American Society of Mechanical Engineers and of the Boston Society of Civil Engineers.

Fremont Wilson, a civil engineer of Marion, Ind., was killed in that city Sept. 15 as the result of a collision between an interurban electric car and the automobile in which he was riding. He was at one time engineer in charge of construction of the Chicago, Indiana & Eastern Ry., from Muncie, Ind. to Converse (now a part of the Pennsylvania System), and he was County Surveyor of Grant County from 1908 to 1912. At the time of his death he was in charge of some road construction near Marion. He is survived by a widow and three children.

ENGINEERING SOCIETIES

AMERICAN CHEMICAL SOCIETY
Sept. 25-30. Annual meeting in New York City. Secy., Charles L. Parsons, Washington, D. C.

EFFICIENCY SOCIETY OF AMERICA.
Oct. 7-9. Annual meeting at New York City. Secy., G. E. Burroughs, Pittsburgh, Penn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickly, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The American Society of Civil Engineers will hold its annual meeting, Jan. 17, in the Society House, 220 W. 57th St., New York City.

The Canadian Society of Civil Engineers will hold its annual meeting the third week in January. The secretary is Prof. C. H. McLeod, 176 Mansfield St., Montreal.

The New England Water-Works Association will hold its annual meeting in Boston on the second Wednesday of January The secretary is Willard Kent, Narragansett Pier, R. I.

The Society of Constructors of Federal Buildings will hold its seventh annual convention in Washington, D. C., Jan. 15 to 18. The secretary is Charles Reed Marsh, Brattleboro, Vt.

The National Commercial Gas Association will hold its annual convention Nov. 13 to 18, in Atlantic City at the Hotel Traymore. The secretary is Louis Stotz, 61 Broadway, New York City.

The Society for Street Cleaning and Refuse Disposal will hold an annual convention in New York City, Oct. 13 and 14, at the New York Department of Street Cleaning, on 20th St. near 6th Ave.

The American Foundrymen's Association and the American Institute of Metals held a joint annual meeting in Cleveland, beginning Sept. 13, and a very large machinery exhibition in Wigmore coliseum.

The Compressed Gas Manufacturers' Association will hold its annual meeting in New York City at 120 Broadway, on Monday, Jan. 15. The secretary is Otto S. King 120 Broadway, New York City.

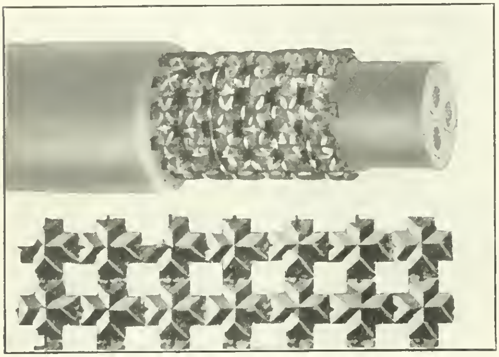
The Society of Municipal Improvements will hold its annual convention in Newark, N. J., Oct. 9 to 13, which will make it possible for the members of this society and of the Society for Street Cleaning and Refuse Disposal to take in both conventions with the maximum of convenience.

The American Public Health Association will hold its annual meeting in Cincinnati, Oct. 24 to 27. Two of the papers are: "What Are the Limitations of Public Health Administration" and "Public Health Administration on the District Plan; an Experiment by the New York City Department of Health." The secretary of the society is Prof. Selskar M. Gunn, while the chairman of the Public Health Administration section is Dr. G. W. Goler, Rochester, N. Y.

Appliances and Materials

Composite Metal Lath Formed of Wire Cloth and Clay

One of the latest additions to the field of fireproof or fire-resistive walls is a composite metal lath, consisting of annealed wire cloth on which is pressed a coating of brick clay. This arrangement provides a plaster base that has considerable solidity, yet at the same time possesses a certain amount of flexibility. The latter quality is emphasized in the lower view, showing this lath construction bent around an electric cable, which it is intended to fireproof. After being bent around the cable, the metal lath is covered with cement mortar, as shown.



THE COMPOSITE LATH AND ITS APPLICATION TO ELECTRIC CABLES

Another application is the lining of forms, where the concrete is subsequently to be covered with plaster or tile. On removing the forms there is a plastered surface, satisfactory for bonding.

* * *

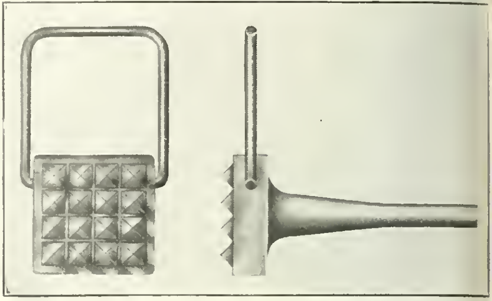
Outdoor Meter Station for High-Tension Lines

On account of the growing number of small high-tension branches on electric transmission lines—without substations—an outdoor high-tension metering station has been developed by the Westinghouse Electric and Manufacturing Co. So far the equipment has been made for 60-cycle polyphase service not over 200 amp. and above 11,000 volts.

Each equipment consists of a standard polyphase watthour meter, two current transformers, a polyphase voltage transformer and three choke coils, all inclosed in a sheet-steel case with cast-iron cover supporting three high-tension outdoor type terminals. The sheet-steel case is subdivided into two compartments, one of which is filled with oil in which the transformers and choke coils are immersed, while the other serves to inclose the meter and meter panel. On the meter panel are also mounted two fuses to protect the voltage circuit of the meter and two calibrating links located in the current circuit of the meter. These calibrating links consist of fuse clips with a brass tube inserted instead of fuses. The meter may be read or checked upon opening the hinged door which covers the entire front of the meter compartment. The arrangement is such that the entire outfit, including meter panel, can be raised out of the tank without disconnecting meter leads. Choke coils are inserted between the voltage transformer windings and the outgoing leads, to protect the transformer windings against high-frequency disturbances.

A Tool for Roughing Slippery Sidewalks

An air-operated tool has been developed for roughing stone or concrete sidewalks, the complete outfit having been put on the market by the Gardner Governor Co., of Quincy, Ill.



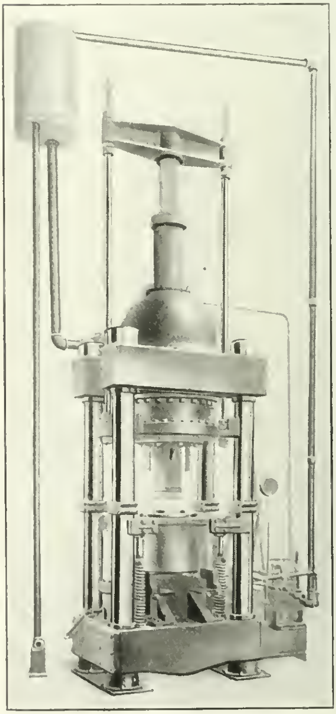
ROUGHING TOOL FOR SIDEWALKS

It is an ordinary plug drill fitted with a casehardened steel block with 16 sharpened raised points. The first machine of this character was recently purchased by the Brinkoetter Monumental Co., of Quincy.

* * *

A 1,000-Ton Hydraulic Press for Briquetting Metal Waste

A large hydraulic press was recently brought out by the Hydraulic Press Manufacturing Co Mt. Gilead, Ohio, designed to form briquettes of metal borings, turnings, etc., so that they may be remelted without the loss of valuable constituents. This process prevents oxidation and also puts the material in a convenient form for handling. The press is of the four-rod inverted-cylinder type and is built in three sizes and pressure capacities — 1,000 tons, 750 tons and 300 tons. The accompanying view shows the 1,000-ton press.



A 1,000-TON PRESS FOR BRIQUETTING METAL SCRAP

The briquette is made as follows. The material is placed in a floating mold supported by four springs. When the pressure is applied from above, the friction of the material of the sides of the mold causes it to flow down over a stationary plunger that projects into the mold from below. Pressure is thus exerted on the bottom as well as on the top of the material, and a briquette of uniform density is obtained. After being formed, the briquette is ejected from the mold by the pressure of the main ram applied upon the briquette with the lower plunger removed. The briquette falls through to the base of the press, whence it is removed by a conveyor installed by the customer.

Engineering News

›LUME 76 OCTOBER 5 1916 NUMBER 14

Capitol Terraces at Last Made Waterproof

The pavement over the terrace chambers of the United ates Capitol at Washington, D. C., after years of effort s at last been made water-tight. Ever since the ter- es were built, in 1856, each attempt except this last prevent the down-leakage of storm water has been ›rtive.

As may be seen from Fig. 1, the terraces form a mason- esplanade on three sides of the Capitol. There are › levels connected at frequent intervals by short flights steps. Along the edge of the upper terrace and be- ›en the steps are masonry plant cases. The chambers der the terraces at first were used as Congressional es, but since the completion of the House and Senate ldings they have been used mostly as building-service r ms.

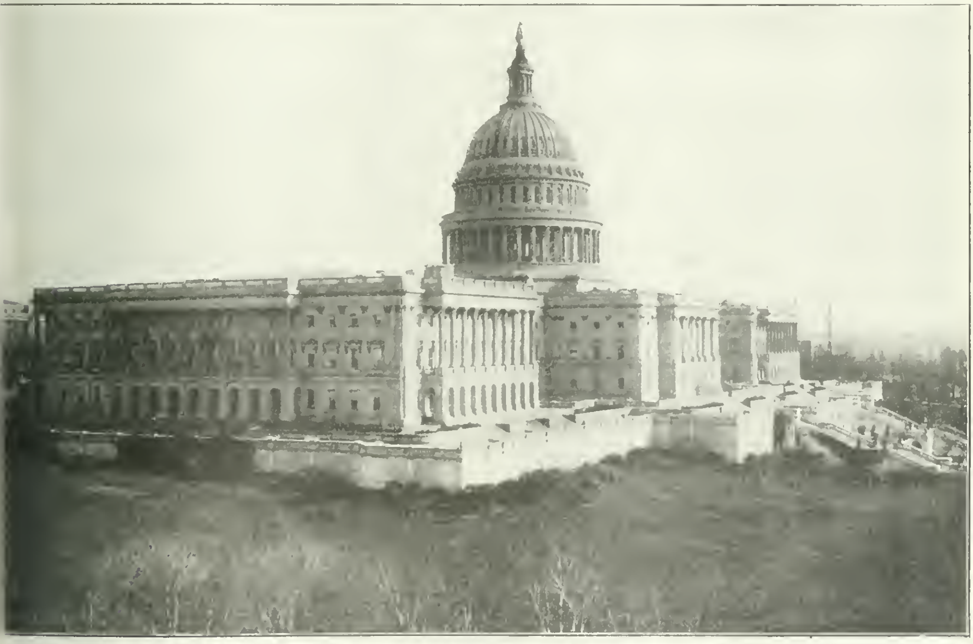


FIG. 1. THE CAPITOL AND TERRACES AT WASHINGTON, D. C.

bout every waterproofing scheme known has been t d on some part of this great expanse (about 200,000 t.) of walk—felt and tar pitch, asphalt and burlap, et asphalt, etc. Perhaps the most notable scheme em- ved up to the recent successful attempt was the use in 1906 of a sheet-lead pan placed under one section. The lead sheet was bedded on cement mortar on the base slab and was covered with a 3-in. reinforced-concrete slab and a 1-in. wearing surface. But even this construction was of no avail, partly because of the extreme expansion movement, partly because of unskilled burning of the sheet joints and partly because of the inherent difficulties of flashing around the vault light frames. The lead sheets on being uncovered were found to be considerably pitted.

The expansion and contraction of the terrace structure are excessive, owing to wide variations in temperature and extreme exposure. The walls on either end of the terraces were forced 2½ in. out of plumb. At least 60% of the Scotch granite stones on the plant cases were out of alignment, and the larger part of the marble balustrade had been forced out of line. All this distortion was due to insufficient provision for inevitable expansion movement, and to this defect can be finally traced the repeated failures to keep the terrace chambers water-tight. This success was largely due to recognizing the expansion difficulties and providing for such movement by water-tight sealed expansion joints.

The Latest Attempt Successful

As a result of a final investigation in 1914, made by Elliott Woods, Superintendent of the United States Capitol Building and Grounds, and David Lynn, Civil Engineer, it was believed that a successful job could be secured. Specifications were issued and tenders were received, as a result of which the material and laying system of the Masonry Waterproofing Co., Brooklyn, N. Y., were selected as the most desirable for the conditions involved. The notable features of this concern's proposal (employing what is commercially known as the Sheffield or "Larutan" system) consisted (1) in securing a bituminous compound blended to secure maximum adhesiveness and cohesion, (2) in using small (1-sq.yd.) freshly saturated membrane sheets, with wide laps, mopped into place and armored, (3) in free use of special expansion and flashing joints.

FIGS. 2 TO 4. SLAB CRACKS MADE INTO EXPANSION JOINTS, CAPITOL TERRACES

The material over the terraces was removed down to the concrete slab over the floor arches. When the wearing surface was removed, there were found numerous fractures in the base slab, inevitably occurring in a structure of this sort. Each crack of this description was treated as an expansion joint. The cracks were cleane out, heated with a gasoline torch, partly filled with compound and tooled with a hot iron—all as shown in Figs. 2, 3 and 4. The slab was also cut for expansion joints as shown in Fig. 5.

After the expansion joints were filled, then the pavements were brought up to subgrade (about 6 in. abov the brick supporting arches and base slab and about 2½ in. below finished grade) by a filling of 1 : 3 : 6 concrete Upon the leveled subgrade were laid single sheets of im pregnated cotton drill. The sheets were 1 yd. squar and were laid with 2-in. laps. A small area of subgrad was cleaned and mopped with hot compound just pre vious to laying each sheet. The laps were made by fol lowing with a hot smoothing iron. To prevent the men' shoes from injuring the membrane while working, a littl pile of sand was placed in the center of each sheet a laid. The men could easily walk from one sand pile t another. Upon the membrane thus made there was laid as armor for the waterproofing and as a wearing surfac a granolithic pavement (1 : 1 : 2 mixture with ½- to ¾ in. washed bluestone chips), marked off in squares, sep arated by expansion joints continuous with the expansio joints in the sub-base, as shown in Fig. 5, along the balus

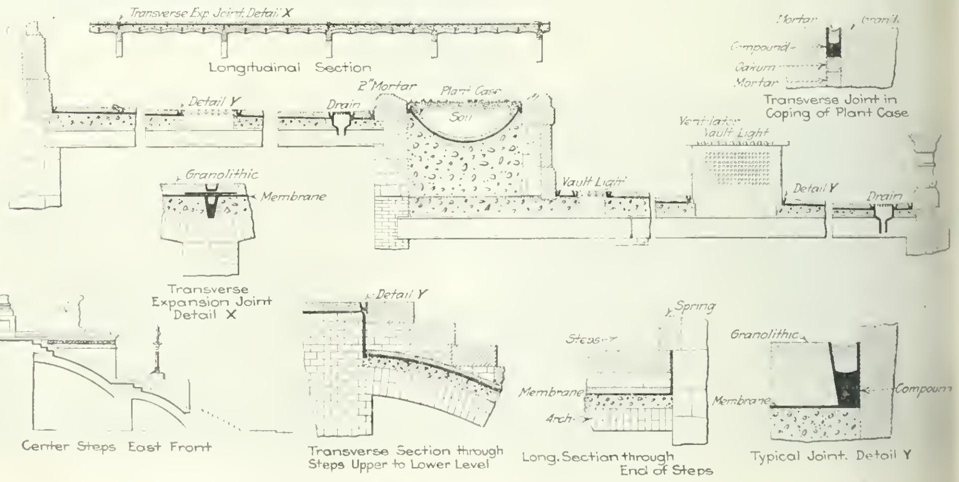
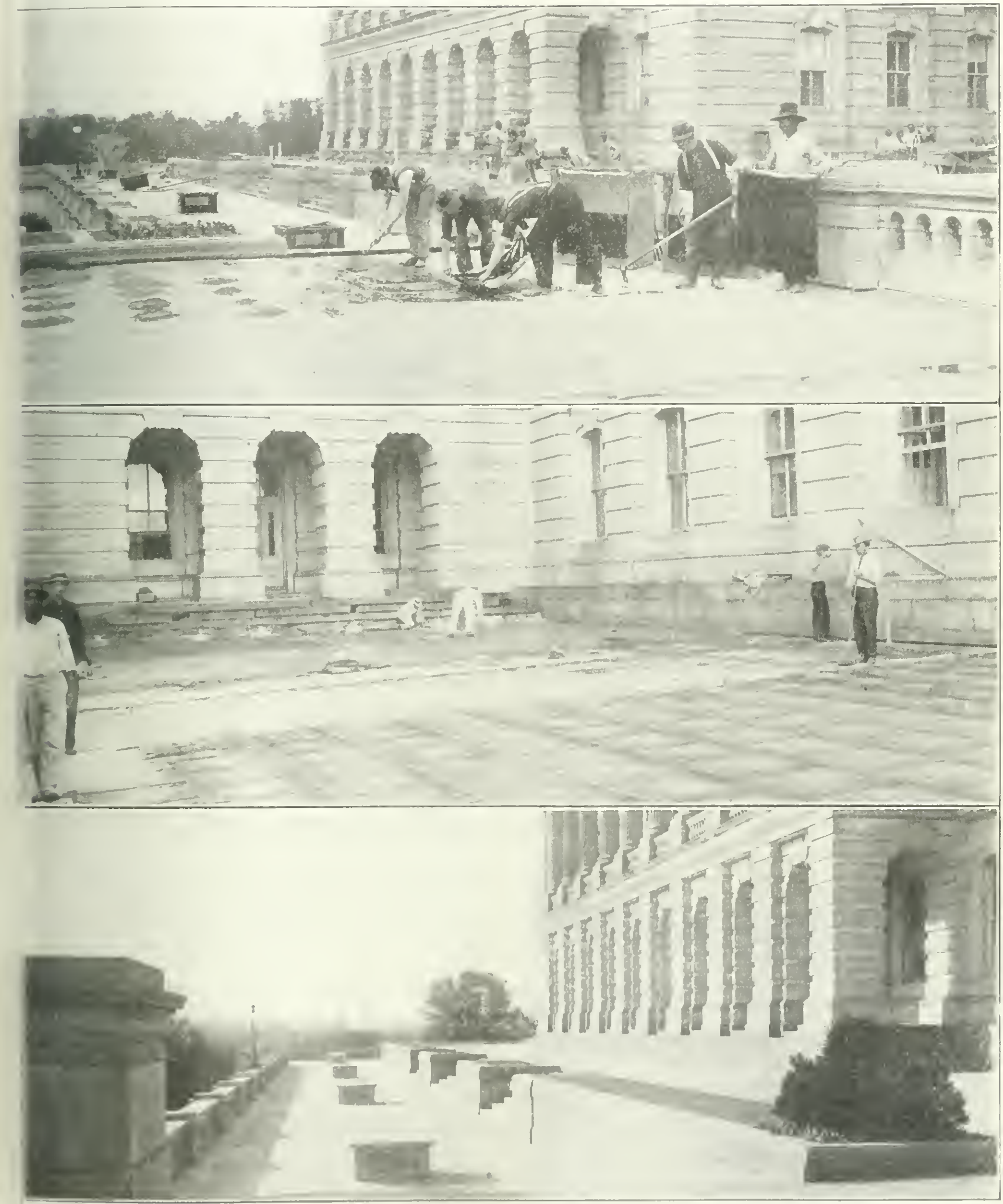


FIG. 5. WATERPROOFING SYSTEM EMPLOYED ON CAPITOL TERRACES AND EAST STEPS

Designed by the Masonry Waterproofing Co., Brooklyn, N. Y.; Oscar Sheffield, Chief Engineer rades, vault lights and at every point where flashing vould ordinarily have been employed. There was over ,500 lin.ft. of these joints; not a piece of metal flashing as used on the work.

The expansion joints are of particular importance, inerest and novelty. The cut in the bottom slab was eated, painted and partly filled with compound. Then he membrane was brought down into the reservoir and the joint pointed with mortar. The joint was covere with a patch strip (see detail on Fig. 5), completing th lower half. When the granolithic paving was laid, woo strips, tapered $^3/_4$ to $^1/_4$ in., were inserted as joint forms When the concrete had set, the wood was pulled out, the opening heated and partly filled with compound. The remaining space was pointed with mortar. In this wa a covered and sealed reservoir was created at each ex-



FIGS. 6 TO 8. WATERPROOFING THE CAPITOL TERRACES AT WASHINGTON
Fig. 6. (Upper)—Laying the membrane. Fig. 7. (Middle)—Placing granolithic armor on the membrane. Fig. 8. (Lower)—A corner of the completed terraces

pansion joint. As the structure contracts and expands, the mortar plug is drawn down or forced out, the seal being preserved. On inspection this summer the joints were found all closed nearly tight, demonstrating that by use of a thin plastic membrane underlying the wearing surface the latter could be kept from spalling or cracking.

Before the wearing surface was placed, it was decided to remove the old stone gutter which had been set in the old construction and which in some parts of the terraces was a stumbling block. To secure good drainage a slight valley was formed in the wearing surface with enough drains at intervals to carry off any downpour. The valleys are so slight as to be hardly noticeable to the pedestrian. During the past winter the entire area was drained so successfully that the usual slippery surfaces of earlier years were eliminated.

The scheme of using expansion joints along the edge of the paving eliminated the cutting of reglets in the marble balustrade and granite base and prevented the disfigurement that would have resulted.

Steps and Plant Cases

The steps leading from the higher to the lower terrace levels had to be reconstructed. The old steps were simply stone slabs or beams resting on pier walls. They were removed and a brick barrel built up (see Fig. 5) to support the stone. On the brick was placed a 4-in. layer of concrete; on this in turn was the waterproof membrane, laid as already noted, and finally on this 1½ in. of mortar armor. At last, on the completed and waterproofed barrel, brick steps were laid up to carry the stone treads.

The plant cases, being directly over the basement corridors, were made into water-tight basins. The earth-filling, existing waterproofing and a part of the concrete bottom were removed. First, new concrete was laid so as to give an elliptical basin—to prevent the freezing of the earth-fill from dislodging the sides. The waterproofing membrane was laid on the concrete and a 2-in. granolithic armor placed over it. A flashing joint was made between the concrete and granite coping stones, similar to the expansion joints on the terraces, already described, and the membrane was sealed into it. This joint was made to prevent leakage in the unexpected event that the coping stones were again moved out of alignment.

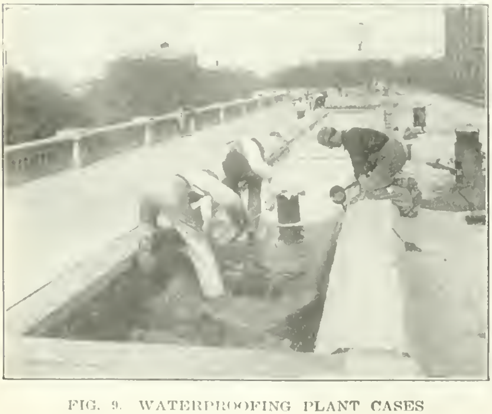


FIG. 9. WATERPROOFING PLANT CASES

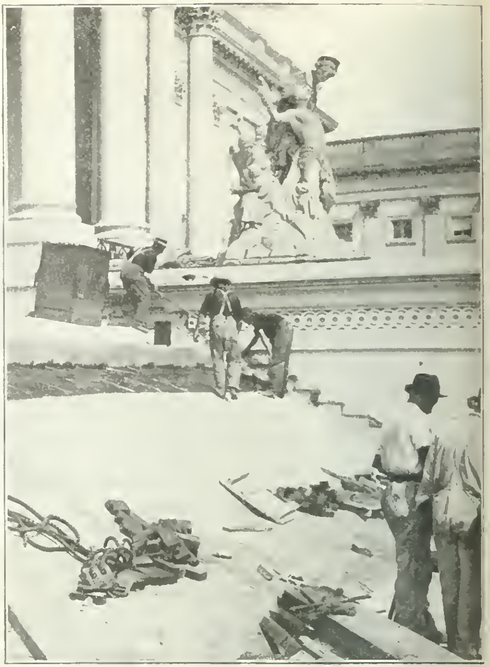


FIG. 10. WATERPROOFING THE BARREL OF CAPITOL EAST STEPS

The chipped, scaled and cracked condition of the steps at the east front of the Capitol had been the subject of criticism for years. An appropriation was made for reconstructing these at the time of making the appropriation for waterproofing the terraces. The work was done at about the same time, and the vaults under the steps were given the same treatment.

Rebuilding the East Steps

These steps were originally built on a masoury barrel. After the old stone treads were removed, the brick filling was cleaned away down to the arch. An inch of lean mortar was put on to give a smooth bed for the waterproof membrane. Over this was 6 in. of granolithic armor. On the enlarged barrel thus built up, brick risers were constructed to carry new stone slabs.

The appropriation for the terraces was $83,500, but the tender for the desired material and work ran in excess of the appropriation. However, a way out of the difficulty was found without the delay necessary to increasing the amount available. The Superintendent of the Capitol, Elliott Woods, secured an agreement with the Masonry Waterproofing Co. whereby the concern's system and materials were used, but the actual labor was done under the Government payroll—the company's workmen (a supervisor and seven men) being temporarily hired by the Capitol Superintendent. In addition, Oscar Sheffield, the chief engineer of the company, gave personal attention to the work. As a result the work on the terraces proper was done with an expenditure of $67,000 out of the appropriation. The waterproofing of the east steps and other work not covered in the first specifications required $11,692, leaving an unexpended balance of $1,800.

Tunnels for Electric Cables*

In Chicago there are 12 tunnels for carrying power ıbles across the river and several others for telephone ıbles, gas pipes and water pipes. In Detroit, similar ınnels are used for getting conduits through alleys that e blocked near the surface by other structures.

The Chicago power and light tunnels are built in the ıape of an inverted U with the vertical height 6 ft. in. in the clear, and the width 6 ft., with 9-in. conrete walls. The tunnel has a slope of 1 or 2% toward sump at the foot of one of the shafts, so that it can pumped out as a preliminary to cable pulling. At ıch end of the tunnel is a shaft 6 ft. 6 in. internal ameter, with 15-in. concrete walls. At the upper end each shaft is a manhole which forms the terminus of e conduits leading to and from the tunnel. It is found ınvenient to have the tunnel shaft extend 2 ft. above e bottom of the manhole, for convenience in working ıd as a protection to the workmen. A permanent galnized-iron grating is placed over the unoccupied portion the upper end of the shaft so as to prevent accidents.

On completion of the tunnel a standard conduit is stalled in the horizontal portion and in each of the afts, leaving a gap at the junction of the tunnel with e shafts to allow for proper training of the cables. Thi nction should be built with a curve having a radius about 6 or 8 ft. to give proper working space and rmit the cable to be installed with easy curves. The rtical conduit in the shafts can be built with singleet vitrified tile, fiber pipe or stone conduit. Tee irons e fitted into the shafts at intervals of about 2 ft., so to leave a clear space in the center of the shaft about ft. wide. With the dimensions given for the shaft about or 10 ducts can be installed between the tee irons and e shafts on each side.

A brick or concrete pier under the curve in the cables the lower end of the shaft will support a considerable rtion of the weight of the vertical cable. Some addinal means of support for each cable should be installed the top of the shaft. Care should be exercised to oid clamping the cable too tight or placing too great strain on lead sheath.

The telephone company in Chicago has used iron pipes clusively for the vertical conduits in shafts, and has ıde the connections between these vertical pipes and the nduits in the tunnel with bends of 6 or 8-ft. radius such a manner that the duct is continuous from the p of one shaft to the top of the other. Copper pull res are installed at the time the conduit is built, so to avoid difficulty which might be experienced with n wires. It is thus practicable to pull in the cables any future time without pumping out the tunnel, and the same time eliminate all joints from the bottom the shafts. It is probable that the same scheme could used with smaller cables for electric light and power rposes, but this is not the practice.

A useful auxiliary in connection with such tunnels is motor-driven pump of about 15-hp. capacity for reving the water from the tunnel. Such pumps can be tained with either a direct-current or alternating-curnt motor, which can be readily lowered into the clear ace in the tunnel. These outfits are built preferably with a vertical shaft, and for convenience in assembling are made in two parts.

The tunnel shaft should be erected from 25 to 50 ft. away from the river edge, depending upon local conditions. Where the river bank consists of made ground, it may be necessary to use a steel shield, extending into the impervious clay below the river. With a stiff clay the depth of the tunnel below the lowest portion of the river should be about 15 to 20 ft. If there is not sufficient depth of clay above the rock to give this amount of clearance to the river the tunnel should be built in the rock. In Chicago these tunnels are made at least 15 ft. below the surface of the rock, so as to avoid any danger of letting in water while blasting.

The cost of such a tunnel in clay will be about $25 to $35 per lin.ft., plus $50 to $60 per foot for the shaft. If built in rock the expense will be increased about 50%. These prices do not include manholes at the top of the shafts, or the conduits in the tunnel and shafts.

Very little water has been encountered in building tunnels in hard blue clay. Considerable water is usually present in building tunnels through rock, as the surrounding rock is somewhat shattered by the blasting, thus opening up water seams which add considerably to the difficulty of constructing the tunnel. When completed, tunnels through clay are generally dry while those through rock are somewhat leaky.

Slight leaks that do not interfere with construction work or prevent pumping the tunnel out for cable installations are not objectionable, as it is the practice to allow the tunnels to fill up with water after the cables are installed. Tunnels built in the manner described have been in service for about twelve years and no difficulty has been experienced in the operation of the cables contained therein.

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*From a report of the Committee on Underground Conuction, presented at the annual convention of the National ectric Light Association, in Chicago.

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Strong Dredge Pins for holding together the bucket line on elevator dredges are of the utmost importance and are discussed in the "Engineering and Mining Journal" by Ralph A. Young, Chemist and Engineer of Tests, Marion Steam Shovel Co. The first pins with which Mr. Young is familiar were forged from steel of about 0.25 to 0.30% carbon, machined. These being very soft they soon wore out and had to be replaced. The next were made of openhearth steel of 0.40% to 0.45% carbon content, and these gave better service but were not trustworthy. Later, higher carbon steels were used, but at 0.90% the leaf of the pins began to break, while the cost also increased owing to the difficulty in machining. Manganese steel has not proved a satisfactory metal for dredge pins. It has a high coefficient of expansion and a very low heat conductivity. A dredge pin in use on one of the larger machines is 7 or 8 in. in diameter, and unless the manner and speed of heating, the temperature and the quenching are absolutely correct, internal checks develop. Manganese steel to be of any value must contain 12 to 13% manganese. In 1914 80% ferro-manganese sold at $36 per ton At the present time it is quoted at $100 to $450. Mr. Young has endeavored to produce, in a measure, from carbon steel the same results that have been attained by use of alloys. First, a steel was chosen whose carbon content would with proper treatment produce a high degree of hardness, yet retain sufficient toughness to prevent breakage. It must also be of uniform composition, free from burnt oxides, incorporated slag and piping When the billets from which the pins are to be forged reach the forge department, test drillings are taken, to check the mill. Test specimens are also cut from many of the billets, and these are prepared and examined under the microscope. The pins are sent next to the machine shop and thence to the bucket line. Following are a few results selected at random from a recently manufactured line of pins:

	1	2	3	1	5
Tensile strength, lb. per sq.in.	88,500	88,680	85,750	89,000	86,400
Elastic limit, lb. per sq.in....	55,700	51,100	53,100	58,250	52,610
Elongation in 2 in., %........	23.5	28.0	24.5	21.5	23.6
Reduction in area, %........	61.2	61.7	58.7	53.8	57.6

Hollow-Tile Sewers Built at Clinton, Iowa

Sewer districts Nos. 2 and 3 at Clinton, Iowa, now under construction, will serve all the territory known as the Hill District and also part of the business section of the city, a total area of about 352 acres. This southern part of the city has been very closely built up during the past 30 years, but owing to the large size of sewers required and the low valuation of the property, the city hitherto has been unable to finance the project. The system comprises 6.3 mi. of sewers ranging from 10 in. to 54 in. in diameter, with a 54-in. outfall in 5th St. and a 33-in. outfall in Franklin Ave., discharging into Beaver Slough.

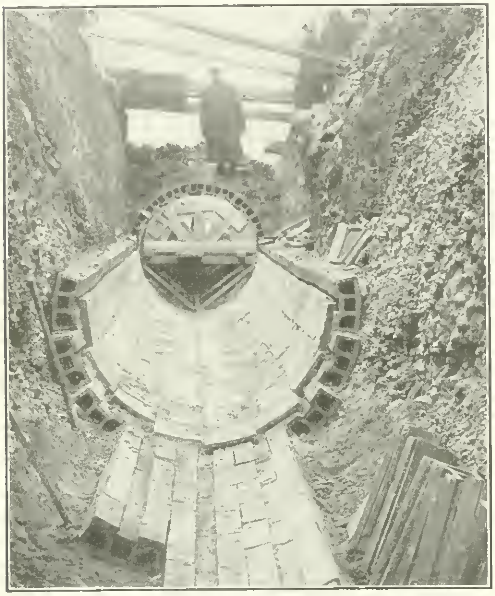

FIG. 1. SEGMENTAL BLOCK SEWER CONSTRUCTION AT CLINTON, IOWA

Three interesting features of the work are the use of vitrified segmental sewer blocks, the large amount of rock excavation and three difficult crossings under the adjacent main tracks and yards of the Chicago & Northwestern Ry., the Chicago, Burlington & Quincy R.R. and the Chicago, Milwaukee & St. Paul Ry. Sewers 21 in. in diameter and larger are built of two-course vitrified segmental blocks, of the Ferguson type. An exception to this is the 33-in. double-strength vitrified pipe that was used in the Franklin Ave. outfall sewer. Sewers less than 21 in. in diameter are of vitrified-clay pipe. Manholes and catchbasins are of concrete.

In the segmental-block construction the blocks of the outer course are hollow, while those of the inner course are flat liner blocks having a smooth surface curved to the required diameter and two ribs on the back to key or interlock with the outer course. This construction is shown in Fig. 1. The blocks are laid up in 1:2 cement mortar, and the inner blocks are laid in a bed of this mortar, so as to make a water-tight and rigid structure. The chambers in the outer blocks serve to carry the drainage or seepage water during the construction thus enabling the men to work in a trench practicall dry.

A considerable amount of the trenching was rock, wit a depth of 1 to 10 ft. and a cover of 2 to 9 ft., so tha the maximum depth of trench to grade was about 19 f The rock excavation amounted to 9,000 cu.yd.

Backfilling from the spoil bank of soft material deposited by the excavator was done by means of a Waterlo backfiller. This machine consists of a gasoline hois mounted on a truck and operating a cable attached to scraper on the opposite side of the trench. The scrape is guided and pulled back by hand, two men being required to operate it. The hoist is on a revolving platform carried by the truck, so that it can operate th cable through a considerable angle and thus backfill good length of trench from each position before bein shifted. This hoist was used also to pull the trenc sheeting. A fall was hooked to a tripod straddling th trench, with a grip at one end, while the other end wa led to the niggerhead of the hoist.

The railway tracks and yards of the three railway were crossed at 5th St., 15th Ave. and Franklin Ave. the length of crossing being approximately 240 ft., 38 ft. and 200 ft. respectively. The first two were constructed with double-course vitrified segmental block and have interior diameters of 39 in. and 45 in. Th third crossing was constructed with 33-in. double-strengt vitrified sewer pipe. In all cases the blocks and pip are surrounded with 4 in. of concrete, made with 1 par

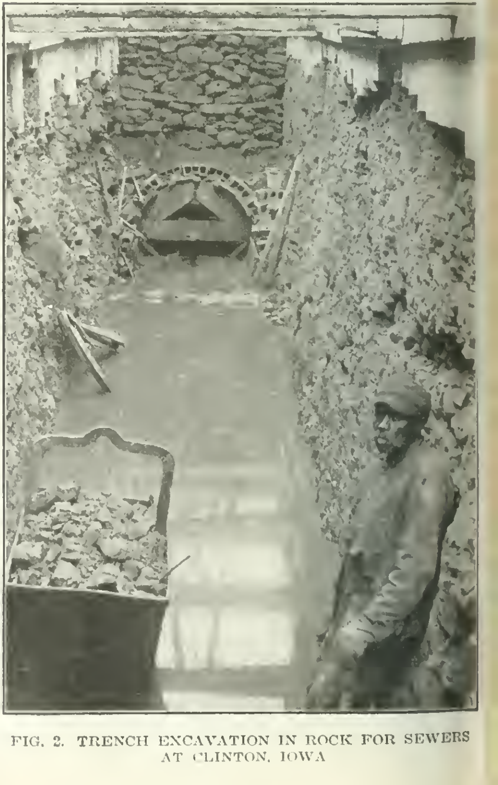

FIG. 2. TRENCH EXCAVATION IN ROCK FOR SEWERS AT CLINTON, IOWA

of cement to 6 parts of river gravel. The concrete was reinforced with a continuous sheet of American Steel and Wire Co.'s woven-wire netting with 4-in. triangular mesh. This was bent in oval form, being 1⅛ in. from the inner surface at the vertical diameter and 1½ in. rom the outer surface at the horizontal diameter. This reinforcing sheet had 9-in. longitudinal lap joints in he upper quarter of the concrete ring.

The sewers were constructed under the railways in pen cut, the tracks being supported on pile bents driven y a steam piledriver mounted on trucks. These bents vere capped, and stringers were placed to carry the racks. Owing to the large amount of traffic, no obstructions above the surface could be allowed.

The contract for this work was let Sept. 14, 1915, o Thomas Carey & Sons, of Clinton, Iowa. The contract prices for block sewer work were $8.15 per ft. for l-in., $7.15 for 45- and 39-in., $6.15 for 36-in., $5.15 or 33-in. and $4.15 for 30-in. The cost was paid partly y special assessment to abutting property according to he benefits received. The balance was raised by bond ssues supported by a district tax and a main sewer x, as provided by the Iowa law. This sewer system r the two districts was designed by J. G. Thorne, ty Engineer, and was constructed under his direction.

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Waterproof Coal Pits and Fireproof Ashpits

In the concrete coal pits of railway coaling stations of e elevator type it is essential that the pit (fo. the elevar bucket) should be water-tight. The pit is usually conderably below the groundwater level and is subject to essure, and when once put in operation it is a matter of ficulty and expense to get at it and make repairs.

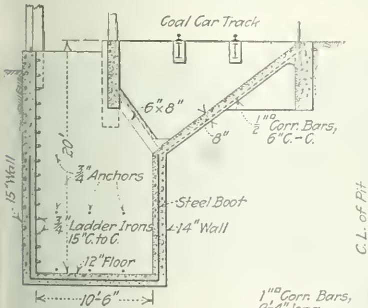

FIG. 1. CONCRETE COAL PIT WATERPROOFED WITH STEEL BOOT

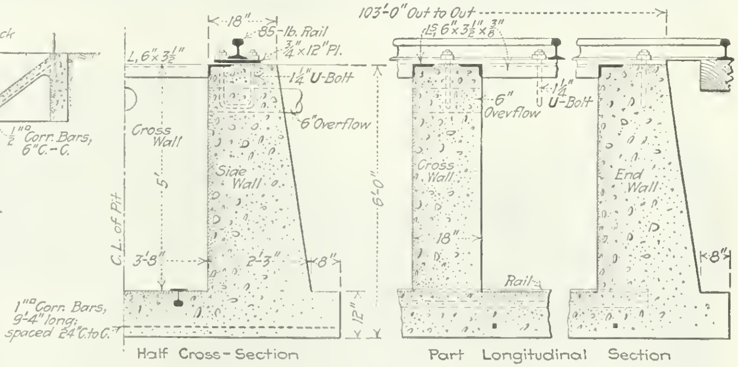

FIG. 2. CINDER PIT WITH FIRE-RESISTIVE CONCRETE MADE WITH GOLD-ORE SLAG

A plan which has been used with success is to place thin the concrete a steel boot or tank with joints soldered the field. A 6-in. thickness of concrete is placed first, d then the steel boot is set in position and soldered. hen this has been made water-tight it is lined with 6 in. concrete. All attachments, bolts, ladders, etc., are set this inner lining.

The drawing shows a pit having a boot 6 ft. 11 in. by 11 6 in. and with a height of 11 ft., its top being above undwater level. It is made of No. 20 galvanized iron, l the expectation is that if the metal should rust in course of time it would still form a waterproof diaphragm by combination with the cement. The concrete is a 1 : 5 mix, made with gravel, and mixed moderately wet. The use of a similar boot composed of burlap and asphaltic composition has given fair success. To place a waterproof lining outside of the concrete would involve greater excavation and additional form work.

In concrete ashpits or clinker pits, where locomotives clean and draw their fires, the concrete frequently deteriorates under the action of the intense heat from the bed of clinkers. In time large pieces fall out of the walls and repairs are difficult to make and maintain. After some experimenting it has been found that a fire-resistive concrete can be made with gold-ore slag as the aggregate, and this has been used with entire success. The maintenance work is very small. The slag is obtained from smelters or refineries at Omaha and Denver, and costs only about 90c. per ton. It is screened to a size of 1½ in. for the concrete, and a 1 : 2 : 5 mix is employed, using portland cement, sand and slag.

A clinker pit made in this way is shown in Fig. 2. It is 100 ft. long, 5 ft. deep and 3 ft. 8 in. wide, with heavy side and end walls and 12-in. concrete base. An 18-in. cross-wall divides the pit into two sections, each of which has a 6-in. overflow for the water used in quenching the clinkers. There is also a 6-in. overflow pipe in the cross-wall. The corners of the walls are faced with steel angles 6x3½ in., and second-hand rails embedded in the floor protect the concrete from damage by the grab buckets used in removing the clinkers. These buckets are handled by locomotive cranes.

On each side wall is a continuous ¾-in. steel plate, 12 in. wide, bored to fit 1¼-in. U-bolts which are embedded in the concrete and spaced 2 ft. c. to c. The track rail is laid directly upon this plate and secured by clips and nuts on the bolts.

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Motors for Electrified Lines in Southern France and to the Spanish frontier are being built in the American shops of the Westinghouse Electric and Manufacturing Co. They are 48 in number and will form the drive for eight 1,500-hp. Midi Ry. locomotives. They are being made here on account of the crowded condition of the French Westinghouse Co.'s shops. Single-phase current was first used on the Midi Ry. in 1905, 10 mi. of track near the Mediterranean coast being experimentally operated. In 1910 change of motive power on 70 mi. of main line and 105 mi. of branches was authorized. Large amounts of hydro-electric power are available.

New Methods and Progress on Twin Peaks Tunnel

By A. J. Cleary*

A general description of the Twin Peaks tunnel, the new highway on the line of Market St. in San Francisco, was published in *Engineering News* of Feb. 18, 1915. Since construction was started, on Nov. 30, 1914, the bore has been advanced from both ends an aggregate distance of 7,500 lin.ft. Eureka Valley station and 70% of Laguna Honda station have been completed, as well as the two shafts by which the tunnel will be ventilated. An outline of the construction procedure was contained in *Engineering News*, Nov. 4, 1915, p. 869. In the interim several new features in the method of handling the work have been introduced.

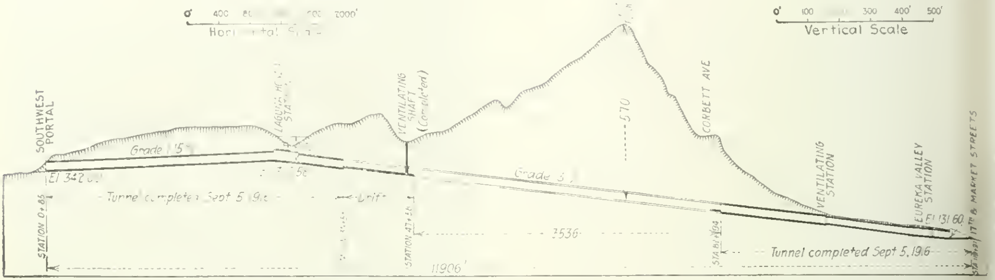

FIG. 1. PROFILE THROUGH TWIN PEAKS TUNNEL, SAN FRANCISCO, SHOWING PROGRESS TO DATE

Key and wall-plate pilot drifts with solid timbering are still excavated in advance of the main headings. Besides, from a point near the west portal a fourth drift had to be run at invert grade eastward along the center line, 600 ft. in advance of the heading to drain the wet, loose sand formation traversed west of Laguna Honda station. In both directions from this station, with a summit elevation of 375 ft., the tunnel slopes downward toward the west on a 1.15% grade, and toward the east on a 3% grade.

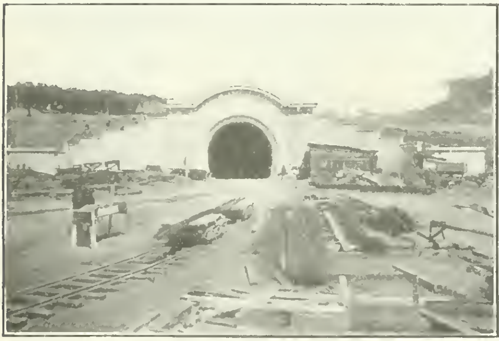

FIG. 2. COMPLETED WEST PORTAL OF TWIN PEAKS TUNNEL

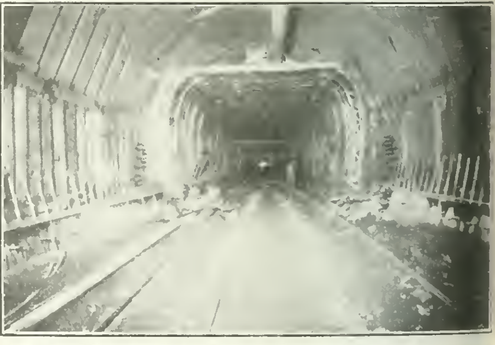

FIG. 3. INTERIOR OF TUNNEL, SHOWING FORMS AND TIMBERING

No unusual problem was presented in draining the 3,000 ft. extending from the west portal to Laguna Honda station, for the grade of the boring was up hill all through a sand formation in which comparatively little water was encountered. But in proceeding eastward from the station the direction of advance was on a 3% down slope through very wet, loose, clayey sand. When the heading was started eastward from Laguna Honda station it was found that 300,000 gal. of water daily drained into the face of the drift. The tunnel under these difficult conditions was advanced in the following manner:

New Method of Advancing Tunnel

A pilot drift 5x7 ft. in section was started eastward from the station. As it proceeded, sumps were bored in its heading to which were led the suctions of three 3-in. centrifugal pumps. These served to keep the drift unwatered and also by continual operation lowered the water plane in the surrounding formation a depth of 60 ft., but working conditions were still extremely unfavorable. To afford more adequate drainage a second drift was started westward from the ventilating shaft located 1,300 ft. east of Laguna Honda station. The ventilating shaft finished will be 13 ft. in inside diameter, but excavation for it was made 20x32 ft. and 110 ft. deep, so as to include the full tunnel width and allow for timbering and forms. Timbering for the shaft consisted of vertic piles forming a solid sheeting and held in place by 12x1 in. bracing.

Several very treacherous deposits of quicksand we traversed by the latter drift as it was advanced easter from the vent shaft. In one case it was necessary t bore an additional drift adjacent to the original one, i order to drain the formation. On July 20, 1916, th drift from Laguna Honda station reached the heading o the original drift from the ventilating shaft. The poi of meeting was 120 ft. westerly from the shaft. Th rough drift amply drains the formation traversed and kes possible rapid progress in the construction proper.

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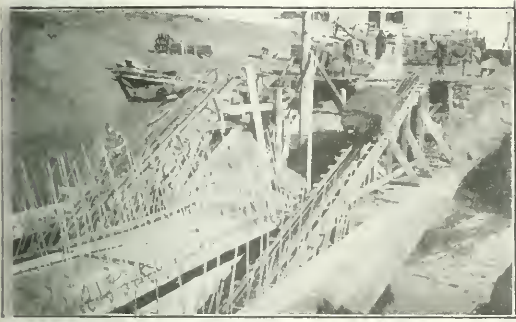
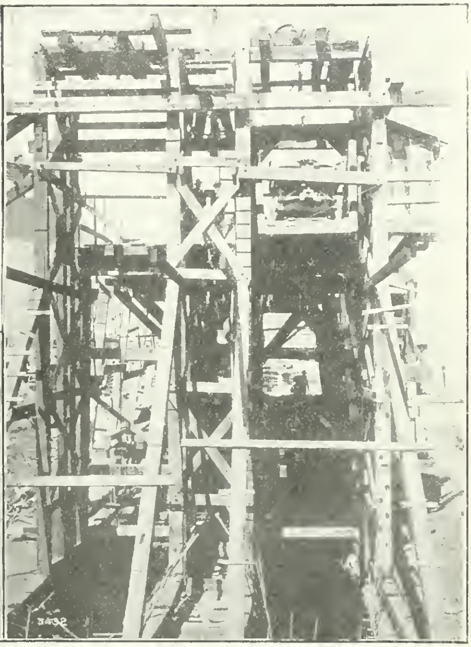
*Assistant City Engineer, San Francisco, Calif.

As the heading advanced from the easterly portal, very tle except local pockets of water was encountered in chert formation, and the tunnel excavation was almost tirely in rock. Several means of disposing of excavat terial were tried. At the east end, where the subway tion was constructed in open cut, an endless-chain alator, as shown in Fig. 4, was used to backfill over the t-top structure. When this backfilling was completed, tor trucks were loaded right at the east face and, ng the completed tube as an avenue of travel, emerged the east portal and carried the excavated material to ais Creek district, 5 mi. distant, to fill swamp lands. e poisonous gases from the exhaust of the motor trucks ide the completed tunnel caused the abandonment this scheme, since which time cars have been hauled m the face by mules and conveyed to the top of bunk- , into which they are dumped on an automatic elec- ally operated elevator situated in the slab opening or- ally occupied by the escalator.





FIGS. 4 AND 5. METHODS OF REMOVING SPOIL FROM TWIN PEAKS TUNNEL AT SAN FRANCISCO

Earlier escalator shown at left and later elevator at right

'oncrete is now placed in the tunnel lining by the umatic process. Two plants have been installed, near each portal. Specifications for concrete call a consistency of 1 part cement to 2¼ of sand, with cient rock added so that the mortar fills the voids roximately 5 parts. With every 100 lb. dry cement . hydrated lime is mixed for waterproofing.

Special Pneumatic Delivery of Concrete

rom the mixers on the surface, charges are dropped t ough a measuring hopper into the air chamber, whence t s forced into the forms through a pipe with spiral ections to give the mixture a rotary motion. At the end, concrete has been conveyed pneumatically 2,500 t p a 1.15% grade, and it is anticipated that a distance ,000 ft. will be served up the 3% grade from the east ing plant. The sequence of the concrete operations ows: (1) 100 ft. of footing poured on each side; second and third days following, footing forms oped, tracks laid for form tower and steel forms set; 40 ft. of side walls and ceiling slab started the third after initial pour; ( ) while sect on of walls and ceil- are being poured, the re naming wall and ceiling s are set, excavation finished and next forms set.

he arch was poured in long continuous sections, being part of the regular schedule for pouring as outlined before. Excavation for the invert and the pouring of the concrete in the invert are postponed until the necessity of carrying muck and materials over a given stretch is relieved by the building of a new working inlet.

Both the design and the construction of Twin Peaks tunnel are under the direction of City Engineer M. M. O'Shaughnessy. L. T. McAfee is resident engineer for the city. Robert Storrie & Co. are the contractors.

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Competent Engineers Essential to Road Construction—The main question that the people of the Union are immediately concerned with, is whether we shall get a dollar's result for every dollar we spend for roads. If, as the result of this Act, the people are induced fully to realize the necessity of placing skillful and experienced men in charge of road building and road maintenance, a great advance will have been made and the efforts of those who labored to secure the legislation will have been rewarded. I assume, as a matter of necessity, that this law will require the employment in every state of experts—of real experts. This word is very much misused and abused, as the word "theorist" is. I frequently hear a contrast drawn between the theorists and the practical men There is no basis for it. The classification ought to be into good theorists and bad theorists, between practical men and unpractical men. A really good theorist is highly practical; and so is a real expert. The public is somewhat suspicious of experts, because, I think, so many people pose as experts who are not. I repeat that this Act will necessitate trained intelligence in the service of the state as well as in the service of the Federal Government. It requires the state to accept it. That, as I understand it, implies the assent of the state to every provision of the Act One of these provisions is that projects, plans, specifications, and contracts shall be submitted for approval to the Department of Agriculture, and I have a suspicion that plans and specifications will not be approved unless they are submitted by people who know about such things.—From an address by Secretary Houston, of the Department of Agriculture, before the delegates of 37 states interested in Federal aid to state road construction.

Wind Cripples Bridge Portals and Lower Laterals*

By Clifford Older†

A destructive storm distorted a steel bridge over the Kankakee River, near the line between Kankakee and Iroquois Counties, Illinois, on Mar. 21, 1916. The bridge was left in such condition that the effect of the wind pressure could be traced plainly.

The bridge consists of two 185-ft. spans, with trusses 26 ft. high spaced 17 ft. 2 in. apart. It was built probably about 15 to 20 years ago.

As a result of the storm the trusses of the west span now lean decidedly toward the north (see Figs. 1 and 2). The east span was not so badly damaged, but it also has an inclination in the same direction.

Shearing Failure of the Portals

The top chords, though displaced laterally, were found to be in perfect alignment. The top lateral struts and diagonals were practically undamaged. The upper lateral system is light, and there is no sway bracing intermediate of the portals (Fig. 3); further, the top lateral struts were too shallow to transmit any of the top-chord wind load into the posts by portal action.

From the facts and the condition of the portals it is evident that the top lateral system served, as intended in the design, to carry the wind load to the portals. The portals, however, proved to be too weak to transmit it down the end posts to the foundation.

The portals of the west span and the west portal of the east span were distorted, with contraflexure near mid-length. The distortion occurred largely in the portion not affected by the kneebraces (Fig. 2). The lacing bars, which were flat bars with one rivet at each intersection, were buckled in the compression system, and some of the bars in the tension system were pulled in two.

It seems evident that a slightly greater wind load would have caused complete failure of the portals, resulting in tipping over of the trusses and complete collapse of the spans.

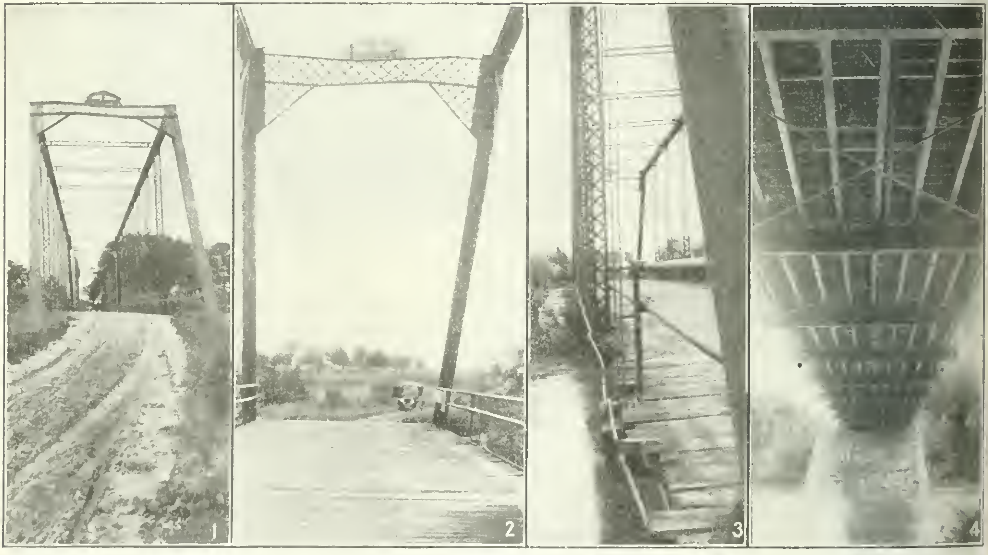
The original shop drawings do not give the name of the shop or the name of the designer. The portal is marked "Standard Portal No. 5," with the note, "2½x3x¼-in. angles, rivets ⅝, open holes $\frac{13}{16}$."

Lower Chord Failed as Chord of Wind Truss

A partial failure of the lower lateral system of each span occurred also. In the case of the west span this was of such kind that failure was imminent here, as well as in the portals. Notice the curve of the stringer lines in Fig. 4.

The lower chords are eye-bars for the full length of the span. The lateral rods are round bars passed through holes near the ends of the floor-beams and bearing on bent plates riveted to the floor-beam webs o the far side. They did not fail, although the bent plate were somewhat distorted by the pressure of the nuts an the rods were probably somewhat overstressed. Some o the diagonals of the opposite inclination, however, showe signs of failure of the wind truss as a whole by bein pushed through until the nut was an inch or more awa from the bent plate (Fig. 5).

The partial failure of the lower lateral systems o curred because of reversal of the dead-load stress in th lower-chord bars on the windward side. The lower chord



FIGS. 1 TO 4. HOW THE KANKAKEE RIVER BRIDGE FAILED UNDER WIND PRESSURE

Fig. 1—From the west, showing west span leaning to north and both portals distorted. Fig. 2—Destruction of west portal of west span. Fig. 3 The buckled bottom-chord eye-bars on the south side of the west span. Fig. 4—Curved alignment of the stringers, showing the lateral failure

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*Reprinted with slight condensation from an article in Illinois Highways."

†Bridge Engineer, Illinois Highway Department, Springfield, Ill.

5. VIEW DOWNWARD AT COUNTER ROD IN LOWER LATERAL SYSTEM, SHOWING NUT PUSHED AWAY

re found displaced laterally, but are in perfect alignnt from the second panel point at one end to the ond panel point at the opposite end of each truss.

Bridge Seats Displaced by the Pull

It is evident that the wind force brought to the shoes, excess of that necessary to overcome the horizontal nponent of the dead-load thrust of the end posts, would e a tendency to pull the shoes off the foundations. at this excess load was considerable was indicated by displacement of the stones on which the shoes rest at pier. Movement of the upper ends of the end posts, the portals yielded, no doubt aided the displacement the stones. It is doubtful if much uplift occurred, ause of the lack of sway bracing and the failure of portals.

No hinged bolsters were provided, but rollers were place under the pier shoes. This expansion device ears to have been sufficiently serviceable to have pertted a recovery movement of the lower end of the end ts when the wind load was released. This movement s limited, however, by the length of the slotted holes ough which the anchor bolts passed.

The horizontal component of the dead-load stress in end posts was not sufficient to push the shoes back place after the wind subsided. Neglecting uplift, this uld lead to the conclusion that the total wind force plied to the shoes during the storm must have been re than double the horizontal component of the dead-load stress in the end posts. It is difficult to determine just what wind load would produce such a force, owing to the complicated action of the lower lateral system after reversal of the dead-load stress in some panels of the lower chord. Approximate computations seem to indicate, however, that the wind pressure must have been in excess of 220 lb. per lin.ft. of lower chord.

⁂

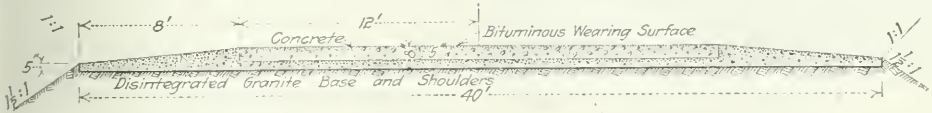
Special Concrete Pavement for Motor Trucks; Los Angeles

The County of Los Angeles, Calif., is constructing a concrete pavement of special design for the use of motor trucks between the harbor of the City of Los Angeles at San Pedro and the business district of the city. The total length of this route from Alameda and Slauson St. in the City of Los Angeles to the northwest boundary of Wilmington, which is a portion of the City of Los Angeles, is 13.3 mi.

The concrete base for this road will be 24 ft. in width and 8 in. thick. It is made of 1:2:4 concrete. This base will rest on a cushion of decomposed granite 5 in. thick and 40 ft. in width. Shoulders 8 ft. wide will be built of decomposed granite on each side of the concrete base. The standard section for most of the Los Angeles County highways is a concrete base 20 ft. in width and 5 in. in thickness, with 5-ft. shoulders. Transverse expansion joints across the full width of the concrete will be placed at 25-ft. intervals.

On the concrete is to be a bituminous carpet of a character common in California roadwork. The specification for the surfacing is worded as follows:

> After the concrete pavement has been constructed, all dust, mud, earth or foreign material of any kind which may have accumulated upon it shall be removed and the surface flushed with water. When it has become sufficiently hard and dry and in the opinion of the Road Commisioner is ready to receive it, asphaltic oil shall be applied in one application of approximately ½ gal. to the square yard.
>
> Directly after the oil has been applied, stone screenings or sand shall be uniformly spread upon it in sufficient quantity to combine with the oil without leaving any excess screenings or sand on the finished road surface. The stone screenings or sand are to be spread in a direction parallel with the road and never crosswise. If necessary, from time to time, additional screenings or sand shall be spread, as the Road Commissioner may direct, to cover any oil which may come to the surface, until the final completion and acceptance of the work.


1:1
8'
12'
Concrete
Bituminous Wearing Surface
1:1
5"
1½:1
Disintegrated Granite Base and Shoulders
40'
1½:1

CROSS-SECTION OF SPECIAL CONCRETE PAVEMENT; ALAMEDA ST., LOS ANGELES

It is estimated that this road will cost approximately $26,000 per mi. The County of Los Angeles is furnishing all material used in its construction.

⁂

Test for Corrosion Resistance with Aerated Water—By circulating heated and aërated water from a small storage tank at fairly rapid rate through coils of pipe made up of alternate lengths of different kinds of pipe, F. N. Speller, of the National Tube Co., has been able to get in a short time comparisons of the corrosion resistance of the several kinds of pipe used. A test of three months, he states, gives about as much corrosion as two years of normal service in a hot-water line. An air ejector is used to aërate and circulate the water The ejector, with pump, a thermostat-controlled gas heater, and the tank and coil of pipe make up the whole device The air is first filtered through excelsior to remove oil

Types of Dump-Cars Used On Construction Work--II

SYNOPSIS—The first part of this description of various types of dump-cars used on contract and other construction work was published in "Engineering News," Sept. 28, 1916, and dealt with various styles of cars of 1-yd. to 30-yd. carrying capacity. The present article describes other types of cars with capacities ranging from 18 yd. to 40 yd. and also includes the use of unloader plows for dumping material from flat-cars and gondola cars.

The dump-cars described in the former article are all of the tilting type, and one special class of cars of this type remains to be dealt with, before taking up the non-tilting type of car.

Sectional Tilting Cars

Sectional tilting cars are unusual, although several varieties of them have been built. The car has three or more rectangular boxes (sometimes V-shaped hoppers) mounted on the underframe and so arranged as to dump independently and to either side. In this way material may be discharged in small lots at different points, or different materials, as sand and stone for concrete, may be carried on one car. These cars have been used also for handling concrete. In one design the boxes are set much lower than usual, convenient for hand loading, and have a lateral travel to one side before tilting, so as deliver the load clear of the track.

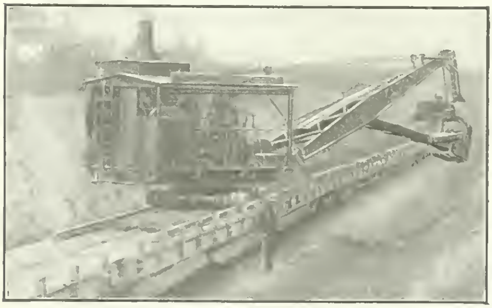


FIG. 1. TRAIN OF FLAT-CARS WITH SIDE BOARDS TO INCREASE THEIR CAPACITY

Several street railways have used construction cars this general type, but of two different classes. One cla has separate boxes or bodies, as just described: the oth has a single body, but divided by transverse partitio into separate compartments each having its own doors. train of 18-yd. cars of this class (motor car and trailers is shown in Fig. 2, operating on the Cleveland Electr Ry., Cleveland, Ohio. These cars were built by th Differential Car Co., of Nashville, Tenn. With such ca different materials can be carried in one load, or wit the load level full, not heaped up, the contents of th compartments can be delivered at different points alo the line.

Flat-Cars and Unloader Plows

While the flat-car does not dump its load, but requir a plow for power unloading, it is employed so extensive in handling material on construction and maintenan work that it must properly be included here. In railwa service the use of flat-cars in connection with unload plows is general for handling excavated material, both construction work and in such maintenance work as ditc ing and widening cuts, also to some extent for ballasti track. One reason for this is that the cars are part of th regular equipment of the road. They are suitable f miscellaneous work when it is not practicable or econom cal to invest in special equipment, and they can adapted either to work-train or freight-train service, may be required. The question of the factors affectin the selection of the type of car for any particular wor was discussed editorially in *Engineering News*, Sep 28, 1916.

The cars are liable to damage from rough treatmen but repairs are likely to be simple and cheap, due to th use of standard parts. Much work has been done we and at low cost with flat-cars, especially where the add tion of sideboards has enabled fairly heavy loads to carried.

Flat-cars may be of advantage in handling heavy roc stumps, logs or other material that cannot well dumped. Some railways consider, however, that suc cars are not economical under ordinary conditions an

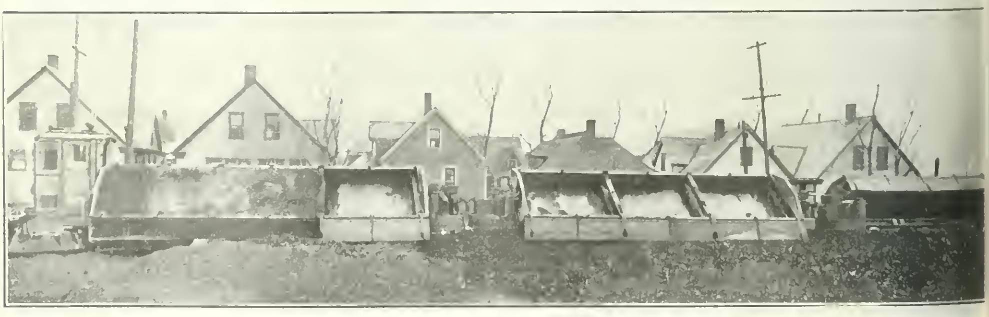
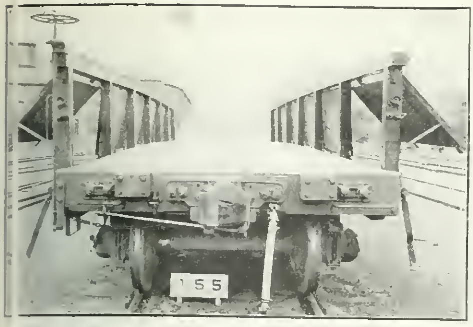


FIG. 2. SECTIONAL DUMP-CARS ON ELECTRIC RAILWAY AT CLEVELAND, OHIO
Differential Car Co., Nashville, Tenn., builder



F . 3. SIDE-DOOR GONDOLA CAR WITH TWO DOORS IN POSITION FOR UNLOADING

t on account of the relatively small amount of material t can be loaded on a flat-car it is better to have dump- and to leave the flat-cars for revenue freight service.)n some of the work in the Culebra Cut of the Panama ıal the excavation came out in such large blocks that dling by flat-cars was about the only practicable hod. The cars for this work had one solid side and open side, with the floor extended about 12 in. on this er side. They were unloaded by a side plow that ıld throw off the rocks whatever their size. With these heavily loaded and the material piled against the d side, the center of gravity was thrown to one side he center line of the car. This caused severe wear of rail head and high cost of track maintenance, espely on curves.

ınly a limited yardage per car can be loaded unless boards are used. These may be loose boards held by es in the car pockets, or they may be permanently ched by hinges or short chains, so as to fall down nst the sills when lowered. Aprons cover the spaces veen the cars, so that the material being unloaded will fall through upon the track, and they also carry the v across these openings. Fig. 1 shows a train of flat- in railway ditching work, with loose side boards ched by chains and held in place by stakes. The hing machine travels along the train, and the boards placed as the cars are loaded.

Vith the old style of blunt plow this method of unload- material was rather slow. With the more modern plow of smaller angle and greater length this objection does not apply, as the material does not pile up upon the plow and the pressure of the material against the sides of the car is not nearly so great. In this way there is less obstruction to the movement of the plow, with consequent higher speed and less damage to the cars. In operating on curves the cable must be led through snatch blocks hitched to the car, and there is liability of additional damage due to the strains on stakes and stake pockets.

Unloading material in this way has the advantage that it can be distributed in quantity as desired by stopping or moving the train while unloading. The use of plows in connection with gondola cars is discussed later. The field for flat-cars is where the material is to be handled over existing standard-gage tracks, particularly where it is necessary to load by hand.

Side-Door Gondola Cars

These cars, like flat-cars, do not dump the load, but require shoveling or plowing. They are similar to ordinary open freight-cars, but the sides instead of being fixed are formed by swinging panels. They may have low sides hinged at the bottom, but generally the sides are higher and hinged to a top rail. Latches hold the doors closed. Movable ends or end gates are fitted.

Fig. 5 shows a large car of this type for track elevation and other work on the Chicago & Western Indiana R.R. The cars are 40 ft. long, with a carrying capacity of 50 tons and a light weight of 19 tons. They were built by the Haskell & Barker Car Co., of Michigan City, Ind. The top rail of the side frame is carried on heavy stakes, and to this the side panels or doors are attached by strap hinges. A locking bar extending along the sill has lugs that bear against the doors to hold them closed, and this

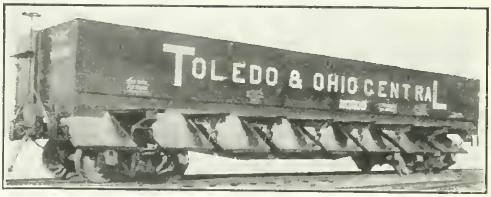


FIG. 4. DROP BOTTOM GONDOLA CAR FOR SIDE DUMPING
Ralston Steel Co., Columbus, Ohio, builder

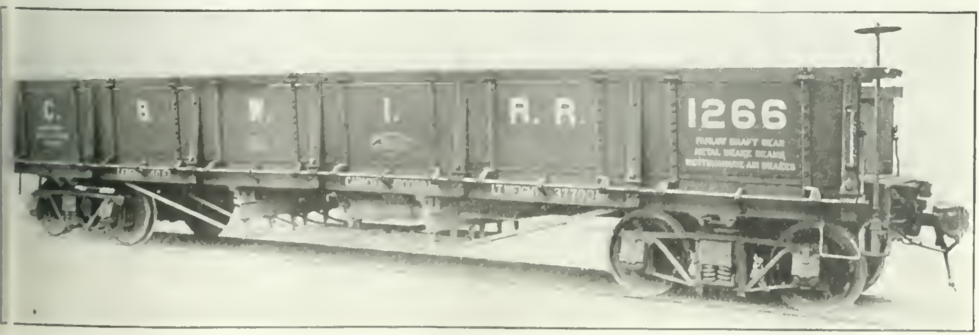


FIG. 5 SIDE-DOOR GONDOLA CAR FOR USE WITH UNLOADER PLOW
Haskell & Barker Car Co., Michigan City, Ind., builder

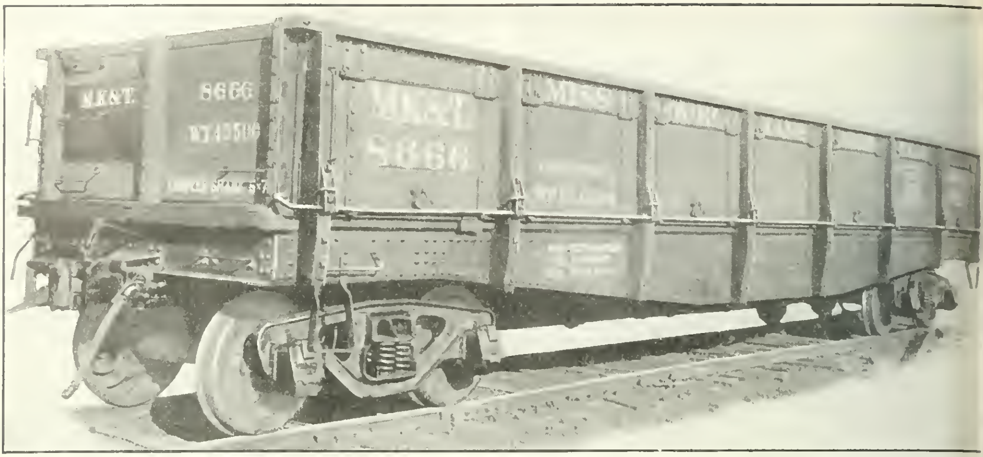


FIG. 6. CENTER-DUMP CAR FOR BALLASTING (CONVERTIBLE INTO SIDE-DOOR GONDOLA CAR FOR UNLOADING WITH PLOW)
Rodger Ballast Car Co., Chicago, builder

rod is operated by end levers to lock or release the doors. Fig. 3 is an interior view of the car, showing the doors unlatched and the two doors at the end propped open in the position they occupy when material is being plowed out. At the far end of the car is shown the steel apron to cover the opening between cars and prevent material from falling on the rails.

The gondola car will hold 20 to 40 cu.yd., as against 8 to 12 yd. (or 12 to 15 yd. with side boards) on a flat-car 32x8½ ft. But the doors cause slower unloading
means of the plow, and unloading by hand is slow a
expensive. However, in some cases, as on track elevatio
a large gang of men unloads the cars and then distribut
the material and raises tracks until the next train arriv

If the contents are to be plowed out, the end gates a
removed from the cars before loading, and the spac
between the cars are covered by steel aprons. For unloa
ing by hand, the end gates may be left in place, in whi

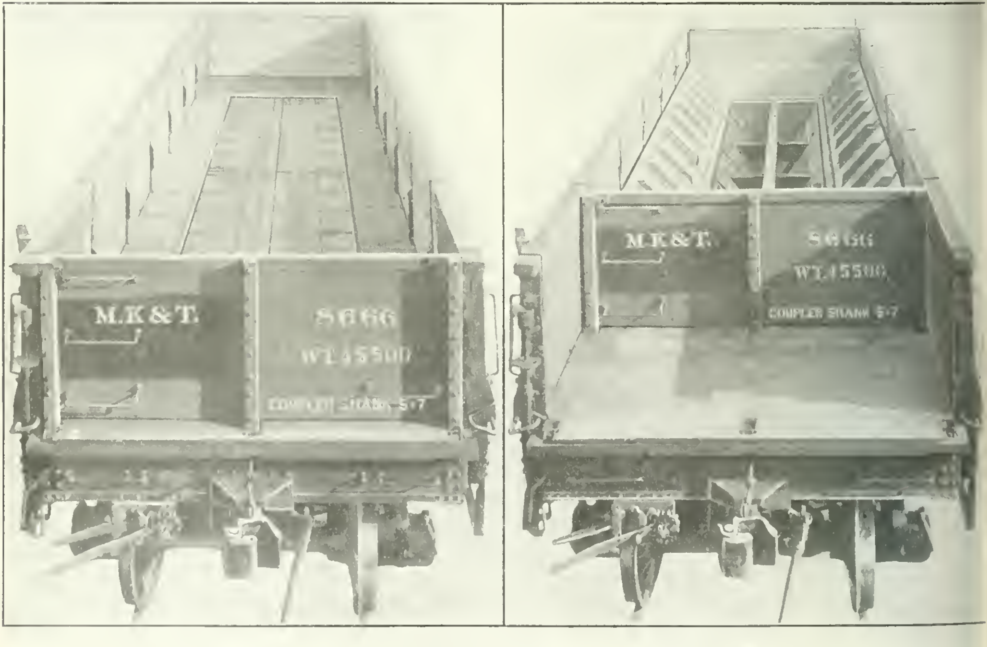
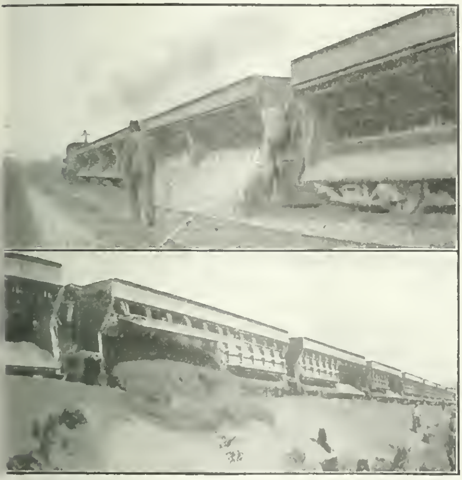


FIG. 7. CONVERTIBLE CENTER-DUMP AND SIDE-DUMP CAR
The right view shows the interior of the car arranged for ballasting, with sloping floor and longitudinal hopper. The left view shows hopper covered and car suitable for general transportation. With ends removed the contents may be plowed out through side doors

se larger loads can be carried. While some engineers wide experience consider that these cars give economi- l service with the use of unloader plows, others believe em economical only for such light materials as sand d cinders and not for heavy plowing. It has been sug- sted, however, that unfavorable opinions are based prob- ly on efficient handling or experience with the older yle of equipment, as with modern equipment properly ndled the plow is a quick and effective means of loading.

The cars are favored more by railways than by contrac- rs and have the advantage that when not required in rk-train service they can be put to regular freight vice. Their special advantage is where large quantities material are to be handled on main line and for con- erable distances; when running, they have more stabil- than dump-cars. They have been employed exten- ely on filling for track elevation and for filling trestles bridges. For distributing ballast they have been used a limited way, but center-dump cars are generally pre- red for this work.



8. TRAINS OF 30-YD. STEEL HOPPER CARS PLACING BALLAST AND WIDENING FILL
Goodwin Car Co., New York, builder

DROP-BOTTOM GONDOLA CARS

These are flat-bottom cars with closed ends and fixed es, having the bottom composed of panels hinged unst the center sill and dropping toward the side to angle of nearly 45°. Usually half the doors on each e are operated independently, making four sections. e cars are seen largely in revenue service for hauling l and in work-train service for filling trestles. They usually too heavy for temporary trestles in making y fills.

A car of this type built by the Ralston Steel Car Co., Columbus, Ohio, is illustrated in Fig. 4. The doors raised and lowered by a cranked operating rod carried bearings beneath the ends of the transoms of the main me. This view shows all the doors on one side lowered, half the doors on each side can be operated independ- ly of the others. The Ralston car was described in *gineering News*, Mar. 30, 1916.

The cars are specially suitable for dumping through the open floors of trestles and track hoppers. On solid track, however, much of the material rolls back on the rails and must be removed before the car can proceed. Hand shoveling in this way is slow and troublesome. Sometimes a tie is chained across the rear truck to act as a plow in clearing the rails. This is objectionable practice, as the heavy loads will skid the wheels and cause flat spots, while the tie is likely to get blocked and cause derailment. Some material also will fall through the spaces between the opened doors and thus drop upon the rails. These cars are rarely found in connection with steam-shovel work.

As practically the entire bottom drops, the cars are self-cleaning. If used for widening a bank on one side, however, only half the drop-floor can be operated, and shoveling is necessary to empty the car. The operation of the dumping levers is not always convenient or safe on trestles, but in some such cases the lever has been worked from the ground by means of a long rope. The doors being operated in four groups, the load can be distributed along the track or at different points, which may be desirable in ballasting. The cars must be substantially built, or after a little rough usage the doors will not close properly.

CENTER-DUMP CAR

Equipment of this class includes gondola cars with a longitudinal V-shaped hopper beneath the floor, the lower part of this being formed by doors hinged at the upper side. The hopper may be in the center of a flat floor, or it may extend to the vertical sides of the car. In the former case, for a convertible car, hinged panels extend the slope from the top of the hopper to the sides.

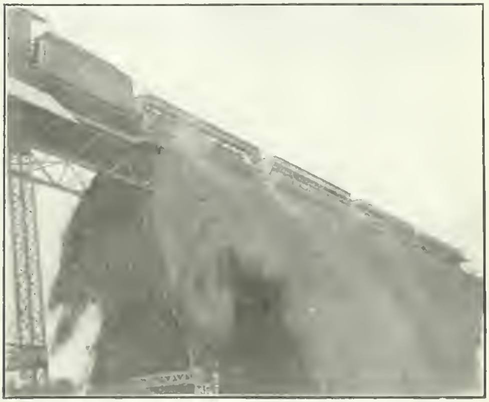


FIG. 9. FILLING STEEL TRESTLE FROM 30-YD. CARS WITH TRAIN IN MOTION

As dump-cars they are used mainly and very extensively for ballasting. The material can be discharged while the train is moving, the amount being regulated by the width of dump opening and the speed of the train. A plow under the rear car levels the material and throws it clear of the rails. Care must be taken not to open the doors too wide or too rapidly, as the rush of material may cover the track and cause stalling or derailment of the train. Such cars may be so built as to be available for hauling grading material and filling.

The Hart convertible car of this type, Figs. 6 and 7, can be operated as a center-dump car, a side-dump gondola for use with an unloader plow, or as an ordinary gondola car in freight service. This car has a flat floor, with a longitudinal hopper, and movable panels extending the slope of the hopper to the vertical sides of the car. These panels are hinged at the edges of the hopper and can be folded down so as to cover it and make a flat floor. The vertical sides may also be composed of panels hinged at the top so that the car may serve as a side-dump gondola for making fills, widening banks, etc. With this last arrangement the car may be unloaded by hand shoveling, or the ends may be removed to permit the use of an unloader plow. This car, therefore, can be utilized for handling and depositing excavated material, distributing ballast and carrying revenue freight.

Fig. 6 shows a steel-frame Hart car of 50-ton capacity and a light weight of 23 tons, as used on the Missouri, Kansas & Texas Ry. for ballasting and filling. The longitudinal central hopper may be seen behind the deep girder sill, and the sides are formed by doors hinged at the top, as in the side-door gondolas already described. Fig. 7 shows the car arranged for two kinds of work. At the left is the position for ballasting, with the central hopper uncovered and its slope extended to the sides by the hinged floor panels. The end gates are set back to the hopper, which of course is only between the trucks. At the right is the position for ordinary freight service, with the panels folded down to form a solid floor and the end gates shifted out to the end sills. For use with an unloader plow, the solid floor remains and the end gates are removed, while hinged steel aprons cover the openings between cars. These cars are built by the Rodger Ballast Car Co., of Chicago.

SIDE-DUMP CAR WITH INCLINED FLOOR

In this type of car the floor is of A-shape, sloping down from a center ridge to the sides, which are hinged at the top so as to swing outward. These cars are not used extensively in construction work. They have been employed to a limited extent in distributing small lots of ballast locally, also for dumping material for shouldering permanent track or raising such track to a new grade. An objection is that they deposit the material too near the track. They are apt to be rather top heavy for filling trestles, and some engineers consider them uneconomical for widening banks. Further, the load is likely to damage the doors as it escapes, causing high repair cost.

The principal field for cars of this type is in railway service, for handling ashes from locomotive terminals and removing refuse from yards and busy freight stations. For this work they may be small cars on four wheels or larger cars on trucks. They must dump on both sides, unless hand shoveling is resorted to, though a few special cars have been built with the floor sloping from the top of one side to the bottom of the opposite side.

COMBINED CENTER- AND SIDE-DUMP CAR

A special type of large car for a great variety of purposes is the Goodwin dump-car. This has a fixed steel body of hopper shape, provided with bottom doors and aprons for regulating the discharge, and so arranged that the car can empty its contents on either side or both sides of the track (outside the rails), or on the inside of one or both rails, or partly outside and partly inside the track. For the side discharge the flow of material can be restricted, or the entire side of the car can be swung out to give full and unrestricted dumping. The lower parts of the sides are hinged at the upper edge and are normally inclined inward to form a V-shaped hopper. Their position is regulated by means of chains attached to the sides and led to the piston rods of horizontal air cylinders placed across the top of the car.

The Goodwin cars are built entirely of steel, and thei capacity is 30 yd. level full or 40 yd. with heaped load The dumping is effected by hand or by air and can b done for the cars separately or for the entire train simultaneously. The inclined aprons throw the material clea of the track, and the slope of the sides is such as to mak the cars self-clearing even with sticky material. As th body is fixed and nontilting, the dumping can be don on bridges and trestles without causing shock to the structure, even whenthe train is in motion. The cars ar built by the Goodwin Car Co., of New York.

Cars of this kind are shown in Figs. 8 and 9. Th upper view in Fig. 8 shows a train in motion depositin stone ballast. The car at the right is delivering th ballast inside the rail. The next car, on which the operator is riding, is delivering outside the rail, the flow bein controlled by the operator. The lower view shows a trai making a fill, the sides of the cars being released an hanging free, so that they give unrestricted flow to th contents.

On much of the work done the cars are unloaded whil the train is moving at 10 to 20 mi. per hr. In this wa the filling or placing of material progresses rapidly an the work trains can be operated on main track with minimum of interference with regular traffic. Fig. shows the filling of a steel viaduct by means of these car with the train in motion.

The cars can handle rock and boulders as well as loo material, and in industrial service they are employed fo transporting such articles as pig iron, billets, rail ends scrap, etc. They are used extensively both by contractor and railways for grading, making and widening fills, distributing ballast, filling trestles or old bridges and fo hauling stone, sand or gravel.

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Dredging for Coal in the rivers of Pennsylvania is an industry by which, it is estimated, about 250,000 tons are annually recovered. The method of dredging is described b Howard I. Moses in the June issue of the "Journal" of th Engineers' Society of Pennsylvania. The anthracite-coal district of Pennsylvania is found principally in Lackawann Luzerne, Carbon, Schuylkill and Northumberland Counties, an over 80,000,000 tons of coal is mined yearly. Nearly one-hal of this coal is prepared by the "wet process," requiring th use of vast quantities of water which, when wasted, carrie in suspension millions of tons of fine culm, by which name designated the fine coal that passes through the smalles screen in a dry-process breaker. Much of this finds its wa into the principal rivers draining the anthracite district— the Lackawanna, the Susquehanna and its north branch, th Schuylkill and the Lehigh. They carry culm waste for man miles downstream, depositing it in shallows and eddies, bac of dams and over valley bottoms. There are two princip types of dredges in use for recovering the coal—the suctio dredge and the bucket dredge. The former is used exclusivel at Harrisburg, while the other type is more favored elsewher The season averages eight months, and the total output of dredge ranges from 8,000 to 10,000 tons. The dredging machinery is generally mounted in a stern-paddlewheel flat-bottom boat of 15-in. draft. The coal is discharged into flatboat or scows having a capacity of 12 to 14 tons. In and abou Harrisburg, river coal—steaming sizes—sells from $1.10 t $1.50 per ton delivered, and f.o.b. flats at river's edge from 7 to 90c. per ton. Compared with similar sizes of run-of-min anthracite at the prevailing prices, these show a considerabl saving.

City Replanning in Duluth

By W. B. Patten*

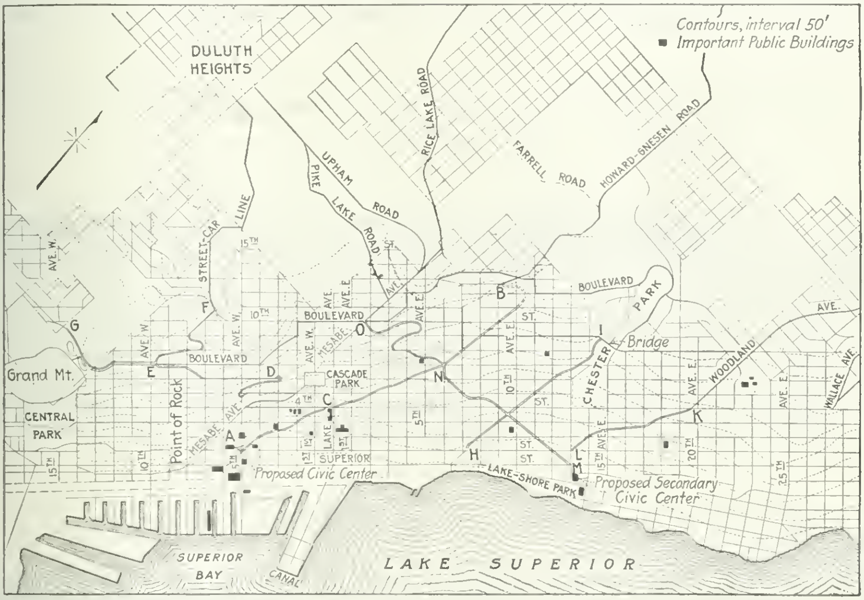
The central portion of Duluth, Minn., is an example of y planning without regard to topography, symmetrical owth, transportation or intercommunication. Although upying a hillside rising rapidly from the shores of the ke and Bay of Superior, the highways, with two excep- ns, were designed on the gridiron system (see accom- nying map). The streets, 300 ft. apart, running proximately parallel with the shore line and contours, ve light grades throughout their length, except where y cross the so-called Point of Rocks, which separates main business and residence sections from the West d. The avenues, 400 ft. apart, being at right angles h the streets, are generally normal to the contours. exception to the rectangular system is Mesaba Ave., ich skirts the easterly side of the Point of Rocks and ich has been improved to the top of the hill, about 500 above the main business street, but it is poorly located has long stretches of grades running from 9 to 12½%. other diagonal thoroughfare was called Washington , and was about 1¼ mi. east of Mesaba Ave. This nue, except for one block, was vacated in the early his- y of the city.

cting as a member of the City Planning Committee he Duluth Commercial Club, the writer, who was for- rly city engineer of Duluth, has planned several di- nal arterial highways leading up the hill by easy grades m proposed main and secondary civic centers near the erfront.

he new layout is shown on the accompanying map. main thoroughfare extends diagonally from Superior St., through the civic center *A* to a connection at *B*, with a rural highway leading northerly, and with The Boulevard, which is a driveway constructed along the old lake beach 475 ft. above the present lake level.

From the intersection of this arterial highway with Fourth St., at *C*, using platted streets where possible, and condemning across property where necessary, a route is shown passing through points marked *D, E, F, G*, which opens up the thinly populated districts near the center of the city.

The highway from *H* to *I* is a relocation of Washington Ave., formerly vacated; and that from *K* to *L* is an extension to First St. of Woodland Ave., the present terminus of which is at Fourth St. At *M* is a secondary civic center with two large auditoriums frequently used for public assemblages. It is proposed to open a diagonal highway from this point to an intersection with the one first described at *N* and with an extension westerly to a connection at *O* with Mesaba Ave. above its steep grades, and below its junction with several rural highways, which are heavily traveled, and at its intersection with The Boulevard.



PROPOSED ARTERIAL HIGHWAYS AND CIVIC CENTERS FOR DULUTH, MINN

The projected civic center, hotels, freight and passenger depots and docks, and the main wholesale district lie on the lower levels of the city and just east of the Point of Rocks, the office buildings and retail trade adjoining to the east. The residential sections are north and east of the business zone.

The steepest part of the hillside is in the immediate vicinity of the civic center, the rise being over 500 ft. in less than 3,000 ft. The growth of population has been toward the east and, except along street-railway lines that have been found feasible, with decreasing density as the hill is ascended. There are thus, within very short distances horizontally of the business center, large tracts of and that are almost unpopulated. A small part of this territory is given the limited service of an elevated incline passenger railway, which operates in connection with a surface railway running to a settlement back of the crest of the hill.

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*Manager, Duluth Engineering Co., Palladio Building, uth, Minn.

The local street-railway company refuses to operate on grades of over 7½%. Consequently, its service is not extensive and above Superior St. is confined to those streets that can be reached by selecting avenues which are within the maximum grade limit. This leads to a duplication of lines on portions of some streets and roundabout routes with frequent right-angle turns. Thus, the West Fourth St. line in running from 5th Ave. West and Superior St. to its terminus, which is less than 1,500 ft. distant horizontally, travels 10,800 ft. and turns four square corners; and of this distance over 6,000 ft. is over streets on which other lines are compelled to run and which, owing to its proximity to the center of the city, is also a minimum-revenue territory.

To overcome the present difficulties and to avoid the inconveniences and congestion of traffic which will come in the future, following the large increase in population which is confidently expected, the writer has suggested the establishing of the several arterial highways shown on the accompanying plat and just explained in detail.

Relining a Leaky Reservoir at Omaha, Neb.

Basins 1 and 2 of the Walnut Hill reservoir for the Metropolitan Water District of Omaha, Neb., were built some years ago by throwing up earth embankments surrounding roughly square basins and lining the bottom and the inside slopes with a 6-in. thickness of plain concrete. Some time ago this concrete lining began to crack badly (see Fig. 3) and although the destination of the leakage was not evident, the presence of nearby houses and the possibility of the loss of the embankment led the engineers to reline both basins with an additional 4 in. of reinforced concrete laid directly on the old lining.

The new lining consisted of 4 in. of 1 : 2¼ : 4½ concrete reinforced in both directions with ⅜-in. square twisted rods spaced 7 in. c. to c. No expansion joints were provided in the whole new lining. The reinforcement was laid on the old concrete, as shown in Fig. 1, over the whole area before any of the new concrete was placed, the rods being tied and held the proper distance from the old lining with special clips.

The concreting was carried out with the special mixing and placing outfit shown in Fig. 2, which had been de-

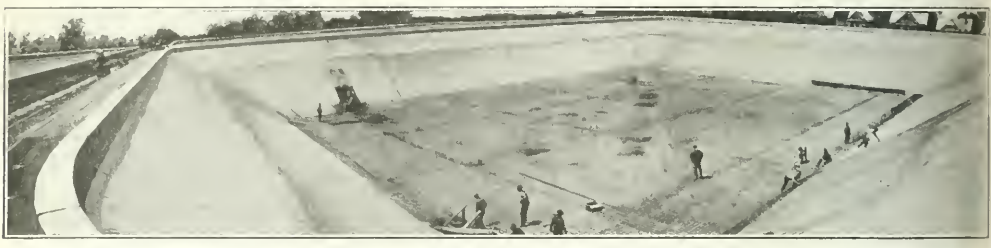


FIG. 1. BASIN NO. 1 OF WALNUT HILL RESERVOIR, OMAHA, WITH REINFORCING RODS IN PLACE

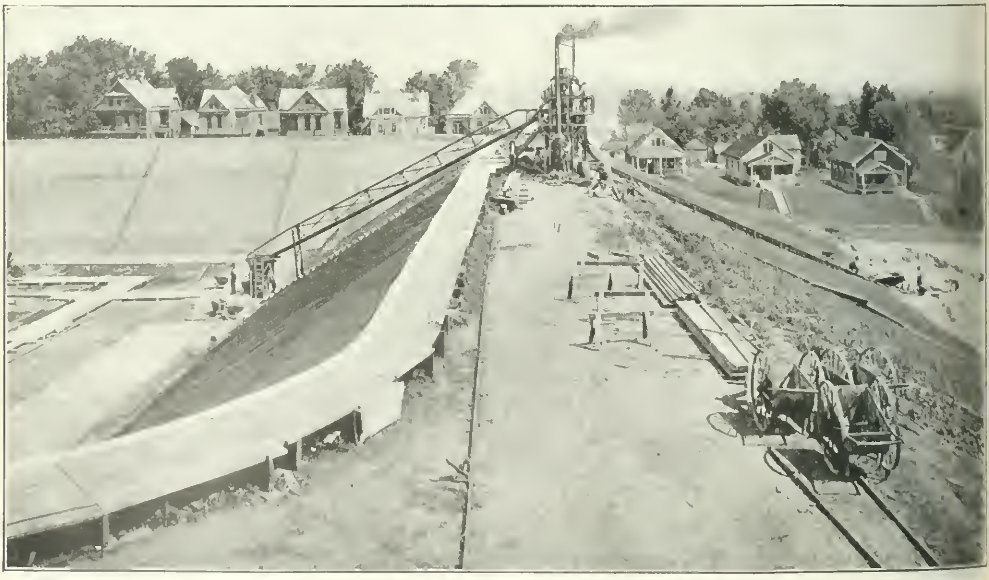


FIG. 2. MIXER AT WORK LINING BOTTOM OF RESERVOIR

G. 3. CRACKS IN OLD LINING

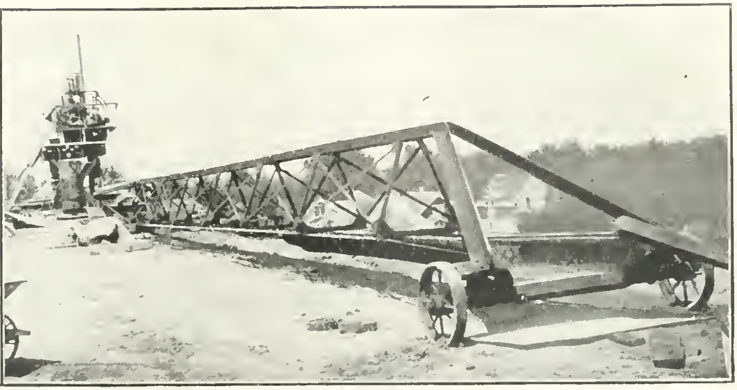


FIG. 4. CHUTE FRAME ON TOP OF RESERVOIR

ned by Homer V. Knouse, Construction Engineer of Water District, for the lining of Basin 6 at the rence Station of the Water District. This outfit con- ts of a Smith mixer mounted on a timber platform ich was set on the top of the embankment, and pro- led with a feeding track extending down the outer pe and a chute extending down the inner slope. This xing plant was complete in itself, was self-driven by team engine and remained in this one location through- t the relining of the basin.

The mixer was fed from the ground elevation out- e the basin (Fig. 2) by a skip which traveled on a ck laid down the slope and which was controlled from ioisting cable at the mixer. The special track was med at the mixer so that the skip would dump di- tly into the drum. Sand, stone and nent were all stored at the lower level l dumped into the skip as needed for h batch.

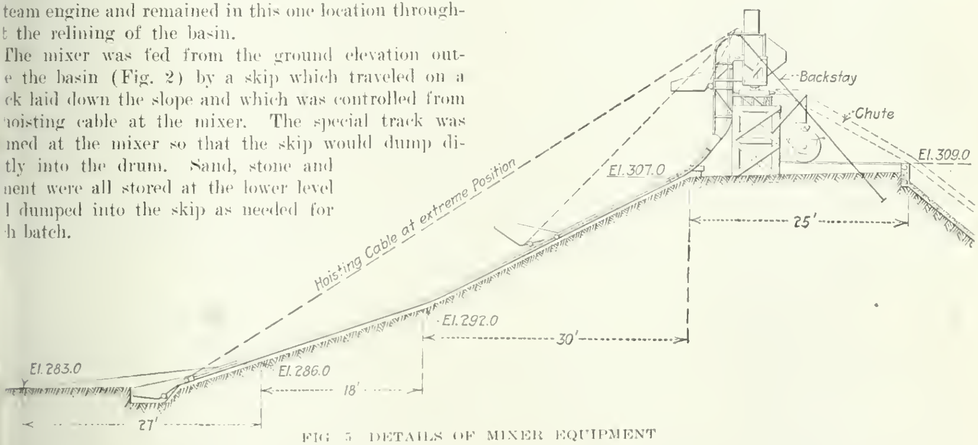


FIG. 5. DETAILS OF MIXER EQUIPMENT

The delivery from the mixer was made through a ecially designed chute (Fig. 4) mounted on a struc- al frame which was laid parallel to the inner slope ig. 2). When the bottom was being concreted, this me was fastened to the mixer and the concrete was l directly into it and at the bottom was dropped rough a hopper into buggies which were wheeled to required location. In concreting the slope, the ute frame was detached from the mixer and rested on eels running at the top and bottom of the reservoir. e concrete from the mixer was then carried in bug- s to the top of the chute and fed down the slope to required place. The chute was in sections so that could be detached and the concrete allowed to spill any part of the slope.

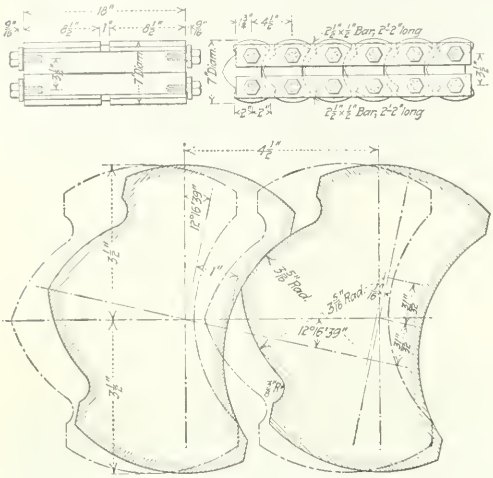
The work was done under the direction of Geo. T. ince, Chief Engineer of the Metropolitan Water Dis- ct of Omaha.

New Roller Shoe for Bridges Prevents Tipping

In the truss spans of the recently remodeled Herron Ave. bridge in Pittsburgh, use was made of a novel type of expansion bearing roller, developed by the Bridge Division of the city's Bureau of Engineering (T. J. Wilkerson, Division Engineer). Troublesome experience with the ordinary type of segmental roller on the new Point bridge showed that a change in design which would prevent the rockers from tilting over too far was desirable. At the Point bridge one of the 531-ft. spans stood during an unusually cold winter with no paving or sidewalk slabs in place. The rollers had been set to the correct position for full dead-load, and in consequence of the extreme temperature contraction and the fact that the bottom chord was not elongated to its normal dead-load length they were rocked beyond the safety point and tipped over, shearing the bolts in the side bars. To replace the rollers was a difficult problem, involving the lifting of the end of the span in very restricted space. It was accomplished by the use of nickel-chrome steel billets for lifting beams, and special bearings under eye-bar heads and pin ends.

The roller is shown in the drawing on the next page. One side of the segment is cut away, as is frequently done to save weight, while the other is cut to a double-centered curve so designed that after a horizontal movement of ¾ in. either way from the vertical the roller will lock. While in the usual type of bearing the locking places the entire load on a few easily sheared bolts, in this design there is a roller-to-roller contact, giving stability.

The new rollers promptly justified themselves. After erection defective expansion in the long girder approach at the south end was found to throw a considerable movement into the top of the last bent of the approach, which is tied to the bent supporting the span. The movement at the top of these two bents, added to the normal temperature elongation of the span during summer weather, has been enough to cause the rollers to reach their maximum position of roll, at times, and to lock.



NEW SELF-LOCKING ROLLERS FOR PITTSBURGH BRIDGE

Standard Water-Rate Forms Adopted in Montana

Standardized general, metered- and flat-service rules and regulations, for use by water-supply utilities in Montana, have recently been adopted by the Public Service Commission of that state. In connection with these rules standard forms for stating rates have also been adopted and all water-utilities are required to revise their schedules to this form. The forms of course do not prescribe the actual amount of the rates, as will be seen in the accompanying reprint of the new schedules.

The prescribed general rules require service to all applicants but permit asking a deposit of 1½ times the estimated regular bill. Interest at 6% is to be paid on deposits. The company taps the mains at its own expense but the cost of laying and maintaining service pipes is borne by the consumers. Leaky plumbing fixtures have to be repaired immediately or water may be shut off. Special permits have to be secured for use of water on construction work, sprinkling, etc. Violation of the rules by a customer, or nonpayment of bills, is penalized by shutting off water; when service is resumed, the cost of turning water off and on may be collected—up to $1.

The flat-rate service rules penalize for serving outside persons without permission by shutting off water and adding the cost of this to the bill. Flat-rate bills are payable in advance. Additional fixtures may be installed on notice to the water company; reductions may be similarly cared for with a reduction of charge.

Under the metered-service rules, any customer may have a meter set on request. Meters are to be owned by the companies, and may be placed on any service where there is waste. When a customer desires more than one meter on one service line, he may be required to pay $1 a month for installation, maintenance and reading. Where a meter has stopped or has been tampered with, the bill may be based on the average of the past two months.

Commercial Meter Rates.
For Each 100 Cubic Feet (750 Gallons) Monthly.

	Cubic Feet	Gallons	Rate Cents	Total Cu. Ft	Total Gallons	Total Amount
First	100	750		100	750	
Next	100	750		200	1,500	
"	100	750		300	2,250	
"	100	750		400	3,000	
"	200	1,500		600	4,500	
"	200	1,500		800	6,000	
"	200	1,500		1,000	7,500	
"	200	1,500		1,200	9,000	
"	300	2,250		1,500	11,250	
"	300	2,250		1,800	13,500	
"	400	3,000		2,200	16,500	
"	400	3,000		2,600	19,500	
"	400	3,000		3,000	22,500	
"	500	3,750		3,500	26,250	
"	500	3,750		4,000	30,000	
"	500	3,750		4,500	33,750	
"	500	3,750		5,000	37,500	
"	1,000	7,500		6,000	45,000	
"	1,000	7,500		7,000	52,500	
"	1,000	7,500		8,000	60,000	
"	1,000	7,500		9,000	67,500	
"	1,000	7,500		10,000	75,000	
"	5,000	37,500		15,000	112,500	
"	5,000	37,500		20,000	150,000	
"	5,000	37,500		25,000	187,500	
"	5,000	37,500		30,000	225,000	
"	5,000	37,500		35,000	262,500	
"	5,000	37,500		40,000	300,000	
"	10,000	75,000		50,000	375,000	
"	10,000	75,000		60,000	450,000	
"	10,000	75,000		70,000	525,000	
"	10,000	75,000		80,000	600,000	
"	10,000	75,000		90,000	675,000	
"	10,000	75,000		100,000	750,000	
"	10,000	75,000		110,000	825,000	
"	10,000	75,000		120,000	900,000	
"	10,000	75,000		130,000	975,000	
"	10,000	75,000		140,000	1,050,000	
All over				140,000	1,050,000	

Industrial Meter Rates.
For Each 100 Cubic Feet (750 Gallons) Monthly.

	Cubic Feet	Gallons	Rate Cents	Total Cu. Ft.	Total Gallons	Total Amount
First	3,000	22,500		3,000	22,500	
Next	1,000	7,500		4,000	30,000	
"	1,000	7,500		5,000	37,500	
"	5,000	37,500		10,000	75,000	
"	5,000	37,500		15,000	112,500	
"	5,000	37,500		20,000	140,000	
"	5,000	37,500		25,000	187,500	
"	5,000	37,500		30,000	225,000	
"	10,000	75,000		40,000	300,000	
"	10,000	75,000		50,000	375,000	
"	10,000	75,000		60,000	450,000	
"	10,000	75,000		70,000	525,000	
"	10,000	75,000		80,000	600,000	
"	20,000	150,000		100,000	750,000	
"	20,000	150,000		120,000	900,000	
"	20,000	150,000		140,000	1,050,000	
"	20,000	150,000		160,000	1,200,000	
"	20,000	150,000		180,000	1,350,000	
"	20,000	150,000		200,000	1,500,000	
"	50,000	375,000		250,000	1,875,000	
"	50,000	375,000		300,000	2,250,000	
"	50,000	375,000		350,000	2,625,000	
"	50,000	375,000		400,000	3,000,000	
"	100,000	750,000		500,000	3,750,000	
"	100,000	750,000		600,000	4,500,000	
"	100,000	750,000		700,000	5,250,000	
"	100,000	750,000		800,000	6,000,000	
"	100,000	750,000		900,000	6,750,000	
"	100,000	750,000		1,000,000	7,500,000	
"	200,000	1,500,000		1,200,000	9,000,000	
"	200,000	1,500,000		1,400,000	10,500,000	
"	200,000	1,500,000		1,600,000	12,000,000	
"	200,000	1,500,000		1,800,000	13,500,000	
"	200,000	1,500,000		2,000,000	15,000,000	
"	200,000	1,500,000		2,200,000	16,500,000	
"	200,000	1,500,000		2,400,000	18,000,000	
"	200,000	1,500,000		2,600,000	19,500,000	
"	200,000	1,500,000		2,800,000	21,000,000	
"	200,000	1,500,000		3,000,000	22,500,000	
All over				3,000,000	22,500,000	

MONTANA STANDARD FORM FOR METERED WATER-SERVICE RATE SCHEDULE

Apartments	[1] Not over 5 rooms or persons	$
	Each additional room	
	Each additional person	
Bakery	[2] Using not more than 1 barrel flour per day	
	Each additional barrel	
Banks	[2] Not more than 5 persons	
	Each additional person	
Barber Shops	[2] One chair	
	Each additional chair	
Barrel	Each time filled	
Bath, Tubs	[3] Private, one	
	Each additional one	
	Public, one	
	Each additional one	
Shower	[3] Private, one	
	Each additional one	
	Public, one	
	Each additional one	
Beer Pumps	Each	
Blacksmith Shop	[2] One fire	
	Each additional fire	
Boarding House	[1,2] Not more than 5 persons	
	Each additional person	
Book Bindery	[2] Not more than 5 persons	
	Each additional person	
Bottling Works and Breweries	[2] Not more than 5 persons	
	Each additional person	
Brickyard	[2] Not more than 5 persons	
	Each additional person	
Building and Construction	Brick, per 1000	
	Cement walk, per 100 sq. feet	
	Concrete work, per cubic yard	
	Lime or cement, per barrel	
	Plastering, per 100 sq. yds.	
	1 coat	
	2 coats	
	3 coats	
	Settling earth, per 10 cu. yds.	
	Stone work, per perch ($16\frac{1}{2}$ c. f.)	

Hotel	[1,2] Base Rate: Kitchen dining room and sitting room	
	Each additional room	
Hydrant—Yard	Not more than 5 persons	
	Each additional person	
Ice Cream Parlors	[1,2] One table or counter	
	Each additional one	
Jail	[2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
Laundry, Hand	[2] Not more than 5 persons	
	Each additional person	
Steam	[2] One washing machine	
	Each additional one	
Lavatory, Private	Private, one	
	Each additional one	
	Public, one	
	Each additional one	
Lodging House	[1,2] Not over 10 rooms	
	Each additional room	
Market, Meat, Fish, Vegetable	[2] Not more than 5 persons	
	Each additional person	
Municipal Stables	Two animals, 1 vehicle	
	Each additional animal	
	Each additional vehicle	
Manufactories and Shops, N. O. S.[3]	[2] Not more than 5 persons	
	Each additional person	
Office Building	[2] Each room or office	
Photograph Gallery (Commission recommends meter rate)	[2] Not more than 5 persons	
	Each additional person	
Printing Office	[2] Not more than 5 persons	
	Each additional person	
Railroad Depot	[2] Not more than 5 persons	
	Each additional person	
Restaurant	[1,2] 12 chairs or stools or less	
	Each additional 4 chairs or stools	
Saloon	[1,2] Not more than 5 persons	
	Each additional person	
School	[1,2] Not more than 30 pupils	
	Each additional 5 pupils	
Sink, Private	One, not more than 5 persons	
	Each additional sink	
	Each additional person	
Soda Fountain	[1] Each one fountain	
Stable, Livery	[2] 4 stalls (2 double) & 2 vehicles	
	Each additional stall	
	Each additional vehicle	
Private	[2] One animal and one vehicle	
	Each additional animal	
	Each additional vehicle	
Sprinkling	Lawn, sidewalk, etc., 1st 25 ft. front	
	Each additional foot	
State Building	[1,2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
Steam Engines	Each horse power, per hr. per day	
Traction	Each time filled	

14. Butcher Shop	[2] Not more than 5 persons	
	Each additional person	
15. Cement	See Building.	
16. Church	[2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
17. Cistern	Each 100 cu. ft., Min. . . . c. f.	
	Each additional 100 cu. ft.	
18. City Building	[1,2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
19. Concrete	See Building.	
20. County Building	[1,2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
21. Cows	One cow	
	Each additional cow	
22. Dairy	Not more than 5 cows	
	Each additional cow	
23. Dwelling	[2] Not more than 5 rooms or persons	
	Each room in excess of 5	
	Each person in excess of 5	
24. Elevators, Hydraulic	Not more than two stories	
	Each additional story	
25. Foundry	[2] Not more than 5 persons	
	Each additional person	
26. Fountain	$\frac{1}{32}$" nozzle .... $\frac{1}{16}$" nozzle	
	$\frac{1}{8}$" " .... $\frac{1}{4}$" "	
	$\frac{3}{8}$" " .... $\frac{1}{2}$" "	
27. Fire Hydrant	Municipal, 1st .... hydrant	
	Each additional one	
	Private, first hydrant	
	Each additional one	
28. Fire Protection	1" pipe . $1\frac{3}{4}$" pipe . $2\frac{1}{2}$" pipe	
	$1\frac{1}{4}$" " . 2" " . $2\frac{3}{4}$" "	
Stand Pipes and Automatic Sprinklers	$1\frac{1}{2}$" " . $2\frac{1}{4}$" " 3" "	
	1" " . 3" "	
	$1\frac{1}{2}$" " . 4" "	
	2" " . 6" "	
29. Garage	[2] Private, one car	
	Each additional car	
	Wash rack, one car	
	Each additional car	
Commission recommends meter rate	Public, 5 cars or less capacity	
	Each additional 5 cars	
	Wash rack, 5 cars	
	Each additional 5 cars	
30. Government Building	[1,2] One cold-water faucet	
	Each additional cold-water faucet	
	Each hot-water faucet	
31. Greenhouses	[2] Each 100 sq. ft. of floor area	
32. Halls, Lodge rooms	[2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
33. Heating Plant (Steam or Hot Water)	First 1,000 c. f. heating space	
	Each additional 1,000 cu. ft.	

57. Store, Drug	[1,2] Not more than 5 persons	
	Each additional person	
Grocery, Candy, Fruit	[1,2] Not more than 5 persons	
	Each additional person	
Wholesale Liquor	[1,2] Not more than 5 persons	
	Each additional person	
N. O. S.[3]	[1,2] Not more than 5 persons	
	Each additional person	
58. Tanks, Portable	Each time filled	
59. Theater	[2] One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
60. Tubs, Private Laundry	One cold-water faucet	
	Each additional one	
	Each hot-water faucet	
61. Urinal, Private	One, self-closing	
	Each additional one	
	One, continuous flow	
	Each additional one	
Public	One, self-closing	
	Each additional one	
	One, continuous flow	
	Each additional one	
62. Water-Closet, Private	One, self-closing	
	Each additional one	
	One, continuous flow	
	Each additional one	
Public	One, self-closing	
	Each additional one	
	One, continuous flow	
	Each additional one	

Minimum Meter Charges.

Size	Min. Mo. Chg.	Size	Min. Mo. Chg.
$\frac{1}{2}$"		$\frac{5}{8}$"	
$\frac{3}{4}$"		1"	
$1\frac{1}{2}$"		$1\frac{1}{4}$"	
$1\frac{3}{4}$"		2"	
$2\frac{1}{4}$"		$2\frac{1}{2}$"	
$2\frac{3}{4}$"		3"	
4"		6"	

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[1] Includes sink and hot and cold water faucets.

[2] Does not include bath, urinal, water-closet.

[3] Not otherwise specified.

MONTANA STANDARD FORM FOR FLAT-RATE WATER-SERVICE SCHEDULE

Computing the Stresses in the Quebec Rocker Casting

In previous issues of *Engineering News* it has been explained how the cause of the disaster in the Quebec bridge erection on Sept. 11 was traced to the breakage of the steel rocker casting between the southwest end shoe of the bridge and the lifting girder.

The question asked by engineers everywhere is, Why did this casting break? Was it designed of sufficient strength? What were its loads and stresses?

PERMANENT STRETCHING OF THE SOUTHEAST HANGER CHAINS

A new fact of great importance to this question has been revealed by careful measurements just made to determine whether the hanger chains suffered any permanent stretch during the fall of the span. The measurements were made by tape, measuring from the lowest free pinhole of each chain link to the lowest open hole of the link next below. *The chains of the southeast hanger show ⅜-in. to ⅝-in. stretch in each 30-ft. link!* A slight stretch, $\frac{1}{16}$ in. to ⅛ in. per link, was found in the southwest hanger chains. The north hangers have not yet been measured, but there is no special reason to expect a stretch here.

The significant conclusion follows from the great stretch of the southeast chains that this hanger was subjected during the fall to an excess load of something between 60% and 100%. Tests on steel bars like those of the chain, made two years ago for the bridge company, showed elastic limits ranging around 27,000 lb. per sq.in. stress on the net section. Because of the small length of net section in the chain links, and the large stretch, it is believed by those closest to the work that a stress of at least 30,000 lb. per sq.in. on the net section must have been acting when this stretching occurred. Since the dead-load stress was only about 17,000 lb. per sq.in., the excess load during the fall must have attained a value of over 60%.

This excess is the load which was thrown on the southeast hanger (after the southwest support had failed) by the resistance of the portals and lateral systems. The top laterals, which were the weakest elements, consisted each of four 4x4x½-in. to ⅝-in. angles of nickel steel, with end connections of unusual strength. Computation shows that the force required to tear these laterals, applied at one corner of the span, is not far below the 1,200-ton. dead-load reaction at that corner. The picture taken during the fall proves that the top laterals tore bodily.

Thus the southeast rocker withstood at least 60% more than normal load, *without failing*, the latter fact being fully shown by the evidence presented in *Engineering News* of Sept. 21. This proved high strength of this rocker is striking, in view of the failure of the adjacent southwest rocker, and may not be lost sight of in considering the question of the stresses to which the rockers were subjected.

LOAD ON THE FAILED ROCKER

The entire end support of the suspended span was designed for 3,000,000 lb. load at each corner. This figure represents a weight estimate of 2,500,000 lb., and 20% allowance for impact. It includes the weight of t rocker support itself.

Since the span was perfectly quiescent, there can l no question of impact addition at the time of the failur The load at this time was 2,370,000 lb. There coul not then have been any excess of load at one or anoth corner due to uneven action of the jacks, because the spa was hanging from the pins in the fixed jacking girde (see sketch Fig. 2), and therefore was in balanced, u strained condition.

With respect to load on the rocker at other times, i creased load due to lifting one corner a trifle ahead the adjoining corner was a possibility. The lifting operations were, however, held under such control that th adjoining ends were never more than ¼ in. apart i level (1½ in. on the indicator). If by chance the tw ends of the span were momentarily in opposite pha with respect to out-of-level condition, there would be twist in the span corresponding to ½ in. lift of o corner. The lifting force required for this lift is smal and does not add appreciably to the normal shoe reactio

All the rockers carried the span while on falsewo at Sillery Cove, and here they bore an overload fro track, a 30-ton locomotive crane, and material train Careful reëstimates of this overload give its stat amount as more than 10%, apart from the impact an vibration effect of the locomotive crane. Thus, th failed rocker had carried perhaps 15% overload withou breaking. In addition it had resisted the longitudina tipping moment arising from pin friction as the spa slid along the longitudinal (lower) rocker pin becau of expansion on the falsework. This friction is est mated at possibly 8%; its overturning lever arm wa about 10 in.

THE BRIDGE COMPANY'S STRESS CALCULATIONS

The St. Lawrence Bridge Co., in accordance with it policy of giving to the profession full information a to all the facts and circumstances in connection wit the disaster, has furnished at our request a calculatio sheet, which they state is "a copy of our calculations i designing the casting," and it is printed in full below

The unit stresses (for erection material) were fixed b the specifications at 20% higher than those allowed i parts of the permanent structure. Thus the figures o 18,000 lb. per sq.in. for rolled steel and 16,000 lb. pe sq.in. for steel castings, as specified for parts of the bridge were raised for the erection appliances to 21,600 lb. pe sq.in. for rolled steel and 19,200 lb. per sq.in. for stee castings. Later, special consideration of the chain hangers, based on elaborate tests, led to an agreement betwee the bridge company and the Board of Engineers to lim the hanger tension to 20,000 lb. per sq.in. (for load plu 20% impact). In this way it came about that substantially equal unit stress was employed for the chain bar and the steel castings.

The bridge company's calculation sheet, below, ha three parts.

The first relates to the bending effect on the lowe bracket arm of the rocker. The calculation involve assumption that the casting does not bear on the all the way, but deflects away from the pin at the ls; and this action is assumed to be just enough to re-

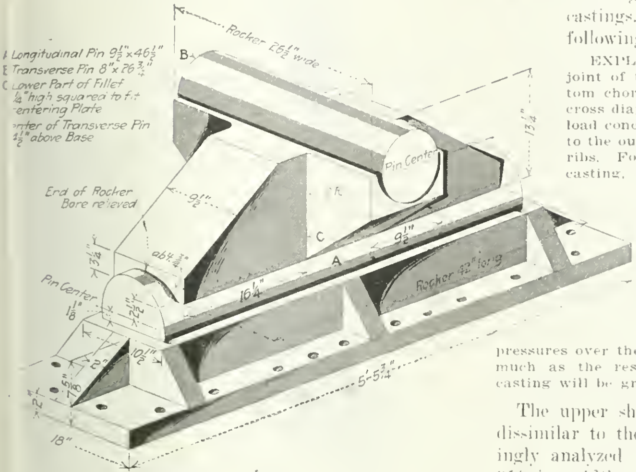
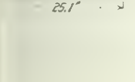

Longitudinal Pin 9½"x46½"
Transverse Pin 8"x26¾"
Lower Part of Fillet ¼" high squared to fit entering Plate
enter of Transverse Pin 4½" above Base
Rocker 26½" wide
B
13¼"
Pin Center
End of Rocker Bore relieved
9½"
C
9½"
A
ab4¾"
3¼"
Rocker 42" long
16¼"
Pin Center
1⅛"
2½"
10½"
2"
5/16
7
2
5'-5¾"
18"

FIG. 1. ROCKER AND LOWER SHOE

heet lead ⅛ in. thick under shoe. Centering plates bolted sides of shoe and projecting up to fit tight against side ket at C.

e the bending action at the root of the bracket to the wed stress intensity of 20,000. The second compuon deals similarly with the lower pin. The third, using the same method of calculation, deals with the r shoe casting, which rests on the lifting girder.

otal load on castings including 20% impact = 3,000,000 lb. rtbution of load allowing bending units of 20,000 lb. per . for steel castings and 30,000 lb. per sq.in. for pins.



Stress per unit of length = $\frac{3,000,000}{9\frac{1}{2} + 2x}$

$M = \frac{3,000,000}{9\frac{1}{2} + 2x} \times \frac{x^2}{2} = \frac{3x^2}{19 + 4x} 10^6$

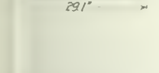
Sec. Mod. of casting = 182.5

Allowable Mom. = 20,000 × 182.5 = 3.65×10^6

$\frac{3x^2}{19 + 4x} = 3.65$; x = 7.8 in.

Casting will distribute load 9.5 + 7.8 × 2 = 25.1 in.

Bearing unit = $\frac{3,000,000}{25.1 \times 8}$ = 15,000 lb. per sq.in.



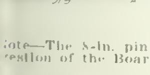
Mom. on pin = $1.5 \frac{x}{2} \times 10^6$

Sec. Mod. of 8-in. pin = 50

Allowable Mom. = 30,000 × 50 = 1.5×10^6

$1.5 \frac{x}{2} = 1.5$; x = 2 in.

25.1 + 2 × 2 = 29.1 in.



Mom. on casting = $1.5 \frac{x}{2} \times 10^6$

Sec. Mod. = 52.3

Allowable Mom. = 20,000 × 52.3 = 1.046×10^6

$x = \frac{1.046}{1.5} 2 = 1.4$ in.

Total distribution = 29.1 + 1.4 × 2 = 31.9

ote—The 8-in. pin was changed to a 9½-in. pin at the estion of the Board

t will be seen, as the final result of this calculation, the lower shoe is *supposed* to bear on the girder for ngth of only 31.9 in., although actually the shoe is it twice this length.

Through the courtesy of C. N. Monsarrat, Chairman of the Board of Engineers, *Engineering News* has been furnished with a copy of the original calculations made in checking the design of the lifting-apparatus castings. The calculation is introduced by the following statement:

> EXPLANATION OF ASSUMPTIONS—The XLO joint of the suspended span [at the end of the bottom chord] is designed by means of heavy vertical cross diaphragms and bottom plates to take this full load concentrated on the middle rib and distribute it to the outside ribs in proportion to the areas of these ribs. For this reason it is assumed that the upper casting, Pattern No. 210, delivers 75% of the load to the middle rib and 12½% to each of the outside ribs. It is also evident that the series of castings and pins, acting as a whole, will deflect more under a unit load than the surfaces against which they bear. For this reason the bearing pressures at or near the vertical axis of the castings and pins will be the greatest and therefore the following assumptions of uniformly distributed bearing pressures over the limited areas shown will be justified inasmuch as the resulting calculated bending stresses in the casting will be greater than can actually be the case.

The upper shoe, which is a cross-shaped casting not dissimilar to the rocker in its general form, is accordingly analyzed for a central load of 2,176,000 lb. on 9½ in. width, and end loads of 362,000 lb. each centering 24.6 in. from the middle of the shoe, and for a pin reaction distributed uniformly on the entire 26¾-in. length of the transverse rocker pin.

The ribs of the shoe are stressed to 18,400-lb. tension and 21,700-lb. compression if the side ribs carry this amount, but the longitudinal ribs have ample strength.

SAME METHOD FOLLOWED IN CHECK CALCULATIONS BY BOARD OF ENGINEERS

To find how this 8x26¾-in. pin delivers the load to the top of the rocker casting, its bending-moment capacity at 30,000 lb. fiber stress is computed, and then by calculation it is found that if the reaction against the bottom of the pin is distributed over a length of 22.32 in., the overhang of load over reaction develops the full 30,000 lb. unit stress in the pin. The 22.32 in. length of reaction is accordingly taken to be the true length of distribution, and from it the stresses in the rocker casting are determined, as follows:

Upper or Transverse Bracket [of rocker casting].

Moment on Section a-a [at root of bracket].

$$\frac{\frac{1}{2}(22.3 - 9\frac{1}{2})}{22.3} \times 2,900,000 \times \tfrac{1}{4}(22.3 - 9\tfrac{1}{2}) = 2,650,000 \text{ in.-lb.}$$

Section modulus = 188.65 in.^{3}.

Bending fiber stress = $\frac{2,650,000}{188.65}$ = 14,000 lb. per sq.in.

Lower or Longitudinal Bracket—

Section modulus of casting = 188.65 in.^{3} If casting is strained to 19,200 lb. per sq.in. in Section bb [at root of bracket], it will be distributing the 2,900,000-lb. load uniformly over length x. The moment the casting is resisting for this condition is 19,200 × 188.65 = 3,600,000 in.-lb. Therefore

$$\frac{2,900,000}{x} \times \frac{x - 9.5}{2} \times \frac{x - 9.5}{4} = 3,600,000$$

Solving for x, x = 25.4 in.

Calculation of 9½-in Pin—

Section modulus of pin = 84.0 in.^{3} If pin is strained to 30,000 lb. per sq.in., acting as a cantilever beam, it will distribute the 2,900,000-lb. load uniformly over a length x Moment pin is resisting is 84.0 × 30,000 = 2,520,000 in.-lb.

$$\frac{2,900,000}{x} \times \frac{x}{2} \times \frac{x}{4} = 1,450,000 \times \frac{25.5}{4} = 2,520,000, \text{ or } x = 32\tfrac{1}{4} \text{ in}$$

Calculation of Lower Shoe Casting—

Section modulus of casting = 39.92 in. Casting receives its load uniformly distributed over a length of 32½ in. and can distribute this load, while acting as a cantilever beam, uniformly over a length of x inches. Moment casting can resist = 39.92 × 19,200 = 765,000 in.lb.

$$\frac{2,900,000}{x} \times \frac{x}{2} \times \frac{x}{4} - 1,450,000 \times \frac{32.5}{4} = 765,000, \text{ or } x = 34.5 \text{ in}$$

In addition to this the two ⅝-in. cover plates, which are well riveted together and to which the casting is bolted with 1¼-in. turned bolts, will distribute the load over a bearing length of 35.5 in.

The area of the diaphragm material covered by this bearing length of 35.5 in. is 99.3 sq.in., giving a bearing pressure per square inch of $\frac{2,900,000}{99.3} = 29,000$ lb. per sq.in., this unit pressure including the 20% of the lifted load as impact.

THE CALCULATIONS EXPLAINED BY COMPARISON WITH OTHER COMPUTED RESULTS

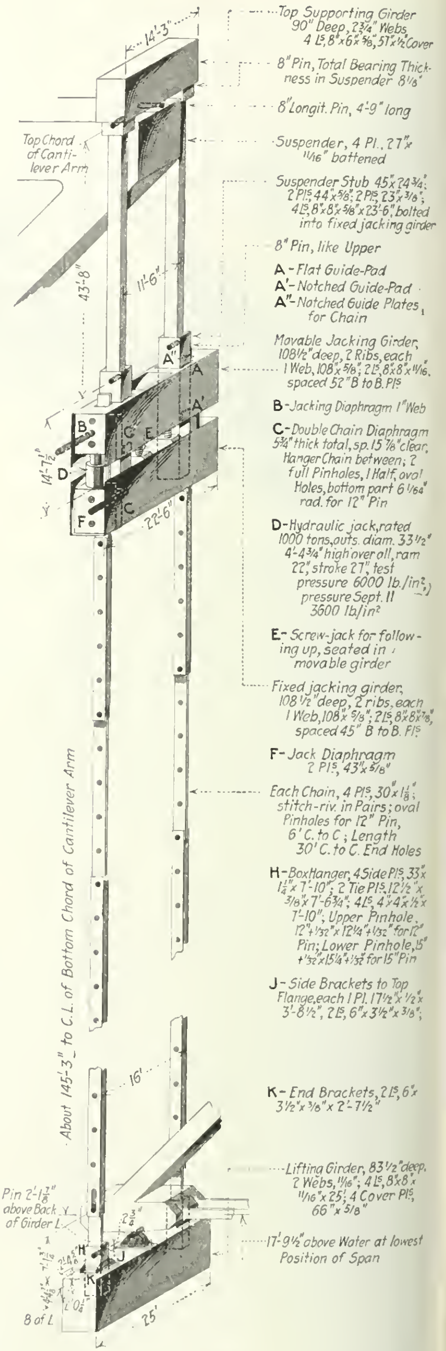
While the above calculations follow an unusual method, further explanation of them would be of little interest if the unit stresses were low or the casting unimportant. Under the circumstances of the case, however, it is essential that the calculation be studied closely to determine what degree of approximation it involves and, if not exact, how large an error it may introduce. The following explanatory statements are therefore added:

1. The calculation deals with a hypothetical condition, or a hypothetical set of castings and pins. The real support can be transformed into the one involved in the calculation by cutting off the ends of the lower shoe casting, so as to reduce its length from 65¾ to 31.9 in.; cutting off the ends of the lower pin so as to reduce its length from 46½ to 29.1 in., and cutting off the ends of the front and rear brackets of the rocker so that they project only 7.8 in. instead of 16¼ in. When all parts are brought into this condition, they are then strong enough to carry the load if distributed on them as assumed. The view being held that the real or longer castings and pins are stronger than what is left after cutting off pieces, it followed that the rocker support as designed was safe.

2. The method of calculation employed—namely, determining the length of bearing that will (with uniform distribution on that length) keep the bending stresses within *previously fixed* limits—might be applied to even smaller castings and pins with the same results, except that still shorter lengths of loading would be found. For example, the brackets of the rocker might be only 7¼ in. thick instead of 9½, in which case they would be only three-fourths as strong; yet the method of calculation would show the same bending stress of 20,000 lb. per sq.in., i.e., *it would show them to be just as safe as the thicker rocker brackets.* This process could be carried as far as desired, evidently.

3. The method of calculation ordinarily used, based on the assumption of uniform distribution of the load along the full length of the pin seat, gives much higher bending stresses in the rocker bracket: For 3,000,000 lb. load, 51,600 lb. per sq.in.; for 2,500,000 lb. load (net load after deducting the 20% impact addition), 43,000 lb. per sq.in.; for 2,370,000 lb., the actual load sustained on Sept. 11, 40,700 lb. per sq.in. These stresses pertain to the lower or longitudinal rocker brackets; they represent tensions in the lower edges of the rocker, each edge only ¾ in. wide.

This narrow edge, more susceptible to cracking than a flat or rounded face, was further affected by the presence of the reëntrant angle at the root of the bracket,



14'-3"
Top Supporting Girder 90" Deep, 2¾" Webs, 4 L^s, 8"×6"×⅝", 51"×½" Cover
8" Pin, Total Bearing Thickness in Suspender 8⅛"
8" Longit. Pin, 4'-9" long
Top Chord of Cantilever Arm
Suspender, 4 Pl., 27"×¹¹⁄₁₆" battened
Suspender Stub 45"×24¾"; 2 Pl^s, 44"×⅝"; 2 Pl^s, 23"×³⁄₁₆"; 4 L^s, 8"×8"×⅝"×23'-6", bolted into fixed jacking girder
8" Pin, like Upper
43'-8"
11'-6"
A - Flat Guide-Pad
A' - Notched Guide-Pad
A" - Notched Guide Plates, for Chain
Movable Jacking Girder, 108½" deep, 2 Ribs, each 1 Web, 108"×⅝"; 2 L^s, 8"×8"×¹¹⁄₁₆", spaced 52" B to B. Pl^s
A"
A
A'
B
C
E
D
F
C
14'-7½"
22'-6"
B - Jacking Diaphragm 1" Web
C - Double Chain Diaphragm 5¾" thick total, sp. 15⅞" clear, Hanger Chain between; 2 full Pinholes, 1 Half, oval Holes, bottom part 6¹⁄₆₄" rad. for 12" Pin
D - Hydraulic jack, rated 1000 tons, outs. diam. 33½" 4'-4¾" high over all, ram 22", stroke 27", test pressure 6000 lb./in², pressure Sept. 11 3600 lb/in²
E - Screw-jack for following up, seated in movable girder
Fixed jacking girder, 108½" deep, 2 ribs, each 1 Web, 108"×⅝"; 2 L^s, 8"×8"×⅞", spaced 45" B to B. Pl^s
F - Jack Diaphragm 2 Pl^s, 43"×⅝"
Each Chain, 4 Pl^s, 30"×1⅛"; stitch-riv. in Pairs; oval Pinholes for 12" Pin, 6' C. to C; Length 30' C. to C. End Holes
H - Box Hanger, 4 Side Pl^s, 33"×1¼"×7'-10"; 2 Tie Pl^s, 12½"×⅜"×7'-6¾"; 4 L^s, 4"×4"×½"×7'-10"; Upper Pinhole, 12"+¹⁄₃₂"×12¼"+¹⁄₃₂" for 12" Pin; Lower Pinhole, 15"+¹⁄₃₂"×15¼"+¹⁄₃₂" for 15" Pin
J - Side Brackets to Top Flange, each 1 Pl. 17½"×½"×3'-8½", 2 L^s, 6"×3½"×⅜";
About 145'-3" to C.L. of Bottom Chord of Cantilever Arm
16'
K - End Brackets, 2 L^s, 6"×3½"×⅜"×2'-7½"
Lifting Girder, 83½" deep, 2 Webs, ¹¹⁄₁₆"; 4 L^s, 8"×8"×¹¹⁄₁₆"×25'; 4 Cover Pl^s, 66"×⅝"
Pin 2'-1⅞" above Back of Girder L
2¾"
17'-9½" above Water at lowest Position of Span
H
J
K
L
8 of L
25'

FIG. 2. PERSPECTIVE DIAGRAM OF ONE HANGER OF TH QUEBEC BRIDGE SUSPENDED SPAN, TO SHOW FLEXIBLE AND STABLE MANNER OF SUPPORT

here the longitudinal and transverse brackets join. This ngle was filleted to 2-in. radius in the casting, but the ›wer part of this fillet had to be partly chipped away › make a bearing for the edge of the centering plate olted to the lower shoe and extending up to engage the ›cker.

4. If, on account of the deflection of the rocker brackts when under load, the bearing pressure be taken as ›ro at the front and rear ends and maximum over the ntral 9½-in. length of the rocker, varying uniformly ence to the ends, the bending stress at the root of e bracket is only about half as great. For a load of 000,000 lb. the stress is 28,000, for a load of 2,500,000 . it is 23,400, and for a load of 2,370,000 lb. it is 22,200 . per sq.in.

5. The greatest vertical load on the rockers occurred at illery Cove; taking it as 10%, it raised the bending ress at the root of the front bracket to 44,800 lb. per .in., if the pin bearing pressure was uniform, and 24,000 the bearing pressure tapered down to zero at the ıds.

6. The preceding figures for vertical load take no count of expansion stresses. The span at Sillery was ranged to slide on the longitudinal (lower) rocker pin d did so slide, a maximum amount of 2¼ in.; this s one-sided creep of the span, due to connection th the material track, and because of it the shoes at e end were then blocked against longitudinal motion. e sliding friction tends to overturn the rocker longidinally, and thereby increases the pressure under the acket toward which the expansion is taking place.

This effect increases the bending stress at the root of e rocker bracket somewhat. For 7½% friction, with -in. lever arm, the increase is about 3,000 lb. per sq.in. der the uniform-pressure condition of the rocker, and out 4,000 lb. per sq.in. for the tapered-pressure condi›n. These increments would not be simultaneous with e 10% excess load.

No damaging effects of the loading at Sillery Cove re noticed. This is in a measure negative evidence, no close examination of the rockers was made. The t visit to the supports, for inspection of the centering ıtes just before lifting started, by George F. Porter d S. P. Mitchell, was made in early morning. At is time the rocker supports were fairly well in the rk and therefore this visit affords no data for judging the condition of the castings.

QUALITY OF THE CASTINGS

The steel castings for rockers, shoes, etc., were required be of openhearth stock containing not less than 0.10% bon at any period of the melt, and in ladle test not re than 0.01% phosphorus (or 0.06 for acid steel), 5 sulphur, 0.75 manganese, and 0.35 silicon. Tension ts from coupons (annealed) were to show 35,000 lb. sq.in. elastic limit, 65,000 lb. ultimate strength, and elongation in 2 in., besides a 120° bend on a diameter twice thickness. These requirements were fixed by the cification for the permanent bridge structure.

The specification was fully met by the material furhed. The material was acid openhearth, made by Canadian Steel Foundries Ltd. The test report from foundry's laboratory shows for the chemical composin: Carbon, 0.26%; phosphorus, 0.033%; sulphur, 32%; manganese, 0.55%; and for test results: Elastic limit 36,300 lb. per sq.in.; maximum strength, 69,700 lb. per sq.in.; elongation, 29%; reduction of area, 44.7%.

The heat from which the rockers were cast included other castings, and it is not known from which casting the test coupon was taken. Nor can the coupon be located now for examination of fracture and structure. However, the process of molding, pouring and annealing was carried out in exactly the same way as for other highest-grade castings. The melt was treated with 1,265 lb. ferrosilicon and 525 lb. ferromanganese to 18 tons charged. The rockers were molded top down, bottom-gated, with four shrink heads taken off the sides of the top (the lower or longitudinal brackets) and rising 20 in. high above the casting. No welding or other curing of defects was done, it is stated very positively. Annealing was done at 1,700° to 1,800° F., and according to best recollections these castings were in the furnace 36 hr.

FIGURES AND FACTS DISPROVE CLAIMS THAT SUPPORT OF SPAN WAS UNSTABLE

A large number of inquiries have been made of *Engineering News* as to the stability conditions of the lifting chains that carried the span in hoisting.

The diagrammatic sketch, Fig. 2, with dimensions and make-up of the lifting rig, has been prepared to supply the needed data. It exhibits in full the ample provision for flexibility and self-adjustment of the suspension. The dimensions of the overturning and righting lever arms at the critical point—lifting girder and rocker—are given in full. The suspension pin of the lifting girder is shown to be 2¾ in. above the upper rocker pin, which assures the stability of the assemblage.

Quite apart from the sketch and figures, however, the facts of the accident as reported in full in *Engineering News* of Sept. 21 prove that the question of stability played no part in the fall of the span. Tipping of one or more of the lifting girders did not take place before the fall started. The severe thrust kick through the span which necessarily would have followed a primary tipping of one lifting girder was not observed. Tipping through an angle of nearly 90°, as would be inevitable if the fall was originated in that way, would have left indisputable evidence of its amount; but on the contrary the amounts of rotation shown by the several girders are relatively small; and the greatest rotation was found at the north girders, where it merely records the tipping of the entire span as the south end went under water. Further, a condition of low stability in the supports would not have permitted the north end to remain firmly seated while the south end, in falling, was twisting the span with force sufficient to destroy both laterals and main trusses. On the contrary, the behavior of the north ends is striking proof that the method of support was insensitive to even very large impact, torsional and longitudinal forces. In fact, considering the low metacentric height, a surprisingly high degree of stability was evidenced.

The preceding relates to rotation on the lowest joint of the hanger system, the pin in the top of the box hanger. The pin in the lower end of the box hanger is not a hinge but a shear connection transmitting the girder load to the hanger chain. The box hanger and girder are held rigidly together by a strong riveted connection at the top flange of the girder. This connection remained entirely undisturbed in the fall of the span.

Notes from Field and Office

Contractor speaks of night work and Sunday work—Concrete road finishing cheapened by a superintendent's kink—Water pipe on wheels for street flushing—Precision of difficult tunnel work assured by careful survey methods, New York and Milwaukee—Roller piledriver for sewer sheeting

Cost of Night and Day Work

By G. H. Hailey*

The article by Mr. Michel as to the relative cost of night and day shifts on construction work, in *Engineering News* of Aug. 17, is very interesting. Where any considerable amount of night work is performed, data as to its cost in comparison with day work would be very valuable to contractors.

We have not found it necessary to put on night shifts except in a few cases, and then only for a few nights to meet an emergency, so that we have no separate data as to the cost. In our concrete work we have very often continued running until 8 or 9 p.m. in order to complete a certain portion, such as the turning of an arch ring or a section of wall, but we have no records as to its cost in comparison with day work.

In a considerable number of cases where railway work was being done under traffic we have found it advisable to work on Sundays, there being less interference with the work on account of fewer trains. In such cases there is of course no question as to the Sunday work being efficient, and the same would apply to night work where the number of trains is less than in daytime. In a general way, however, I am of the opinion that, if the night work is charged with its proper share of the repair work and other overhead expenses incurred during the day, the cost will be 1¼ to 1½ that of day work.

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Canvas Belt Used for Finishing Concrete Road Surfaces

Instead of the usual method of finishing concrete pavement by means of trowels or floats which the finishers manipulate from a bridge spanning the roadway, a new device has been in use by the Board of County Road Con missioners, Wayne County, Mich., for a little over year. This device is a strip of canvas belting 12 i wide with handles bolted at each end. The strip about 1 ft. longer than the width of the roadway.

The concrete is formed to the shape of the finish roadway in the customary manner by means of a wood templet spanning the roadway and sliding on side form Two laborers follow this operation by pulling the ca vas strip gently back and forth across the roadway, givi the smoothness of finish desired.

Patrick McConalogue, superintendent of constructi for the Board of County Road Commissioners, is respon ble for this method of road finishing. It seems that on day when his finishers had quit he attempted to finish t roadway by drawing across the concrete surface a canv tarpaulin used for protecting cement. This meth rolled the stone at the surface and was rejected. S ing a strip of canvas about 4 ft. wide, he tried t and found that it worked fairly well. He doubled it on with better results, so he doubled it again to a width about 12 in., and a very satisfactory finish was obtain Concrete collected in the folds of the canvas, so later was replaced by the canvas belting now in use.

While once over with this strip gives a good fini Mr. McConalogue uses a second strip, a duplicate of t first, which is operated by two laborers whose chief d it is to follow up the work, finish the edge of the ro way, and remove and carry forward the side forms. this way any unevenness or roughness in the surface eliminated as the work moves along.

The canvas belt used in securing the first finish operated by two laborers from the gang working at t concrete mixer. As the mixer is being moved forwa these laborers drop back and finish the section just plac 25 ft. of roadway surface being finished in about 3 m

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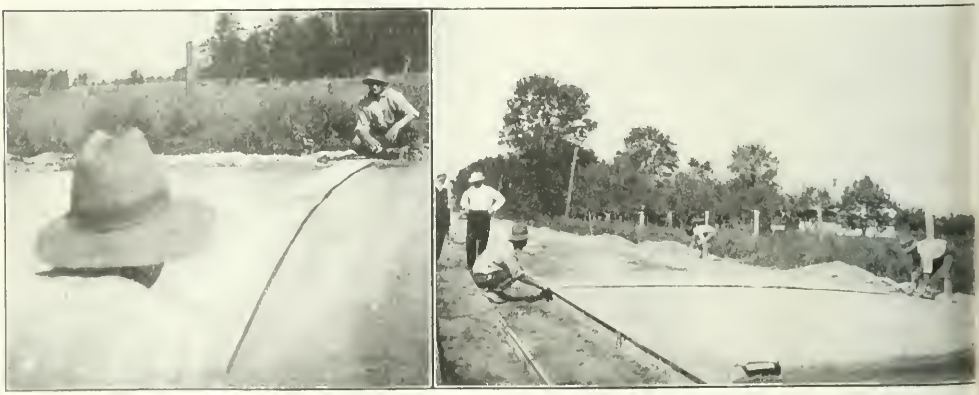
*Chief Engineer, Cleary White Construction Co., Chicago.



FINISHING CONCRETE ROAD SURFACES WITH CANVAS BELTING, WAYNE COUNTY, MICHIGAN

In this way three finishers at 33½c. per hr. have been done away with, resulting in a reduction in the payroll of practically $1 per hour.

Mr. McConalogue has tried rubber belting in place of the second "follow up" canvas belt and has been able to secure a glassy finish. However, as such a finish is undesirable for a roadway the canvas belts only are used. At the end of the day the concrete is thoroughly washed from the canvas belts.

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East River Tunnel Surveys

By C. M. Holland*

The survey work in connection with driving the East River tunnels requires a large survey corps to be on duty both day and night in order to secure accurate and frequent checks upon the position of the tunnel shields. It is necessary that these shields be kept on the correct line and grade, as the cross-section of the tunnels has been reduced to a minimum for purposes of economy. Any considerable deviation from the theoretical alignment would have serious consequences that might delay the completion of the work as well as increase its cost.

Surface Work and Plumbing

The surface surveys and triangulation were completed by precise methods previous to construction operations, but all the work has subsequently been rechecked in order to guard against any possibility of error. The triangulation system selected in each case is a quadrilateral, with a side on each side of the river which could be measured and used as a check on the computed length as determined from the angular measurements. All the angles were read by repetition, using a transit graduated to read to 10 in. of arc, and all measurements were made with standardized tapes corrected for pull and temperature. A system of coördinates was adopted to facilitate the computation of the tunnel alignments and the location of points for line dropping at the shafts.

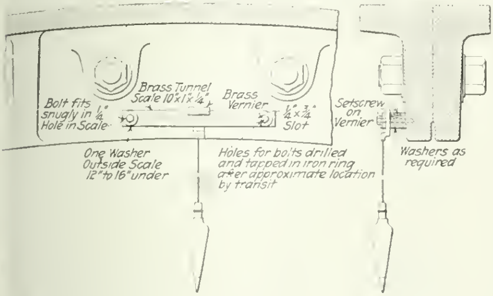
Brass Tunnel Scale 10"x1"x¼"
Brass Vernier
Bolt fits snugly in ¼" Hole in Scale
¼"x¾" Slot
Setscrew on Vernier
One Washer Outside Scale 12" to 16" under
Holes for bolts drilled and tapped in iron ring after approximate location by transit
Washers as required

FIG. 1. VERNIER ROOF SCALE USED IN EAST RIVER TUNNELS

The tunnel surveys are connected with the surface surveys by plumbing down shafts. A base length of 26 ft. was obtained in each case. These plumbings were repeated until successive plumbings in each shaft made it certain that the average result was well within any allowable error. In addition, check line droppings are made from time to time in order to determine whether the shaft points as already established have shifted. It is necessary to do this work on Sundays, as the vibration incidental to the operations in progress on week days makes precise work impossible. At first the shafts were plumbed about every third Sunday, and even at this late date they are plumbed about once every five or six Sundays.

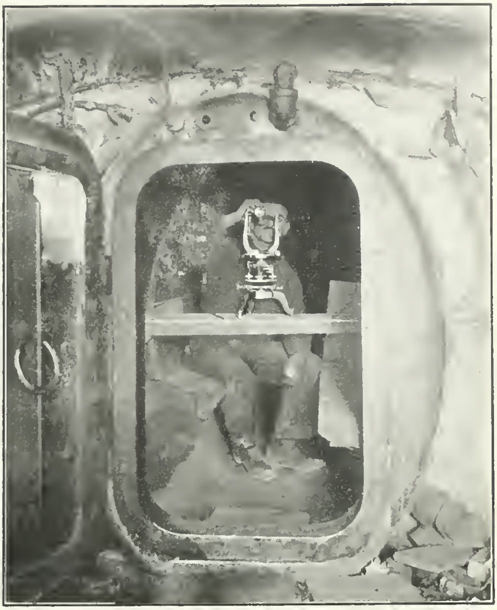

FIG. 2. LINE SIGHTING FROM AIR LOCK

The present distance of advance from the shafts averages about 1,500 ft. The longest distance any line will have to be extended from shaft to heading is about 3,000 ft., or over 100 times the length of the shaft base.

In the underground surveys also, continuous repetition of survey work is the only guarantee of precision, on account of the atmospheric conditions and the movement of the tunnel lining. In soft ground the tunnels shift slightly as the earth resettles around them, affecting line points often some distance back from the face of the heading. Furthermore, this is particularly true of tunnels driven in pairs, where, with one some distance ahead of the other, it often occurs when the second tunnel passes the first that there is a small shift in the line, which can be detected only by instrumental observations. Consequently, reliance is placed chiefly upon the continual repetition of observations with ordinary survey equipment rather than upon a single series of observations of a much more precise character.

Line Prolongation

The tunnel surveys in the East River tunnel work may be classified in three groups—the precise surveys, the construction surveys and the shield checks.

The precise surveys are usually made by parties of four men each, consisting of a chief of party, an instrumentman and two men for scale readings. All line points are carried on scales stud-bolted to the cast iron tunnel lining (Fig. 1). The reading on each scale is fixed by means of a vernier graduated to read to 0.002 ft., and it is customary to estimate the reading to the nearest thousandth. Every effort is made to eliminate all in-

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*Tunnel Engineer, Public Service Commission, 159 Remsen St., Brooklyn, N. Y.

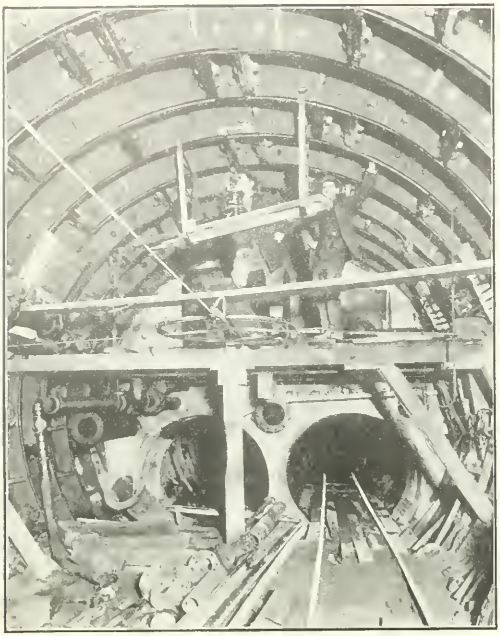


FIG. 3. INSTRUMENT PLATFORM SUSPENDED FROM ROOF

strumental errors in making these surveys, and the use of plumb-bobs for setting over or under points is eliminated. All line work is done by ranging the transits into line ("wiggling" or "bucking" into line), for which purpose the transit is set on a slow-motion shifting head. In addition, considerable emphasis is placed upon the proper lighting of the sights and keeping all equipment in correct adjustment. All angles are turned by repetition with transits reading to 10″ of arc, and the measurements for reading the angle points are made, as in the case of base-line measurements, by standardized tapes corrected for temperature and pull. Errors of personal equation are worked out by having at least two parties working on each line independently, dependence being placed on a large number of observations by different instrumentmen. These precise surveys are run into each heading at least once a week when the atmospheric conditions are the best. The fog, which is a very serious factor to contend with in the survey work, sometimes makes it impossible to get long shots, but every effort is made to get shots at least 250 ft. long.

The construction surveys are made by parties of three men and consist of producing the precise survey lines ahead of the forward scale point, so that a line is always near the working face available for the shield check surveys. This line is carried forward daily. Scales are not used for setting this line, as no final readings could be maintained close up by the shield, so that this survey line is fixed by means of spads driven into boards wedged in between the flanges of the cast-iron lining. On account of the short distance which these surveys are carried in advance of the precise lines it is not customary to work to any great degree of precision, as the results are required to be only approximate.

All line work is carried along the roof of the tunnel, using suspended platforms (Fig. 3).

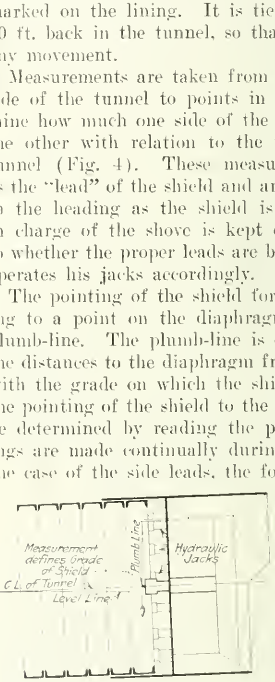
Controlling the Position of the Shield

To keep these shields on the correct alignment, check measurements are required each time a shield is moved. These shield check surveys consist of determining the alignment of the diaphragm of the shield (center), the alignment of the tunnel lining already erected and particularly the alignment of the last ring of iron erected. The transits are provided with a level on the telescope, and from a near-by benchmark the elevation of the shield and of the top of the last ring erected is obtained from the same setup.

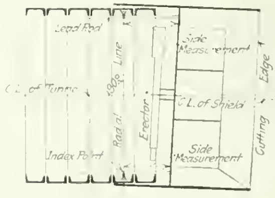
As the completed tunnel under the action of the shield jacks always moves, except in very firm ground, it is necessary to make all measurements from a survey line, as dependence cannot be placed upon the completed structure. The reference line used is a radial line reëstablished by the construction survey party every 24 hr. and marked on the lining. It is tied in to points set some 20 ft. back in the tunnel, so that it can be checked for any movement.

Measurements are taken from this radial line on each side of the tunnel to points in the shield which determine how much one side of the tunnel is in advance of the other with relation to the proper direction of the tunnel (Fig. 4). These measurements are designated as the "lead" of the shield and are taken by the inspector in the heading as the shield is pushed. The foreman in charge of the shove is kept continually informed as to whether the proper leads are being maintained, and he operates his jacks accordingly.

The pointing of the shield for grade is fixed by reading to a point on the diaphragm of the shield from a plumb-line. The plumb-line is of a known length, and the distances to the diaphragm from this plumb-line vary with the grade on which the shield is traveling, so that the pointing of the shield to the tunnel grade can always be determined by reading the plumb-line. These readings are made continually during the shove; and, as in the case of the side leads, the foreman is kept informe as to how his shield i traveling. The metho of shoving the tunne shield and reading o leads and plumb i shown by Figs. 4 and 5. On the present work it has been unusual t have the line or grad of the completed struc- ture vary more than in. from the theo- retical, and when a greater deviation tha this has occurred i has been due to the shield encountering strata of differen hardness or some for- eign substance that ha caused the shiel either to settle or t rise abnormally. Whe this happens, every



Elevation showing Measurements to control Grade



Plan showing Measurements to control Line

FIG. 4. CHECK MEASUREMENTS MADE AT EACH SHOVE OF SHIELD

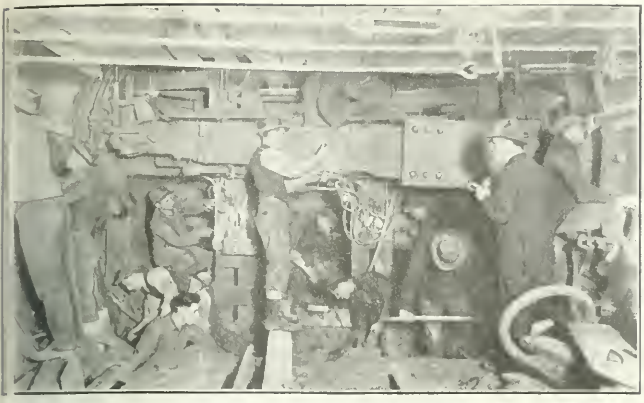


FIG. 5. SHIELD CHECK PARTY AT WORK

rt is made to give the shield a new plumb and a new lead to overcome this action; but a shield weighing e than 100 tons and of considerable length will travel e distance before it plows itself back to the normal ition. The greatest difficulty in driving a shield is to l it to grade, as the character of the ground through ch the shield is passing affects its grade more than its , since the shield has a tendency to settle in soft ground to the material moving out from under the shield into the tunnel.

fter each shove of the shield the instructions for the t shove are worked out from the data as to line and le obtained on the center of the diaphragm of the ld, the side lead and plumb-line readings. From information the grade and alignment of both the ing edge and the tail of the shield are computed, ving not only the exact position, but the pointing of shield relative to the correct line and grade. This f the utmost importance, for it shows what changes necessary in the side lead or plumbing to swing the ld back to the correct line and grade, and in addi- determines whether a straight or a taper ring should provided at the completion for the next shove.

he placing of the cutting edge of the shield in a er position after making allowances for settlement other considerations is worked out by experience. It he all-important factor in determining the position he tunnel, for where the cutting edge of the shield , there goes the completed tunnel.

VARIED BENCHMARKS FOR THE LEVEL READINGS

evels are divided up into the same general classes as nment surveys, consisting of precise levels, construc- levels and check levels. The precise levels are run repetition at least once a week down into the tunnel ling, hitting the benches that have already been es- ished by the construction survey party. The level ty consists of three men, a chief of party who acts as rder, an instrumentman and a rodman. The equip- t used is ordinary survey equipment consisting of py levels and Philadelphia rods. The precise bench- ks are formed by screwing stud bolts into the flanges the cast-iron lining near the bottom of the tunnel, s to avoid long rods which would be necessary in the benchmarks were carried in the roof of the tun- The construction benchmarks are in the roof of the tunnel, because it is more convenient to work with these from the traveling platform that follows immediately behind the shield. The shield checker has for his benchmark a reading on the spad under which he sets for line, so that instead of requiring a rodman to give a backsight with a rod he measures from the spad down to the center of his telescope, which gives him close enough elevation for any one individual shield check. To take every opportunity for increasing the precision of the survey work and guarding against error, cross-checks between tunnels are obtained about every 500 ft. by driving a 2-in. pipe from one tunnel to its mate (the eight tunnels in question are driven in pairs, at South Ferry, Old Slip, 14th St. and 60th St.), through holes drilled in the shell at points computed to match. The pipe itself gives a check on the survey work, but in order to close the traverse the angle through the pipe is read, the distance is measured with a tape, and levels are read.

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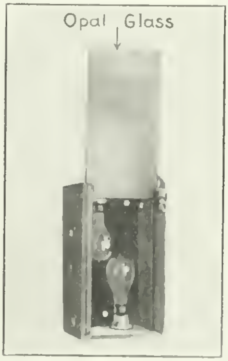
Survey Routine in Shore Tunnel, Milwaukee

Efforts at special accuracy were made in the instrumental work in the Shore tunnel of the new Milwaukee water intake to insure correct direction of the headings and precise meeting. The tunnel is attacked from four headings starting from two shafts. Compressed air is used in all headings. One of the shafts is offset from the tunnel, and the airlock for both headings from this shaft is located in the connecting drift. The two headings are at fractional angles to the line of the drift, necessitating work to single seconds in turning the angles. In the headings it was necessary to give line for the concrete forms at frequent intervals.

The tunnel center line was extended forward to the excavation face twice a week. This particular line work consisted in establishing the center line upon "screw eyes" (screws with flat heads, perforated to receive a plumb-bob string) fastened into 2x4-in. wood blocks set in the center line of the arch when the concrete was placed. These points were placed 30 to 40 ft. apart. The last three screw eyes in position were used for establishing the center line forward, the transit being stationed under No. 1 of the screw eyes and foresight being taken on No. 3 and checking on No. 2 (No. 3 being the nearest to the heading). This work did not require high precision, as all center-line screw eyes were rechecked every two weeks from the permanent or scale center line. The city inspectors employed these screw eyes only for "sighting in" by means of



ILLUMINATED SIGHTING BOX USED IN GIVING LINE IN SHORE TUNNEL plumb-bobs, for establishing excavation center lines and checking the position of the front end of the forms for the concrete shell. The screw eyes were at all times available for sighting.

The permanent or roof-scale center line was established on roof scales (see *Engineering News,* June 15, 1916, p. 1151, for illustration of these scales, the screw eyes and a quick-shift instrument table) set in the arch concrete every 125 ft. The center line on the roof scales was carried forward every two weeks, the scales being read to 0.01 in., the total number of readings on each scale averaging six. After the last scale, or the one nearest the heading, was established for center line, the center-line screw eyes between the last scale and the heading were checked up from the same "set up" of the transit. The bottom of each roof scale was also used as a permanent benchmark.

The length of sights in extending the permanent center line was limited to about 500 ft. because of the presence of vapor, due to the compressed air.

An illuminated sighting box, called the "bait box," was used in the work, because plummet lamps were not distinct enough for accurate work. The box was equipped with two 200-watt 230-volt Mazda lamps. A 20-ft. cord attached to the box made it possible to connect anywhere to the tunnel lighting system. Held behind a suspended plumb-bob the box gave a clear sight.

The transfer of line from the surface into the tunnel was checked once and transfer of elevation was checked twice after the initial transfer at the beginning of tunneling. From the marks at the shaft bottom, line was transferred once and grade transferred twice through the airlock into the heading, using the roof scales. It would have been done oftener if it had not required removing the air-pressure, with the resultant danger of disturbing the soil conditions in the face.

The center line was established on the surface on $1\frac{1}{4}$-in. steel pins set in concrete monuments, near the shafts and adjacent to the tunnel terminal points; on $1\frac{1}{4}$-in.x4-ft. steel pins for permanent intermediate stations; and on 1x2x18-in. wood stakes for temporary intermediate stations. This surface center line was rechecked three times for alignment and twice for distance. The center line on the steel pins was the intersection of a cross marked in the steel by means of a chisel. The center line on the wood stakes was established on small brads. The slant distance or lineal measurement between stakes and steel pins was made by steel tape used with spring balance. A 12-lb. pull was maintained on the tape. Level readings for elevation were taken on the center points and corrections were accordingly made to secure the horizontal distances. All level readings were made from the target. All foresights were established by "double-centering" twice from the backsight, result of the double-centering being divided for true center.

In plumbing the shafts two 20-lb. plumb-bobs were used. The plumb-bobs were suspended on No. 8 piano wire and were immersed in oil contained in buckets at the shaft base.

The headings between the two shafts met late in July and very satisfactory results were obtained between the center and grade lines of the two headings.

The work is in charge of L. G. Warren, Resident Engineer, under the direction of George F. Staal, City Engineer.

Pile Hammer Leads Mounted on Rollers

An unusual piledriving rig was employed in puttir down wooden sheetpiling in excavating for a segment-ti sewer in St. Louis. The piling was driven by a 3.000-l Arnott steam hammer operating in a set of double fix

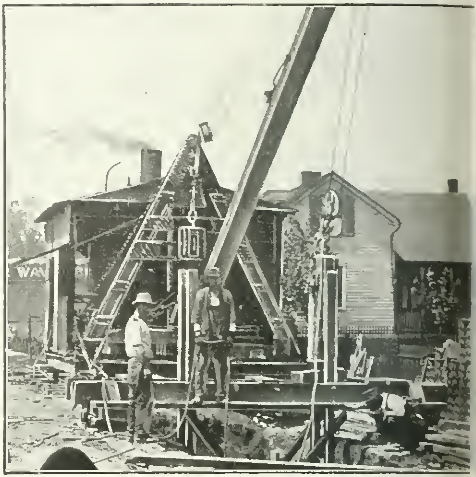


FIG. 1. CARRIAGE FOR SHEETPILE DRIVER LEAD

leads that could be moved by means of rollers locat on each side of the ditch, as illustrated in Fig. 1. H the leads were braced is shown in Fig. 2.

The soil through which the sewer was constructed w quicksand overlain by yellow clay. Through the c

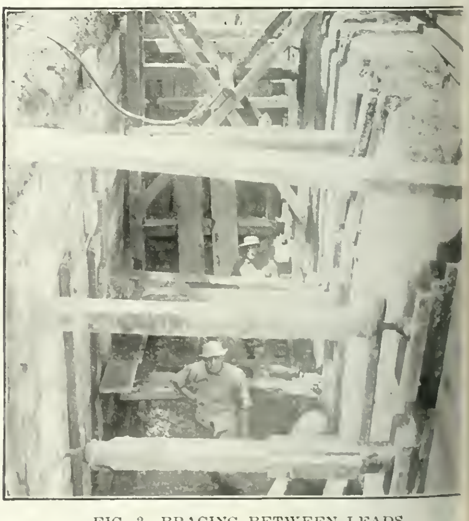


FIG. 2. BRACING BETWEEN LEADS

the trench was braced by horizontal sheeting. Thro the fine sand and quicksand, however, 3-in. tongue-a grooved wooden sheetpiling was driven to a depth o ft. below the flow line of the sewer.

trengthening an Alley Bridge

The east approach of the Van Buren St. tunnel under e Chicago River is crossed by a 31-ft. alley, the east le of which is in line with the tunnel portal. The ving is carried on a concrete slab resting on shelf gles on the webs of 24-in. transverse girders. The pth of paving and slab was 20 in., the lower portion of e girders extending about 18 in. below the bottom of e concrete slab. These girders were placed in 1891, d in 1915 their condition was such that immediate pair or renewal was necessary. The former method s decided upon. There is very heavy team traffic in e alley, and to avoid interruption to business it was cided to do the work from below, the tunnel being sed on account of reconstruction of the west approach.

The lower flanges of the girders were wrapped with panded metal, and strips of expanded metal in the rm of an arch were sprung in on top of these flanges d between the webs of each pair of girders. Transrse reinforcing rods were placed in position between the rders. Forms were then made and supported on false-rk. Grout pipes were placed in position, openings re calked with oakum, and a grout mixture composed 2 parts cement, 2 parts powdered stone and 1 part pedo sand was forced into place under 90-lb. air presre by means of a pneumatic concrete mixer. A heavy eam was placed adjacent to the girder over the portal, d a concrete parapet wall was built in place of the mer railing on this side of the alley.

The work was done by company force by the Chicago ilways Co., under the direction of John Z. Murphy, ectrical Engineer, and J. W. Harris, Tunnel Engineer.

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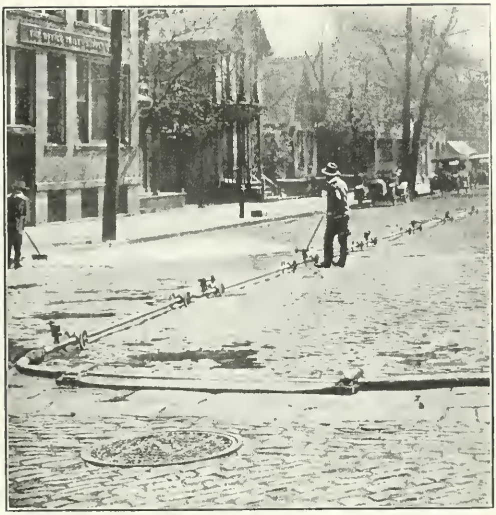


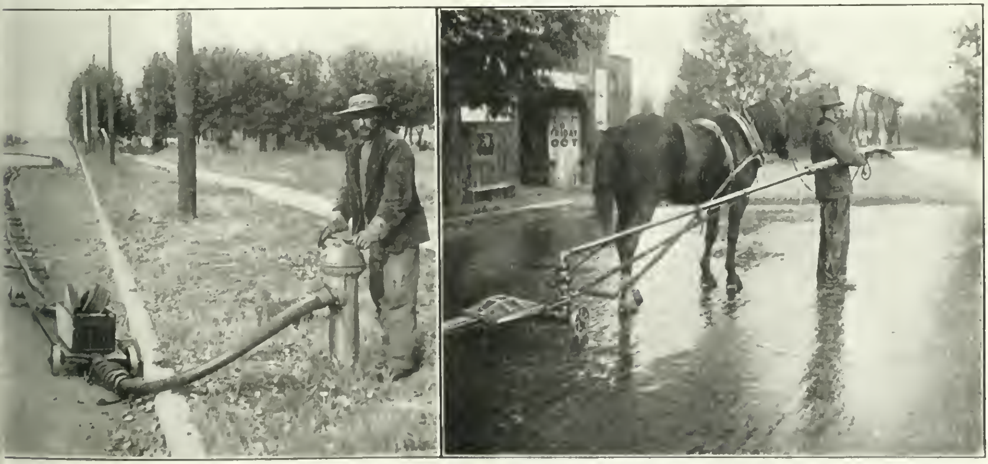
FIG. 3. STREET-FLUSHING DEVICE MADE BY THE BUFFALO MUNICIPAL EQUIPMENT CO.

treet Flushing with Portable Water Mains

In Baker, Ore., a city of 10,000 population, a method street flushing with a water pipe on wheels has been roduced, which is apparently new in this country, hough it has been in use abroad for many years. Baker there are fire hydrants in every block, but they are too far apart to allow more than half a block of pavement to be flushed at one time unless a hose of unwieldy length and weight is used. Therefore in place of hose, sections of 2-in. iron pipe mounted on little trucks have been adopted (see Fig. 1). The sections of pipe are connected with short pieces of hose for want of a better flexible coupling.

A supply main about 500 ft. long is attached to a hydrant, and to move the device a horse is harnessed to the free end, where a swivel-jointed pipe permits the operator to turn the stream in any direction (Fig. 2). Two men are required to operate the pipe line, one being at the hydrant.

There is a patented device on the market, made by the Buffalo Municipal Equipment Co., Buffalo, N. Y., of the same general character. This is shown in Fig. 3. There



FIGS. 1 AND 2. PORTABLE WATER MAIN FOR STREET FLUSHING, BAKER, ORE.

is the same portable water pipe on little wheels, but instead of being continually dragged over the pavement the pipe is merely pulled into position in the middle of the street, where it remains while the pavement is flushed from any one of the valve openings placed at the joints. This device, unlike the first, does not obstruct traffic, as planks are placed on either side of the pipe where it crosses the trafficway, and wagons may drive over it.

FINE AGGREGATE

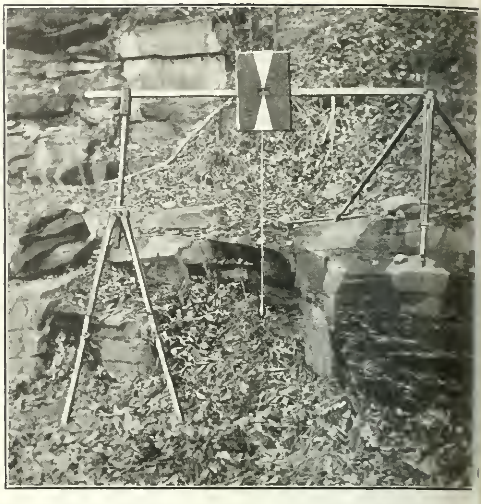
Laying Sewer Tiles in Cold Weather presents a difficulty in the "sweating" of the tile after being laid, causing the mortar to fall out of the joints. In building a fairly extensive sewer of segmental tile, in St. Louis, this condition was overcome by burning straw on the tile before lowering it into the ditch. This expedient is mentioned by Ben Moreell, Assistant Engineer, Board of Public Service, St. Louis.

Finding a Gas Leak with a Lighted Match seems to have just about the same effect on a church as on an ordinary building. The accompanying view shows what happened to a church in Parsons, Kan., on Sept. 16, when a plumber was searching for the source of the strong natural-gas odor that had pervaded the church cellar for some time. The building, a stuccoed brick-wall structure with a roof carried on timber trusses, was badly shattered, and the two men and a child in the cellar at the time were seriously hurt.

WHAT A GAS EXPLOSION DID TO A KANSAS CHURCH

A Geodetic Survey of Los Angeles, Calif., is in progress, according to the annual report for the year ending June 30, 1916, of the city engineering department. The primary triangulation is practically completed and is tied into the United States Coast and Geodetic Survey triangulation net at San Pedro Mountain, Castro, San Fernando and Mount Wilson. An 8-in. Bausch & Lomb direction theodolite is used for this work, and a 150-ft. invar tape is used for base-line measurements. Atmospheric conditions have made it necessary to use heliographs for the primary work, which caused vexatious delays. The methods of the United States Coast and Geodetic Survey are being followed, and a high degree of accuracy is expected. Homer Hamlin is City Engineer, and Charles P. Cooke is field engineer in charge of the geodetic survey.

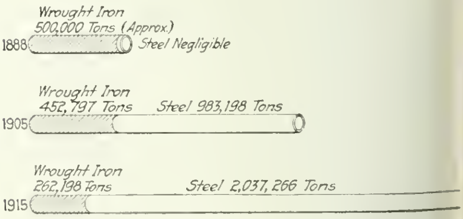
A Special Foresight for Accurate Work—The illustration shows a foresight used for accurately prolonging straight lines. It consists of a New York level rod with a special target. The rod is mounted on two tripods; it is securely clamped to the uphill tripod and rests in the fork of a stick which is wedged in the lower tripod. The target is 12x18 in., painted vermilion and white and is fastened to the regular level target. In use an equal number of shots were taken with the telescope of the transit direct and with telescope reversed, the average giving the position of the point on line. The instrument man gave signals with a large piece of orange-colored cloth. On long sights a telescope was used to see these signals. The accuracy attained depended on atmospheric conditions, length of sights, and number of shots. Under favorable conditions with a length of foresight up to 1,500 ft., with a backsight of 600 ft. or ove averages of 10 shots, 5 with telescope direct, and 5 wi telescope reversed, were less than 0.01 ft. apart; with a bac sight of 800 ft. and a foresight of 3½ mi., the averages two sets of 40 shots each were one inch apart. The apparat can be set up in from five to ten minutes, and shots tak at the rate of 40 to 60 per hour depending on the length sight and conditions of the atmosphere. The party consist of a chief and one or two assistants who manipulated t foresight, an instrument man and a man to watch the bac sight.—R. W. Gansmann, Browns Station, N. Y.



LEVEL-ROD USED AS LONG-DISTANCE FORESIGHT

Board Mattresses for Revetment Work—The Blodgett Co struction Co., of Kansas City, Mo., is doing about $45,000 wor of levee and revetment work on the Red River below Shrev port, La., in which the mattress work is made of 1x6-in. boar It is practically impossible to get willows for this work a boards are specified and being used. The boards are wov together, nailed at points of contact, weighted, anchored a sunk as for ordinary mattress work. No difficulty has be experienced so far with the board mattress, and those th have been sunk are filling in a satisfactory manner.

Varied Uses of Pipe—To the engineer a pipe usually mea a conductor for water, sewage, steam or gas. The applicati of pipe at the present day, however, is of remarkable exte It is used in the construction of agricultural implemen automobiles, architectural ironwork and grillwork, buildi columns, refrigerating machinery, dry-kiln apparatus, e vator cars, wheelbarrows, work benches, ornamental gat elevator grain spouts, safety ladders, warship masts, lightn and high-tension poles, electric-wiring conduits, railway-s nal apparatus, sprinkler systems, signal towers, etc. Coi dent with the extended use of tubular products has been only increased tonnage, but also a change in material. F years ago practically all the screw-joint pipe was made wrought iron. The following diagram, made up by the tional Tube Co., shows the effect on the pipe industry of bessemer and openhearth processes of making steel.



GROWTH OF STEEL-PIPE INDUSTRY SINCE 1888

Editorials

igns of Clearing in Concrete-Patent Situation

In each of the last three numbers of *Engineering News* ere has been reported the defeat of a suit for in- ngement of a reinforced-concrete structural patent. is sequence is of course mere coincidence, but the ac- mulation of such cases and the fact that they were decided against the patentee are significant. The es show a commendable though recent tendency to ing such suits to court rather than to settle them by ivate agreement; the decisions indicate either an in- ligent conduct of the defense, hitherto rare in such its, or else a growing understanding by the judges of real nature of reinforced concrete. Perhaps both counsel for defense and the judiciary have been help- iy influenced by one or two of the more recent *causes èbres,* where clear thinking and exhaustive research ve illuminated the history of this new—though in ne ways quite old—structural material.

While there is no essential similarity between the three ents which were recently decided and while the issues on ich they were fought were in the main different, there ms to run through each of the three decisions (ren- ed, it will be noticed, in widely separated districts) same strain of reasoning. It is possible that the y next reinforced-concrete decision will be diametric- v opposite to these; but reading them broadly, one uld say that the judges are beginning to recognize at many engineers have long contended; that is, that arrangement or distribution of reinforcement to meet tain peculiar ideas of the deviser is not invention l therefore not patentable.

It is possible, in view of such decisions, that sooner later the courts will definitely set up the ruling that essential novelty in reinforced concrete is the com- ation of the tensile-resisting steel with the compression- isting concrete in such fashion as to cause the two terials to work together. This idea, of course, is te old. It dates back to the '60's in the design of all objects such as flower pots, little boats, etc., but dates back to the '70's even in the design of large uctures.

The Brannon patent (1874) noted in the Pittsburgh e in this issue is a remarkable example of pioneer nking. The inventor possibly did not realize the stress uirements of the combination of materials, but he st assuredly did realize its structural possibilities. The nbination of metal framework with a cementitious rtar or concrete is illustrated in that patent in many ys. Hooped columns can be found there; a canal educt with slab bottom and vertical sides resting on ms and columns is illustrated; and most extraordinary all, there is a perfect facsimile of the modern hollow nforced-concrete caisson that is cast on shore and ated out into place, there to be filled with concrete l to settle into its location as a solid pier.

Brannon, beyond all doubt, had the essential idea of reinforced concrete as a structural material. His successors devised a theory and elaborated the design; and in the mind of most of the judges recently considering the question such elaboration and amplification do not constitute invention.

It would be foolish as well as dangerous to assume that the several recent decisions against reinforced-concrete structural patents sound the death knell of all such patents. There may be many that are still legally and morally valid. But the recent decisions go far toward putting the whole question of structural patents on a more rational basis.

⁂

The Quebec Bridge Accident and Stress Analysis

Because safety depends on strength of material and its proportioning to stress, calculation of stress is a vital element in engineering and is bound to remain so. It was vital to the accident at Quebec. The bridge rocker casting whose breaking caused the fall of the suspended span on Sept. 11 broke under circumstances where no one knew how high a stress it carried. Both the builders and the Board of Engineers assumed that the stress could not go higher than 20,000 lb. per sq.in., but they had no assurance that it might not be twice as high.

The rocker casting that broke was too weak by its very design. It was unsafe. So also were its three brother rockers. Because one of the four broke it has been called defective—it was rendered weaker than the others by some internal condition. But calling this one rocker defective does not mean that the other three were safe and adequate.

It has been learned that one of the other rockers carried nearly twice normal load, and did so without breaking. This discovery is most noteworthy. In furnishing an illustration of how a structural member may develop very high strength, it supplements the demonstration of low strength given by the failed rocker. It recalls to mind in a warning way the fact that material is inevitably variable. That is why we employ factors of safety, and why we apply large factors to materials whose variations of quality are likely to be large, and smaller factors to more uniform material.

The stress analysis presented on another page brings out the plain hard fact that the rockers at the time of failure were under very high stress. Figuring on neither the most favorable nor the most unfavorable basis of calculation, it is certain that the stress was higher than would be considered safe even in the very dependable rolled steel members of bridges. It was higher than the stress which the engineers of the Quebec bridge permitted in the rolled steel bars of the great chains by which the span was being lifted, although these had been tested so thoroughly that their large factor of safety was amply established.

Moreover, the engineers *knowingly* allowed higher stress in the rocker castings than in the chains, although (by test) the chains could not fail until 60,000-lb. stress was passed, while the ultimate strength of the rockers was entirely problematical. They allowed the high stress to be applied as a tensile stress to a thin projecting edge of a casting, where, if anywhere, a crack might have its origin. Even worse, the thin edge carried its highest stress at the root of a reëntrant right-angle corner of the casting, where the fillet had been notched to make a carefully fitted seat for a centering plate. This edge, also, was the top of the casting, where impurities often gather.

Because the specifications permitted high unit stresses, a fair degree of definiteness of stress calculation was necessary to make them safe; guessing at stresses may be good enough with very low units, but with high units it is a bit like smoking in a powder magazine. In a truss or girder, or even in a single bridge member, the degree of approximation involved in stress calculation is pretty well recognized. The question stands otherwise with parts and assemblages of the kind represented in the shoe support of the suspended span on its lifting girders.

It is the stress calculation for the parts of this support that is under scrutiny, rather than the unit stresses allowed. The units may still be safe if the method of computation is reliable. That is an "if" which the designer must meet, and meet with no hesitation or frivolous conscience. Looking at the method of calculation actually employed, however, the best that can be said for it is that it will hold true under certain conditions not definitely known.

The case of the pin and casting calculations affords a striking illustration of the old question whether a part may be stronger than the whole; whether a piece can be strengthened by cutting away some of it. The Quebec rocker would figure out to be strong enough if its longitudinal bracket arms were cut down one-half in length. Does this justify the conclusion that without such cutting down the part is also strong enough? The question is seductive, and one is tempted to answer yes, on the view that the smaller part is necessarily weaker. But in the case in hand such reasoning is a fatal error.

It happens that elsewhere all stress calculations involving loads of indeterminate distribution, like the pin and shoe reactions of the Quebec span supports, are computed according to much more conservative principles than used there. The pressures are always assumed to be uniformly distributed except where the physical conditions make likely an even more severe distribution. Thousands upon thousands of column bases and bridge shoes are in use throughout the country which were designed in this way, and none of them give any trouble. It is known that in such cases the distribution of contact pressure may be altered by deflection; but it is also known that this action may be nullified by various circumstances in the condition of the surfaces too minute to control readily.

A bald statement of the method of the calculation employed will appear harsh and unfair. Viewed superficially at least, the calculation is absurd, since it plainly tempers the wind to the shorn lamb; i.e., it adapts the load-distribution to the strength of the part, and therefore, while purporting to determine or verify the strength of the part, it does nothing of the sort. The Board's so-called check calculation presents itself as a verification of the strength of the rocker casting; but in reality it is no such verification, by any stretch of reasoning. All it shows is that, to make the shoe safe, the reaction on the base of the shoe ought to be concentrated on the middle half of the shoe length, and to make the rocker safe its reaction ought to be limited to similar ratio. It does not show that either the shoe or the rocker *is* safe. Yet, apparently, the rocker casting was approved because of some indefinite faith that the base pressure would concentrate itself in accordance with the limit which the calculation showed to be necessary. No attempt was made to compe the base pressure to respect this limit.

So the calculation appears on its face, stated without any fuller illumination. As a matter of fact, it does have some show of reason. It contains an assumption made in the design or analysis of certain kinds of structure and known from the results of practice to be safe for them, but never before applied to a rocker support of the kind here in question. The assumption is that a structure which statically might resist in different ways, but where the elastic yielding under the stresses will tend to decrease the divergence of the different methods of analysis, will be safe and adequate if any one of the methods of calculation shows stability or safe stress. This method is used widely in designing masonry arches, and has been so used for many years. It is used less obtrusively in many other cases of engineering stress calculations.

Physical recognition of deflection is, indeed, involved in the Quebec support calculation, but it does not appear on the surface and is not expressed by any direct computations of deflection. The calculation, it will be found on examining it, is at every point conducted in such a way as to be in general *qualitative* accord with the way in which the several parts deflect. Thus, the lower shoe casting, being longer than the pin which it supports, will deflect by the end rising. If at the start, therefore, reaction pressure was distributed uniformly over the base, then by the deflection of the casting the end portion will tend to rise away from the pressure and may conceivably deflect far enough upward to get no upward load at all. This latter condition is what the calculation actually assumes. So throughout the rest of the assemblage.

As to how true the calculation is quantitatively, there is no information. No check computations appear to have been made to see how much the several parts will deflect and whether they will deflect out of contact with each other or not. It is doubtful whether such checks would have been of any value, as the controlling physical conditions are too much in doubt.

The fact is that all stress calculations dealing with indeterminate load conditions like this one rest ultimately on the conscience of the designer, and the resulting design is always more a tribute to the designer's skill and instinctive knowledge than to the merit of his stress calculation. That is the case, too, in the Quebec problem.

Simply regarded, the "stress calculation" for the Quebec rocker support is merely some formal and unimportant figuring to verify minor features of the design. It does not analyze or approve the design, but tacitly accepts the design as adequate and then deduces a few auxiliary figures from it. It is therefore chiefly significant as being an expression of complete faith in the trained eye and sound judgment of the designer who sketched out the proportions of the castings. Unfortunately that faith was not justified by the event.

Nitrogen in Activated Sludge

If a process of sewage disposal could be perfected that ould yield a sludge convertible into fertilizing material t less than capital charges and operating expenses and ithout creating a nuisance, one of the most baffling unicipal problems of the last half century would be lved. One process after another has come to the front ith such a claim and gone its way without making good.

There seems to be general agreement that the new tivated-sludge process of sewage treatment yields a udge that is unusually high in nitrogen, so that it may cceed as a money maker where other processes have iled. Some of the best of the men engaged in activated-udge studies go further and assert their belief that the udge from this process can be rid of its very heavy ater burden and marketed at a profit.

It might be supposed that long before this sewage-udge dewatering would have been established on a und basis. The fact is that the sludge from each new ocess is a law unto itself. The high nitrogen content of e sludge from the activated process is largely offset, as t, by the difficulties experienced in handling a material at is 99% water.

The foregoing and other related facts make very timely e article on the recovery of nitrogen from sewage sludge, William R. Copeland, and the discussion of the subject George W. Fuller and others, presented elsewhere in is issue. The conservative yet hopeful attitude of these aders in sewage-treatment work should inspire others join in the study of the activated-sludge process, ich presents so much, promises and yet still demands much careful engineering, chemical and biological search. Every city with a sewage-disposal problem vith exceptions to prove the rule) may well feel that it under obligation to itself and to other cities to take a nd in activated-sludge experimentation.

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End of Septic Tank Patent

There is no longer any question as to whether the umeron septic tank patent is alive or dead. The United ates patent was granted Oct. 3, 1899, and so it has now pired, regardless of the question of whether it died with e expiration of the British patent in November, 1909.

Some important questions remain to be settled. One these is the real effect of the see-saw decisions obtained the Knoxville, Iowa, and Winchester, Ky., decisions. the first of these cases the court flatly declared that e United States patent expired with the British patent. the second, a contrary ruling was made. The holder the patent claims that the Knoxville decision was on pulation and affects no other city; that the Winchester ling holds throughout the United States; and that gardless of either decision the British patent (or what s left of it after the Saratoga Springs decision) was the process.

Another unsettled question is, What damages could holder of the patent collect by legal process? This in rn hangs on a third and fundamental question. That What kind of tank (septic tank apparatus claims ving been disallowed) produces the septic process? e Saratoga Springs decision, most engineers think, rows very little light on this question. Moreover, hough it is some nine years since the court ordered timony to be taken to determine the damages in the Saratoga Springs case, the amount has never been fixed. This is not all. For several years the holder of the Cameron patents vigorously pressed claims against the United States Government for the use of the septic process. The claims were contested. The next move in these claims, we understand, has now for some years rested with the holder of the patents.

The sum of the whole matter is that the real status of the Cameron septic tank patent has never yet been determined. Numerous cities, counties, states, the United States itself, have ignored the patents. So have public institutions, private corporations and individuals. And so have unnumbered engineers. Seventeen years have passed. The patents have now expired beyond all question. The Saratoga Springs decision was a barren victory for the plaintiff, so far as that village was concerned, for the plant involved has continued in use and no royalties, so far as we can learn, have ever been paid.

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Oil in Engine Cylinders

We have received a report stating that a Nordberg poppet-valve superheated-steam engine in the plant of the Rockwell Manufacturing Co., at Milwaukee, in the month of July, with a total running time of 224½ hr., used only 2 gal. of cylinder oil. Computation shows that 11¾ acres of cylinder surface was lubricated for 1c., which it is claimed surpasses all previous records of economic cylinder lubrication.

There is a very general idea that economy in the operation of steam engines is measured, to some extent at least, by a low consumption of cylinder oil. It may be worth while to inquire whether this idea has any better basis than the fact that money spent for cylinder lubricants is spent outright, where one can see it, whereas the expense resulting from undue economy in the amount of cylinder oil which is used is not seen and hence is generally overlooked. The usual idea regarding the reason for the use of lubricant inside a steam-engine cylinder is that it reduces the wear and cutting of the cylinder surface and rings. In addition to this, however, if one stops to think, there can hardly be a question that it is worth while to lubricate this rubbing surface, like any other rubbing surface in machinery, merely to reduce the loss of power by friction.

The piston rings of an engine are pressed outward against the surface of the cylinder by a considerable force. The load per square inch is moderate, it is true, but the pressure exists nevertheless; and if we knew the coefficient of friction between the metal of the rings and the cylinder surface under working conditions, it could readily be computed just how much power is used up in dragging the rings over the cylinder surface. There is no room for doubt, either, that this loss of power will be greatly reduced if the rubbing surfaces are lubricated, compared with what will exist if they are dry.

Thus, even though it be true that an engine may be run with so little cylinder lubricant that 11¾ acres of cylinder surface may be swept over by the piston rings with the use of only a cent's worth of cylinder oil, the question arises whether it would not have been better economy to have used five times or ten times as much oil and gained in the value of foot-pounds of power saved, enough to pay perhaps ten times or a hundred times the additional expense for oil.

Letters to the Editor

Croton Watershed Area

Sir—I was very glad to see in an article on "Correcting the Area of the Croton Watershed," in *Engineering News* of Sept. 21, that the Department of Water-Supply, Gas and Electricity of the City of New York has at last decided to adopt, as the official figure for the area of the Croton watershed above the new Croton dam, 375 sq.mi., instead of 360 sq.mi., the figure hitherto given in all official reports. The very careful mathematical calculations upon which the former figure is based were made more than 10 years ago by J. Genthon, one of the engineers of the Aqueduct Commission. In preparing the final report of this commission, covering the years 1895 to 1907, I tried very hard to get the correct area of the Croton watershed, mentioned above, adopted, but the then chief engineer refused to do so, on the ground that the published tables of the rainfall and runoff of the Croton watershed had been generally accepted and that he did not wish to cast any doubts on their correctness.

In a recent water-power case I had occasion to use these tables; and when their value was attacked by the experts of the other side, I was unable to maintain that they were accurate, as I knew that they were not, in respect to the area of the watershed.

To show how reluctant some officials are to make corrections when errors are pointed out, I will mention the curious fact that, while the contents of the reservoirs of the Croton water-works, built prior to 1842, were given in Imperial gallons and those of later storage basins were stated in United States gallons, they were added together, in getting the reservoir capacity of the works, without making any corrections for the different units employed. Thus the contents of Croton Lake were given as 500,000,000 gal. when they were really 600,000,000 U. S. gal. When I drew the attention of the chief engineer of the Water Department to this matter, he was unwilling to change the figures, because he did not wish to make any changes from former reports.

Of course, it will involve considerable work to recalculate the runoff of the Croton watershed; but when that is done, the Croton rainfall and runoff tables will be accurate and valuable, which they are not in their present incorrect state.

E. WEGMANN,
Consulting Engineer.

Park Row Building, New York City, Sept. 22, 1916.

Sir—I have read with gratification your article in your last issue, entitled "Correcting the Area of the Croton Watershed." In 1888, when the late William E. Worthen was acting as consulting engineer, on his recommendation the writer was employed by the Aqueduct Commission to make a careful resurvey of the entire Croton watershed, and the work was prosecuted by the firm of Vermeule & Bien.

On the completion of this survey in 1889 a careful geodetic computation of the area was made by me in just the manner described by Mr. Brush as having bee pursued in 1909. The results have been given by M Brush as of that date.

It will be remembered, however, that the Aqueduc Commission and the Department of Water-Supply wer distinct organizations at that time. The records of rainfall and runoff were kept by the department, which continued to use 338.8 sq.mi. The writer did not have dire knowledge of the later inside history of this matter, bu observed that the old incorrect figures continued to b used, the result being that all precipitation records give in inches in the catchment or in second-feet per squa mile, even those contained in the careful computatio made by Mr. Freeman, were too large to the exte of 4.4%.

In my "Report on Water-Supply," made to the stat geologist of New Jersey in 1894 (page 53) I gave th correct area above the old Croton dam to be 353.1 sq.m Again in my report of 1899 (see page 146, "Annual R port of the State Geologist of New Jersey"), I stat that the survey made by me showed the area to be 35 sq.mi.

Once, when attempting to correct the error pul licly, I was severely chided for my presumption by a eminent engineer, who assumed I was reflecting on t late Alphonse Fteley, whereas he and Mr. Worthen ha stood sponsor for the survey made by me. Being ve busy with other matters, I did not enter into an e tended controversy, concluding that truth would be stro enough to take care of itself, but the sequel proves th it has needed the help of Mr. Brush.

The fact that the original measurement, made by pla survey, agrees closely with the geodetic computation i dicates merely a balancing of errors.

C. C. VERMEULE.

220 Broadway, New York City, Sept. 26, 1916.

NOTES AND QUERIES

The Bridge-Erection Disaster at Quebec is the subj of an inquiry by S. R. B., Dyersburg, Tenn., who writes:

Was the loss complete so far as the material and constru tion were concerned, or was insurance carried for protectio in case of accident to the span?

According to our information, the contractors had mari insurance on the suspended span during the time while was floating on the scows. This insurance terminated, ho ever, when the feat was successfully accomplished of tran ferring the load from the scows to the lifting chains. T loss of the span therefore is not covered by insurance.

Screens for a Water-Works Intake are desired by a corr spondent in Michigan, who writes: "We are figuring on buil ing an intake crib in a shallow river for a 24-in. suction l feeding our cold well. We want to get hold of three inta screens, each one capable of supplying the line with wat The intake fittings should be so arranged that they may closed, screen removed and cleaned, then reopened. Also case we wish to, all three may be closed and the intake pump out for purposes of repair or inspection. While it is quite simple matter to design such a fitting, we felt that there a surely some standard designs on the market, hence our app for information as to the manufacturers."

Nitrogen from Sewer Sludge Plain and Activated*

By William R. Copeland†

SYNOPSIS—A review of the possibilities and difficulties of recovering nitrogen from sewage sludge, with special reference to the activated-sludge studies at Milwaukee. There follows an abstract of some discussion by George W. Fuller and other engineers.

The answer to the question as to whether it is or is not ·acticable to recover the nitrogen in sewage and sewage udge will depend upon three factors: (1) The amount of trogen contained; (2) the cost of recovering and dis- ›sing of the nitrogen; (3) the market value of the trogen.

Recovery of nitrogen, from the standpoint of this paper, s to do principally with the nitrogen in suspension, cause that is the portion which appears in the greatest antity in the sludge. The total obtained will vary th with the treatment process used and with the volume ntained by the raw sewage (see Table 1).

TABLE 1. COMPOSITION OF DRY AND 10% MOISTURE SEWAGE SLUDGE

On the Basis of Dry Sludge*

Source of Sample	Sludge Obtained from	% of Nitrogen
ankfurt-am-Main	Plain sedimentation	2.85
lumbus, Ohio	Septic tank	1.40
sen	Imhoff tank	1.22
lladelphia	Imhoff tank	1.20
›rcester, Mass.	Chemical precipitation	2.77
Sludge Computed on Basis of 10% Moisture†		
ooklyn (Williamsburg)	Dickson (yeast) process	1.4
lumbus testing station	Grit-chamber sludge	1.2
	Plain sedimentation tank	1.6
lladelphia testing station	Plain sedimentation tank	1.2
·veland testing station	Plain sedimentation	1.4
	Septic tank	1.3
	Imhoff tank	1.2
›versville testing station	Plain sedimentation	2.3
	Septic tank	2.2
›rcester, M. & E., Vol. III	Plain sedimentation	2.7
	Septic tank	2.7
anta	Imhoff tank	1.5

*From Vol. 2, Metcalf & Eddy's "American Sewerage Prac-." †Data compiled by J. R. McClintock, Consulting En- eer, New York City.

The gist of the data given in these tables is that the dge which has been obtained heretofore by the best own processes of sewage treatment contained from 1.2 3% of nitrogen. These figures are low and show that sludge did not possess as much nitrogen as the ount contained by the raw sewage would lead us to ect. This condition may be explained by the fact that rge share of the colloidal matter carried by the sewage out in the tank effluent and took nitrogen with it; in the case of chemical precipitation works the lime led drove nitrogen off in the form of ammonia and uted the portion remaining by increasing the amount inert mineral matter. Moreover, various authors te that from 10 to 60% of the volume of the ids deposited by sewage in the sludge-digestion cham- s of Imhoff tanks and other forms of septic tanks is verted into soluble or gaseous form. Much of the albuminoid ammonia is thus changed into free ammonia and free nitrogen, which escape in the liquor or bubble out at the gas vents.

Within the last two years, however, a new method of sewage purification by the so-called "activated sludge" process has been tried out in various cities of America and England. One of the distinctive features of this process is that the colloidal and suspended matters of the sewage are collected in the sludge. If this is not reaërated or overaërated, the solids are not liquefied to such a large degree as they are in septic tanks, and therefore the nitrogen does not escape.

For example, the digested sludge accumulates in Imhoff tanks at a rate of from 4 to 10 cu.yd. per million gallons of sewage treated, whereas by the activated-sludge process 20 to 80 yd. or more may be deposited in the settling tanks, varying widely, of course, with the strength of the sewage and the water content of the sludge.

The Milwaukee sewage-testing station carried on a series of experiments during the summer of 1915 where the city sewage was treated by the Imhoff and activated-sludge processes simultaneously (see Table 2).

TABLE 2. ANALYSES OF MILWAUKEE CITY SEWAGE BEFORE AND AFTER TREATMENT

By Imhoff Tank and by Activated Sludge

		Parts per Million						
			Nitrogen as					
			Ammonia					
Period of Test, 1915	Source of Sample	Suspended Matter	Free	Albuminoid	Organic Nitrogen	Nitrite	Nitrate
August	Sewage	253	14.6	7.88	29	0.15	0.13
	Imhoff effluent	105	16.2	6.10	27	0.19	0.13
	Activated-sludge effluent	14	3.8	3.19	6	0.29	6.00
September	Sewage	300	13.5	8.81	29	0.25	0.14
	Imhoff effluent	116	15.4	7.10	27	0.12	0.09
	Activated-sludge effluent	8	5.7	2.22	9	0.24	5.01

Samples of digested sludge from the Imhoff tank and of the fresh activated sludge were also collected and analyzed in August and September (see Table 3). While it is not correct to say that these sludges represent all of the raw sewage passed through these tanks during August and September, it is fair to assume that they are typical of the sludge that was being produced by those processes at that season of the year.

TABLE 3. ANALYSES OF SAMPLES OF IMHOFF AND ACTIVATED SLUDGES OBTAINED FROM MILWAUKEE SEWAGE

Date, 1915	Source of Sample	Nitrogen Reported as NH_3 on a Basis of Sludge Dried to 10% of Moisture
August	Imhoff sludge	2.87 3.82
	Activated sludge	5.71 4.97 7.04
September	Imhoff sludge	3.88
	Activated sludge	8.69 9.00

The data given in Table 2 show some interesting facts. For example, the Imhoff effluent contained on an average more than 100 parts per million of suspended matter, whereas the effluent from the activated-sludge process contained only about 10 parts per million; the Imhoff effluent contained more free ammonia than the raw sewage, whereas the activated-sludge effluent contained only one-third as much. The Imhoff effluent contained almost as much albuminoid ammonia as the raw sewage, whereas the activated-sludge effluent contained only about one-third as much. The Imhoff effluent contained almost as much organic nitrogen as the raw sewage, whereas the activated sludge contained only one-third as much.

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*Slightly condensed from a paper entitled "Is the Recovery the Nitrogen in Sewage Sludge Practicable?" read before Division of Water, Sewage and Sanitation of the American ·mical Society, Sept. 28, 1916. An abstract of the discussion ows.

†Chemist in Charge, Sewage Testing Station, Milwaukee,

What became of the nitrogen carried by the sewage? Evidently most of the nitrogen in the sewage treated by the Imhoff tank passed out in the suspended and colloidal matters carried by the effluent. The activated-sludge process, on the other hand, converted the free ammonia into nitrate and stored up the undissolved albuminoid ammonia and organic nitrogen, as indicated by the large amount of nitrate in the effluent and high nitrogen content of the activated sludge.

In short, analyses of this material when dry show that activated sludge contains from 4 to 4½% of nitrogen, and sludge from certain industrial plants, such as packing houses, may carry even more.

When it comes to recovering this nitrogen, however, we meet with a serious difficulty, because as the sludge gathers in the settling tanks it contains from 98 to 99% of moisture and the bulk of this water must be removed before the dry material can be sold for fertilizer.

The best information now available points to a combination of settling and decantation as a preliminary dewatering process. By this means the water will be cut down from about 99 to 96%. On passing the concentrated residue through a pressure filter the moisture can be cut down to 75%. The press cake can be dewatered in a drier to 10% of moisture or less. More than 30 samples of activated sludge have been dewatered by sedimentation, decantation and pressing at Milwaukee.

It is an interesting and notable fact that two different types of press can handle the settled sludge without requiring the addition of lime. The sludge is not as gummy as was expected, and it presses fairly easily down to 75% of moisture.

In order to try out the feasibility of further dewatering the sludge four samples of the press cake were sent to fertilizer plants and dried there on a commercial scale. Three of these tests were made in a steam-jacketed (indirect-heat) drier and one in a semidirect-heat drier. In each case the tests proved to be successful from three standpoints: (1) The sludge dried readily to a satisfactory mechanical condition; (2) the processes did not require much power; (3) little nitrogen, if any, was driven off or lost by drying. From the mechanical standpoint, therefore, the recovery of nitrogen in sewage sludge is practicable.

With regard to the question of cost, however, the situation at the time of writing is not so clear. The pieces of apparatus used for settling the raw sludge and drying the press cake were not designed to handle activated sludge in the most economical manner, but were requisitioned as being the best commercial apparatus available at the time.

By comparing the behavior of activated sludge with such matters as packing-house tankage I estimate that this sludge can be dewatered so that the recovery of the nitrogen in it will probably cost, upon present evidence, about $8 to $12 per ton of material containing 10% of moisture, depending upon a variety of local factors. These figures are intended to cover interest charges, depreciation, repairs and renewals, and a liberal provision for labor and fuel, as well as the cost of resettling and decanting of the water of the original sludge, and expens for handling, freighting and marketing the finished product. Obviously, the total cost per ton will be somewha more in the case of a small plant than for a large one. Fo a very large plant, where fuel and labor are relativel cheap, it is possible that further experience will reduce th cost below the lower limit in the range here given.

Analyses of dried samples of sludge are given i Table 4. They indicate that dry activated sludge (basi of 10% moisture) will contain 4.6 to 5% of nitroge figured as ammonia and 0.6 to 0.7% of available phosphoric acid. In addition to this our data show that th dry product contains about ¼ to ½% of potash and fro .5 to 1% of fatty material. At present prices the nitrogen is worth $2.50 per unit (or per cent.). In norma times this nitrogen would be worth about $2 per un The phosphoric acid is worth about 50c.; and the potas may be worth something in the future, although the be that can be said of it at present is that it will assure fo the fertilizer a more ready sale.

TABLE 4. ANALYSES OF COMMERCIALLY DRIED ACTIV ATED SLUDGE, MILWAUKEE

Basis of 10% Moisture*

Sample No.	Character of Drier	% of Nitrogen as Ammonia	% of Available Phosphoric Aci
1	Semidirect heat	4.36	0.70
2	Indirect heat	4.76	0.81
3	Indirect heat	4.56	0.47
4	Indirect heat	5.06	0.39
	Average of four samples.....	4.68	0.57

*Additional analyses for percentage of nitrogen as am monia on the 10% moisture basis showed the following result the dates being dates samples were collected: May 3, 1916, 5.7 June 20, 1916, 4.65; June 13, 1916, 4.88; June 14, 1916, 4.9 June 16, 1916, 5.01.

The fat present in the Milwaukee sludge is negligibl It would not pay to recover the fat, nor will the fat injur the selling qualities of the dried sludge.

SUMMARY

Summing up the whole situation, then, we see tha the dried sludge has a market value upon present figure of $9 to $15 per ton of material containing 10% moistur The total cost of getting this product and placing it o the market will probably run from $8 to $12 commerciall per dry ton, depending upon local conditions. For larg plants this cost may possibly be reduced as a result further experience.

The activated sludge containing 4% or more of nitrogen is much nearer a commercial possibility than th sludges obtained by the older methods of treatment, suc as chemical precipitation, septic tanks, or the Imhoff process, which the data given in Table 1 indicate to contai only 1½ to 3% of nitrogen.

In case the question arises as to the possibility of finding a market for the dried activated sludge it should b added that raw materials containing nitrogen, phosphor acid and potash are capable of being worked up readi as a base for making high-grade fertilizers; and as the are not very plentiful, they are in good demand.

Presumably, however, large cities, such as New Yor Chicago and others, by installing this activated-sludg process would produce so much raw material of this cha acter that the product would have to be parceled o among a number of manufacturers. It is even possib that the production might be sufficient to reduce t price. However, the dried sludge is a good fertilizer ju as it stands and contains enough value to pay for sa and distribution in quite a large local market.

Discussion of Copeland's Paper on Nitrogen Recovery

By George W. Fuller*

Experience showed years ago that plain sedimentation removes about one-third of the total organic matter in ordinary sewages and that chemical precipitation removes about one-half. That which is removed by these tankage treatments normally appears in the accumulated sludge. The balance passes out of the tank with the effluent. Table 2 of Mr. Copeland's paper shows that with the activated-sludge method the removal of organic matter is in the vicinity of 70%. This seems perfectly logical in comparison with the results of plain sedimentation, owing to the fact that the activated-sludge treatment removes colloids and other nonsettling organic matters.

When we consider the nitrogen content of Imhoff tank sludge, and the same would be roughly true for sludge of single-story septic tanks, it is necessary to recognize clearly, as pointed out by Mr. Copeland, that there is a material reduction in organic matter, due to the liquefaction and ultimate gasification of organic matters in a form permitting their direct release into the atmosphere. Obviously, septicization must mean a loss of the nitrogen content and hence of the fertilizing value of sludge.

On the other hand, activated sludge, reinforced with he nitrogen content of colloidal and nonsettling matters, s not only spared the loss of nitrogen, but is actually able o show a substantial gain in nitrogen as a result of conaining some of the more or less oxidized nitrogen. The emoval of free ammonia (Table 2 of Mr. Copeland's aper) is quite striking. Part of it doubtless passes to itrates, but it would be interesting to know what portion f it becomes available for fertilizing purposes by adhernce to the solid sludge as dried.

Nitrogen Content of Dry Activated Sludge

Figured on a commercially dry basis (10% moisture). Ir. Copeland's average figures show a nitrogen content hat may be compared with some other data from activated-sludge tests as follows:

	Nitrogen
ilwaukee data (Copeland)	4.40
lanchester, England (Arden)	4.60
alford, England (Melling)	3.75
rbana, Ill. (Bartow)	3.5 to 6.4
rmour & Co. (Noble)	4.6
nglish range (Fowler)	4.0 to 6.0

These figures are expressed in terms of nitrogen and not f ammonia, as seems to be the custom in speaking of the omposition of tankage from garbage works. Nitrogen is only 2% of the ammonia content. Many published analyses refer o absolutely dry sludge, whereas most of the recent data efer to commercially dry sludge with 10% of moisture.

From a commercial standpoint it is highly important to now whether the analyzed samples of sludge are representtive or not of the annual output of the plant. Where sewage om a separate system of sewers is treated, this is not so ital a matter as in the instance of the sewage from combined ewers, where the amount of mineral detritus is bound to ary materially. Obviously mineral matter dilutes the organic udge with inert material which, pound for pound, costs as uch to dry and prepare for the fertilizer trade as in the ase of organic matter free of street wash and industrial astes.

Dewatering in Three Stages

It is an altogether different matter to dewater activated sludge obtained from a settling tank in a flocculent ondition and mixed with 99% of water than it is to deal ith Imhoff sludge containing 87% of water and mixed ith gas, so distributed as to cause practically all of the olid matters to rise and allow the withdrawal of subnatant water.

Clearly, the first step is to resettle and remove by decantation as much surface water as practicable, as described by Mr. Copeland. This, he says, at Milwaukee allows them to get sludge of about 96% water content. To carry this resettling far seems to be impracticable, owing, among other things, to the fact that the activated sludge after settling and during storage seems to undergo putrefaction within a period of 24 hr. or less. Further aëration for 4 or 5 days would make this settled sludge nonputrescible, but this treatment results in the consumption of a substantial portion of the available nitrogen.

The real problem is to dewater this resettled product. The speaker has given a good deal of attention to this matter recently and offers comments concerning the two latter stages of dewatering, as follows:

Dickson Process for Second Dewatering Stage

Mr. Copeland describes the use of Worthington presses for reducing the water content from about 96 to 77%. Based on general experience, it will cost for a fairly sizable plant about $3 per ton of absolutely dry solids for pressing. For commercially dry sludge with 10% moisture this figure would be about $2.70 per ton. This makes no allowances for interest, depreciation or overhead charges.

It occurs to the speaker that perhaps the Dickson yeast fermentation process might accomplish this result at a much lower figure, although he is not prepared to give any cost data at present. Within the past few months he has had opportunity to investigate, in behalf of New York bankers, a test plant built in Brooklyn under the eastern end of the Williamsburg Bridge for treating about 500,000 gal. of sewage per 24 hr., according to the Dickson process which was originally installed at Dublin, Ireland. The sewage is subjected to plain sedimentation in hopper-bottom tanks from which the sludge is removed at intervals and a portion of the water removed by further sedimentation. This sludge, with 92 to 96% of water, is mixed with about ½% of brewers' yeast and allowed to ferment for about 24 hr. in long, narrow, round-bottom, sloping tanks, which are jacketed and kept heated to about 90°. Anaërobic bacteria decompose the yeast cells and cause the sludge to become so mixed with entrained gases that the solid matters rise to the top in a manner similar to that noted with Imhoff tank sludge, and a fairly clear subnatant water is removed through a perforated pipe at the bottom of the tank. The water content of the remaining sludge averaged about 80%, according to analyses made by Hill and Ferguson, but some samples showed 75%, which, with improved devices could probably be obtained regularly.

No activated sludge has been treated at this plant, which has been shut down for several weeks pending changes. It is proposed to treat activated sludge as soon as material may be obtained from the Brooklyn testing station. So far as known, there appears to be no reason why activated sludge cannot be dewatered by the yeast fermentation process in a manner similar to that experienced with the sludge of plain sedimentation tanks, as is being installed on a large scale by Mr. Watson at Birmingham, England.

Sludge-Drying Possibilities

Mr. Copeland refers to both indirect-steam driers and direct-heat driers, with results that promise practical success for reducing the water content from about 75 to 10%. Much weight should be attached to the fact that success has attended the drying of wet products in other industries, such as garbage tankage and refuse from stockyards, packing plants, etc. To drive off 4 to 6 lb. of water with 1 lb. of coal seems to be attainable with the devices now on the market. Some manufacturers seem willing to guarantee a removal of 10 lb. of water for 1 lb. of coal. A test guarantee of 8 lb. evaporation seems reasonable, according to the conclusion arrived at in the office of the speaker, but in practice it would probably be wise to make some allowance for waste heat, which is characteristic of all plants of this general character.

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*Consulting Engineer, 170 Broadway, New York City.

Whether or not it would be worth while to use an indirect-steam drier for removing a portion of the water and then finish the drying in a direct-heat type of machine is a point perhaps worthy of discussion and upon which the writer has reached no final conclusion.

Other Related Discussion

Sewage-treatment processes, said R. S. Weston, come and go, giving satisfactory effluents, but the sludge problem remains. Driers seem practicable, presses doubtful. The speaker is coming to the conclusion that all the dewatering must be done in one process.

In the course of a paper on activated sludge, presented at the same session, George T. Hammond, Brooklyn, N. Y., made some remarks pertinent to this discussion. Although dewatering apparatus, he said, has long been used in many industries, it has yet to be adapted to sewage sludge and particularly to activated sludge. The possibilities of a partial dewatering by long-continued aëration of activated sludge in the lower chamber of a tank of the Imhoff type are being studied at Brooklyn with good promise. The water is withdrawn from the upper chamber. As the process is continued the volume of sludge to be reaërated grows less.

In concluding the discussion Mr. Fuller said that Mr. Weston's ideas on drying were good, but that drying would probably cost more than pressing.

* * *

Another Reinforced-Concrete Patent Decision

By Edward Godfrey*

A patent suit has just been decided which, if it had been successful for the patent owner, would have meant more to the reinforced-concrete industry than all the other patent cases rolled together and multiplied by a large figure. It was decided against the patent owner.

The Schenley High School of Pittsburgh is a large million-dollar structure just being finished for occupancy. The construction is a combination of steel columns, some steel and some reinforced-concrete girders and beams, and reinforced-concrete slabs, including rib and tile floors for the wider spans. There is also a counterfort retaining wall.

The writer made a complete review and re-design of the structural work. One act of this re-design was to throw out many tons of stirrups. Not a shear member was left. Diagonal tension was provided for in all beams and girders by bending up main tension members and either bending them down again over the supports for anchorage or running them into the next girder or beam to serve the double purpose of anchorage and tension reinforcement across the support for the next beam. By one of those ironies of fate this design, that had been completely swept of all loose shear members, was the target at which a patent owner aimed, whose main claims are for unattached shear rods.

Claims of the Patentee

Frederick Melber, to whom the United States Patent Office granted patents Nos. 660, 518 and 672, 175, in 1900 and 1901, respectively, entered suit against the contractors, Thompson-Starrett Co., the School Board, and Edward Stolz, the Architect of the Schenley High School, for infringement of his patents. Sample claims of his patents are the following:

> In cement or concrete construction metal reinforcing bars. unattached at their ends to other metal reinforcing bars, imbedded therein transversely to the calculated shearing strains, and other metal reinforcing bars imbedded in said construction to resist the tension strains. . . .
>
> An anchor for cement or concrete construction consisting of a member imbedded in the soil in line with the direction of the thrust to be counteracted and a rod or rods fixed to said member and partially imbedded in the base of said construction. . . .
>
> In cement or concrete construction, two or more girders: metal rods imbedded in said girders along the lines of the tension strains; other metal rods, unattached at their ends, imbedded in said girders transversely to the shearing strains, and floor slabs connecting said girders. . . .
>
> In cement or concrete construction, a wall of cement or concrete; brackets attached to said wall and metal reinforcing rods imbedded in said construction.

If these claims mean what they appear to mean on their face, every building having unattached stirrups, every beam and slab building having like shear members in it, every piece of construction that is anchored to a base by bolts or rods, every counterforted retaining wall built in the last sixteen years would have to pay tribute to Frederick Melber.

This case is illuminating in many ways. It shows what may happen to the innocent bystander in the person of an unoffending contractor when a patent suit bomb explodes. These contractors were put to the expense of thousands of dollars because the United States Patent Office did some clumsy work in granting a patent to a man for things that were described, and even patented in the United States, long before he made application for his patent.

Such things ought not to be. The Patent Office ought to be compelled to invalidate a patent when it can be shown, by interested persons, by citing references and by argument, that there is no novelty or no invention exhibited in the specifications or the claims. The only expense this should place on the interested persons should be that of their own search or possibly a nominal fee to prevent incessant opening of cases for such arguments. It should be done by the Patent Office examiners and not by the slow and cumbersome methods of the courts.

It will no doubt be instructive and useful information for readers of this journal to record here the anticipations of Melber's alleged invention, as brought out in this suit, also to state some of the history of the case.

It is doubtful if one reinforced-concrete engineer in a thousand ever heard of Melber and his patent, though they have been infringing his patent claims for nearly the whole life of his patents, which expire in a year or two.

The wording of the Melber patent and the testimony of Mr. Melber, who was his own expert witness, all show clearly that he has the primitive idea that steel rods n concrete can act effectively to take shear between sucessive layers of concrete. In his testimony he was asked, Did you ever hear of what is called diagonal tension in beam?" His answer was: "That is wrong. Whoever ays that there is diagonal tension doesn't know anyhing." The patent drawings show short, loose shear embers. Though the bent-up rods in the high school cted to take diagonal tension and were not designed or shear, and though they acted at the same time as ain tension reinforcement, both in the middle of the eams and over the supports, Melber claimed that they lled his description of unattached shear members beause, forsooth, there were two ends somewhere to the ng rods, that were not attached to anything.

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*Monongahela Bank Building, Pittsburgh, Penn.

A thing that no doubt gave much hope to the comlainant was shown in one of his exhibits. A sketch from he contract plans was taken which showed a header suporting rib and tile construction. In each rib was shown vertical line indicating in foreshortened view the long einforcing bent-up rod. The tiles were indicated by two iagonal lines in the ordinary conventional way. Of ourse the tension rod was shown in the header. This iew, in the "Exhibit" had the vertical and the diagonal nes marked "shear rods." Of course these lines did not epresent shear rods, but this blunder probably had much o do with the bringing of the suit and the large needss expense on unoffending parties.

ANTICIPATING PATENTS CITED

One of the patents that anticipate Melber's is the nglish Patent No. 28, granted to Hyatt in 1877. This hows clearly steel reinforcement used for tension near he bottom of a concrete beam, also compression bars ear the top; also a tension bar bent up near the ends f beam; also flat tension bars having upright bolts or ins through holes in the flats, the forerunner of the tirrup, which many consider as a member that carries he increment of horizontal shear to the tension bar.

Another anticipation is in U. S. Patent No. 206,112, lyatt, 1878. Reinforced-concrete beams and slabs are hown with straight tension bars near the bottom, also he combination of beam and slab.

In English Patent No. 2,128, granted to Brannon in 874, reinforced concrete, among other things, is decribed. Steel reinforcement in cement concrete is one f the things covered by this patent. Brannon states, I also dispose the great strength of the tension work in he plane in which tension forces act in the structure." Melber goes to great length to describe his construction s so reinforced that tension steel is placed in the exact osition of the resultant tension in the concrete. Brannon shows a counterforted retaining wall among the lifferent classes of construction, reinforced throughout vith steel. Brannon also shows floor slabs and girders ombined.

It is interesting to note in passing that Brannon decribes what is practically a hooped column, for it has steel mesh near the surface; also that Hyatt shows a real ooped column, the hooping being flats in circular shape, he wider dimension being horizontal; upright rods pass hrough holes in the flats. Thus the hooped column, which some claim to be covered by a patent granted in his century, was anticipated back in the '70's.

U. S. Patent No. 472,277, granted to Sickels in 1892, hows bridge piers anchored by means of a well extending below the pier and a rod in the well, which rod extends up into the pier, the well being filled with concrete. This is precisely the kind of construction used in the Schenley High School. The "wells" were holes made by driving steel shells into the ground (Raymond piles). Rods were let down into these and concrete was poured around the rods. A short portion of the rod extended up into the footing.

U. S. Patent No. 590,690, Small, 1897, shows anchorage of an arch at the abutment, similar to Melber's patent No. 672,175.

U. S. Patent No. 607,223, De Man, 1898, shows reinforcement somewhat similar to the Schenley High School construction, though some of his features were not made use of.

U. S. Patent Nos. 611,907 and 611,908, Hennebique, Oct. 4, 1898, shows construction similar to that of the Schenley High School, though the stirrups shown by him were entirely omitted in that building.

U. S. Patent No. 611,909, Hennebique, Oct. 4, 1898, shows a pile having upright rods, which rods project above the top of the pile. This is similar to the high school construction and anticipates Melber.

The *Deutsche Bauzeitung* of Dec. 15, 1894, p. 621, describes and illustrates a test made in 1893 on a wall with a vertical and a horizontal slab joined by triangular brackets as counterforts, practically identical in shape with the retaining wall used in the Schenley High School, and with reinforcing rods used in the bracket, all of which is claimed as an invention by Melber. Furthermore, this same wall had an anchor into the ground similar to that claimed by Melber. An L-shaped wall on the same page is also anchored similarly to Melber's claim.

JUDGE'S DECISION AGAINST PATENT

Judge J. Orr in his opinion, in which he declares the patent invalid, pointed out the fact that while earlier inventors made no attempt to locate the exact position of reinforcing rods nor to reason out just why rods are placed in certain positions, the inclusion of such reasoning and explanation in Melber's specifications does not constitute invention and does not give him a patent right on these earlier inventions. To quote Judge Orr, "A man is not entitled to a patent for a structure which is old just because he determines the reason why the structure should be used. Why straw was necessary for the making of bricks by the Egyptians or why cow hair was used in mortar where large surfaces were to be covered, may not have been scientifically observed by those who first engaged in the practices, but none the less their anticipations should prevent the granting of a patent to one who is able for the first time to scientifically state the reason for such uses."

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Concrete Electric Conduits are coming into extensive use, reported the Committee on Underground Construction of the National Electric Light Association at the recent convention in Chicago. Single-duct pipe is used, with the following standard dimensions: Length, 5 ft.; internal diameter, 3½ in.; wall thickness, ⅝ in. Split bends and straight lengths are made as specials. When laid, adjacent lengths are held in place by a sheet-iron band fitting over the ends. A minimum of 1 in. of concrete is laid between ducts and between layers. It is reported that cable burnouts are not communicated to other ducts, as often is the case with vitrified-tile conduit. The cost is about the same as for clay-tile construction.

News of the Engineering World

Creosoted Timber Floor Fire Racks Missouri Bridge

The floor of the highway bridge over the Missouri River at St. Charles, Mo., caught fire on Sept. 26 and practically the whole floor of the bridge and the east approach trestle were destroyed. This bridge was built in 1903 to carry a single-track interurban line and a highway. It consists of four main truss spans, three of which are 416 ft. long and one 300 ft. long, approached on the east end by a 160-ft. deck span (Fig. 2) and a timber trestle and on the west end by a timber trestle. The main line of the Missouri, Kansas & Texas R.R. passes under the west end of the bridge just outside of the last pier.

The floor system consisted of 4x16-in. timber stringers spanning the floor-beams. On top of these stringers were 6x8-in. cross-ties 20 ft. long on which were laid 3x10-in. longitudinal planking with about 2-in. open spaces and a diagonal plank floor. Two years ago the top floor planks were renewed and the floor was relaid with creosoted timber.

About five o'clock in the afternoon of Sept. 26 fire was discovered in the wooden floor system over the tracks of the railroad at the west end of the bridge. In spite of

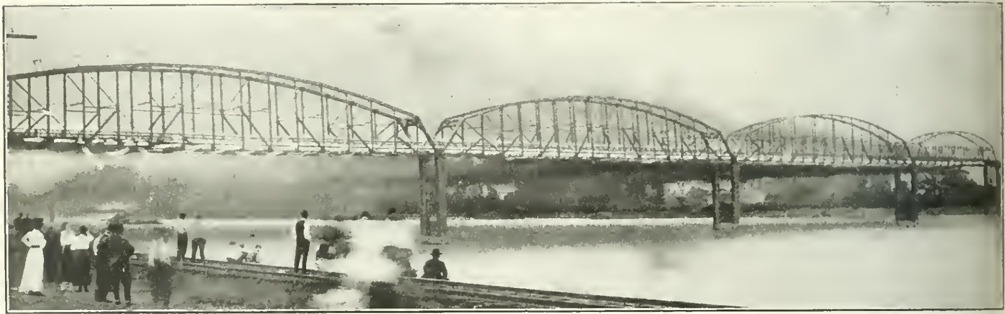


FIG. 1. LOOKING AT THE SOUTH SIDE OF THE ST. CHARLES BRIDGE DURING THE PROGRESS OF THE FLOOR FIRE

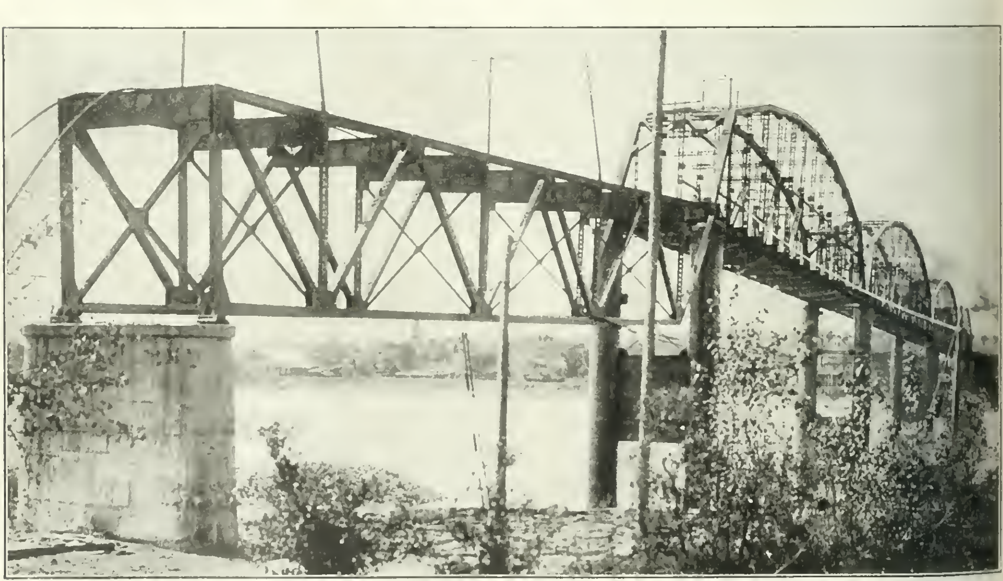


FIG. 2 LOOKING WEST ACROSS THE RIVER AFTER THE FIRE ON THE BRIDGE

Note tipped truss shoe in left foreground at west end of bridge

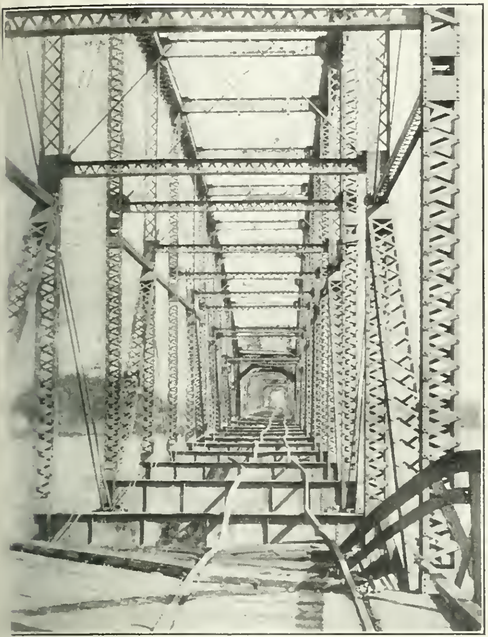


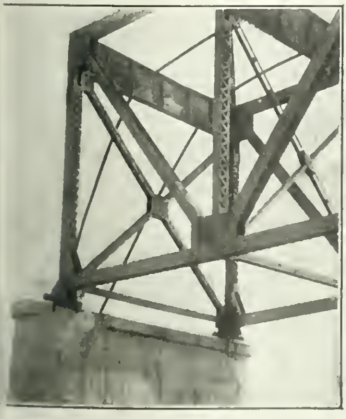
FIG. 3. THROUGH THE TRUSSES AFTER THE FIRE

ıckling of the north posts and diagonals may be noted on the left-hand side of the bridge

e efforts of the local fire department d some equipment from St. Louis, hich is 20 mi. away, it was appar- tly impossible to stop the flames. The nd at this time was blowing steadily om the southwest and drove the flames ry strongly against the north truss. ie fire was also carried across the bridge the diagonal winds and by ten o'clock at night the whole floor system, with e exception of a short piece at the west end. and the whole of the east timber trestle were completely destroyed. It is supposed that the fire caught from a spark from a locomotive under the bridge which lodged in some dry rot material at the corners of the old timber stringers and was whipped up by the wind until the creosoted floor took fire.

An examination of the damage is being made by Ira G. Hedrick, the consulting engineer of the original construction, but Mr. Hedrick has not as yet prepared an estimate of the cost of replacement. The accompanying views show some of the damage. It will be seen that the wooden structure is entirely gone and that the steelwork is quite seriously damaged in places. The south truss is apparently uninjured, but the bottom chords in the lower portion of the uprights of the north truss, which was subject to the more severe heat, are badly warped, some of them being bent to a letter S. Where the circles are on Fig. 4 the most serious buckling may be noted.

An interesting feature of the effect on the steelwork is the fact that the bottom chord members are also warped, and the anchor bolts on the piers of the short deck span have been pulled out, apparently by contraction. This is shown in Fig. 5. Whether this action is due to the suspension and contraction of the truss under the heat or whether the falling pieces spalled the concrete so that there was not sufficient bearing to hold the bridge is not known. Damage is estimated at $250,000.



ıG. 5. EAST PIER AFTER THE FIRE, SHOWING SPALLING OF PIER AND MOVEMENT OF SHOE

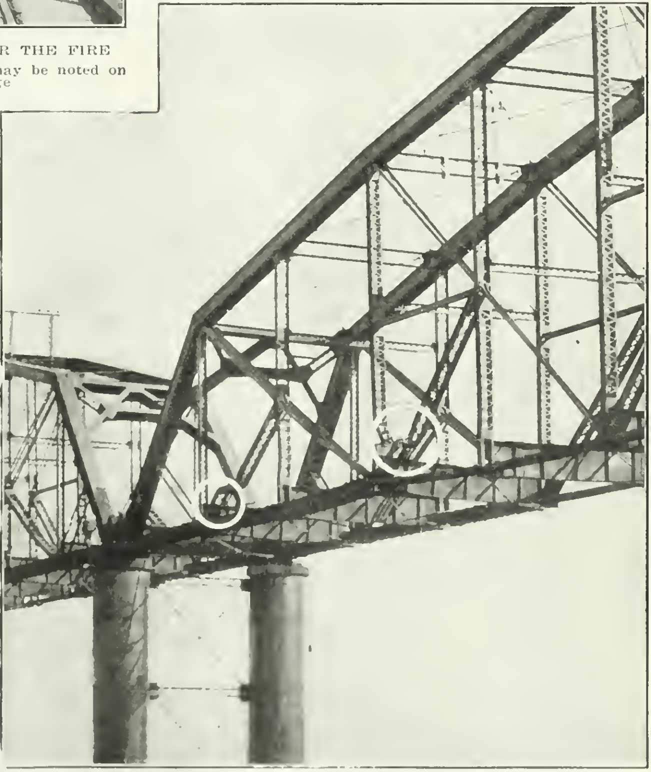


FIG. 4. CLOSE-UP VIEW SHOWING SERIOUS BUCKLING OF MEMBERS ON NORTH TRUSS

Circles indicate the points at buckling

An Organization of Engineers for Public Service

A luncheon was given by William L. Saunders, Chairman of the Ingersoll Rand Co., in New York City on Sept. 28, to consider plans for the formation of an organization "to bring the engineer forward to a position of influence in the affairs of government." Those present at the luncheon included the presidents and secretaries of the national engineering societies and the American Chemical Society, with a number of other well-known engineers.

The underlying thought on which the discussion at the luncheon was based was that a complete nation-wide organization of engineers has been created by the Naval Consulting Board, through its committee on Industrial Preparedness, and has demonstrated the value of the expert service of engineers in connection with the Government's needs. Ought there not to be a permanent organization of engineers, free from the rules and regulations which govern the professional societies, which could make its voice effective when Congress is considering such questions as conservation of natural resources, mining laws, railroad regulation and other questions which call for national and state legislation?

Various opinions were expressed in the discussion which followed the luncheon as to the best methods by which coöperation among engineers to effect the ends desired could be brought about. It was voted to create a committee of five to study the whole matter and report at a subsequent meeting.

⁂

Careless Work Causes Concrete Bridge Failure

A combination of poor materials, improper mixing, and the careless placing of concrete caused the failure of a reinforced-concrete girder bridge at Independence, Ore., on Sept. 21. The bridge failed while the forms were being stripped and at a time when there was no live-load being carried. The accompanying photograph shows the manner of failure. Both columns of the nearer bent settled, shearing the girders of the middle span at the point of minimum resistance to shear. After dropping about 4 ft. these columns developed sufficient resistance to carry the load and the total collapse of the bridge was thus prevented. An examination of the base of these columns indicates the probable cause of the failure. The aggregate was a river gravel made up of generally smooth pebbles and the lack of adherence to the mortar of the pebbles was due to insufficient mixing, apart from the slight coating of clay on the gravel. At the immediate point of failure of both columns there were found large pockets of the coarse aggregate with very little sand. This may be attributed either to lack of mixing or segregation in placing the concrete in the column form. A sign of the careless work, which also without doubt was one cause of the failure, was the presence of a piece of 2x8-in. shiplap about 2 ft. long embedded in the concrete of one column near the point of failure.

The broken columns were reinforced with four ¾-in. bars at the corners and wire wrapping. The unit stress under dead-load was about 200 lb. per sq.in. The County Court under whose direction the bridge was built did not deem it necessary to have any engineering supervision of the construction, and the work was done without an inspector. The question of the responsibility between the county and the contractor for the bridge will probably be decided in court. Repair work will practically involve reconstruction of the entire bridge.

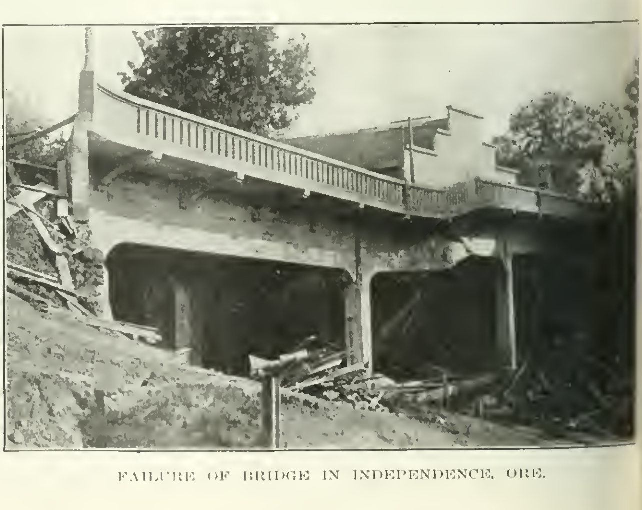
⁂

Progress on Alaska Railroads

Up to Oct. 1 of this year the Department of the Interior reports the following progress in the construction of the new Government railways in Alaska:

During the present year, grading has been completed on the 38-mi. branch to the Matanuska coal field from Matanuska Junction, a point 36 mi. northeasterly from Anchorage, a tidewater point on Cook Inlet, where construction began a year ago, and the rails are now being laid on this branch line. It is anticipated that the line will be completed before the end of the open season. At Moose Creek, a point on the branch line, about 12 mi. from Matanuska Junction, a coal mine has been opened, and coal is now being taken out for the use of the railroad and the town of Anchorage. Clearing and grading are under way on other portions of the line, particularly at points northward from Matanuska Junction, southerly from Anchorage toward Turnagain Arm of Cook Inlet and in the vicinity of Talkeetna (the junction of the Talkeetna and Susitna River about 100 mi. north of Anchorage).

The heaviest work to be encountered on the line is the hard-rock cliffs along Turnagain Arm. Blasting and excavation for line here will be actively pursued during the winter. The Alaska Northern Ry., extending from Seward to Kern Creek, a distance of 71 mi., is being rehabilitated throughout and put into condition to haul construction material for the work along Turnagain Arm between Kern Creek and Anchorage. Clearing and grad



FAILURE OF BRIDGE IN INDEPENDENCE, ORE.

ng are under way on the northern end of the main line n the vicinity of the crossing of the Tanana River at a oint known as Nenana—the aim being to connect the 'airbanks mining region with the Nenana coal fields (a listance of 110 mi.) as early as possible.

By the end of the present working season it is anticiated that at least 85 mi. of new construction will have een completed.

American Company To Build Railways in China

It is announced this week that the Siems-Carey Railway nd Canal Co. has concluded a contract to build 1,100 mi. f railway for the Chinese Government. The company in uestion is controlled jointly by the American Internaional Corporation of New York City, and Messrs. Siems : Carey of St. Paul, Minn. The American International 'orporation has already advanced $500,000 to cover the ost of preliminary surveys and investigation, and will , nance the construction by the sale of Chinese Government bonds. Under the contract with the Chinese Govrnment, the railway lines are to be built at cost plus a ercentage. The work of location and construction is to e under charge of an American chief engineer, who will iter supervise the operation of the lines when completed. Americans are also to be employed at the head of the uditing and traffic departments. It will probably be a ear before final location surveys will be completed, so hat the lines may be placed under construction.

Chemists and Engineers Talk on Sanitary Problems

Nearly 20 papers, mostly on various phases of waterupply and sewage disposal, were read in New York City n Sept. 27 and 28 before the Division of Water, Sewage nd Sanitation of the American Chemical Society, under he chairmanship of Edward Bartow, Urbana, Ill.

J. W. Ellms and S. J. Hauser reported the results of ome experiments on the loss of head in mechanical filters ue to microörganisms. It was found that by manipuiting the valves on the piping system the sand could be haken so as to break up the film of organisms and also top air binding, thus restoring some of the lost head, ngthening the periods between washing and decreasing he wash water. George W. Fuller related some early exerience that corroborated the conclusions of the authors.

A valuable paper by William R. Copeland, of Milwauee, on "Is the Recovery of Nitrogen from Sewage Sludge 'racticable?" dealt largely but not wholly with activatedludge experience at Milwaukee, which seems to answer he question in the affirmative, Mr. Copeland concluded. Most of the paper and an abstract of the discussion by George W. Fuller and others are given elsewhere in this sue.

A review of the activated-sludge method of sewage reatment was presented by George T. Hammond, of Brooklyn. (See articles by Mr. Hammond in *Engineerng News*, Apr. 27 and July 13, 1916, for many of the oints made in this paper.)

Stream inspection as an important aid in the control of sewage-treatment plants was advocated by C. B. Hoover, Columbus, Ohio. Such inspection should in some cases xtend from 2 mi. above to 25 mi. below the sewage-works outlet and may even include dragging the stream bottom for samples. From the popular viewpoint it is important to learn the opinions of riparian owners as to the effect of the treated sewage on the stream.

Water meters were advocated by Henry Leffmann, Philadelphia, in a paper on "Water Meters in their Sanitary Relations." Meters are particularly desirable where sewage is treated. Leslie C. Frank, Washington, D. C., suggested that the cost of sewage treatment be added to bills for metered water.

R. B. Dole was elected chairman, and H. P. Corson was reëlected secretary. The next meeting will be at Kansas City, Mo., a year hence.

Cement Association Now Has Laboratory Adjunct

The Portland Cement Association has just announced that on Sept. 1 it entered into an agreement whereby it will hereafter jointly operate the Structural Materials Research Laboratory at the Lewis Institute in Chicago with that Institute. This laboratory has been for some time conducting exhaustive researches into the nature and behavior of concrete and cement. It is intended in the future to continue these researches and publish them for the benefit of the industry, and at the same time it is hoped that the laboratory will conduct experimental studies of special importance, some of which may be charged for. The details of this part of the work have not as yet been announced. The laboratory is in charge and will remain in charge of D. A. Abrams, who has had considerable experience, both in the Lewis Institute and in the University of Illinois, with the testing of materials.

Smoke Abatement Convention

The 11th annual convention of the Smoke Prevention Association, held at the Planters Hotel, St. Louis, Mo., on Sept. 26 to 29, gave evidence of the practical and economic results of the anti-smoke movement. The meeting was under the auspices of the Joint Smoke Prevention Committee of St. Louis, which represents the Engineers Club, the Civic League, the Business Men's League and the Women's Organization for Smoke Abatement.

Standard smoke ordinances and standard designs for boiler settings and appliances were presented by the committee on standardization. It was decided that these should be accepted as information, action as to their adoption being deferred until the next meeting, so that there might be ample time for their consideration. Two papers related to smoke from heating plants and the design of heating boilers and furnaces. Others discussed the relation of automatic stokers to smoke abatement, and the relation of chimney draft to boiler and furnace operation.

The effective work of smoke abatement at Pittsburgh received a good share of attention. The method of smoke regulation was described by J. W. Henderson, Chief of the Bureau of Smoke Prevention; and the Soot-Fall investigations made by the Mellon Institute of Industrial Research (University of Pittsburgh) were described and illustrated by John J. O'Connor, Jr. Moving pictures were shown by the Pennsylvania R.R. officials, illustrating the methods of cleaning and building fires in locomotives without causing dense smoke, and also showing heavy passenger and freight trains running through the city without the emission of smoke. This is effected by the use of special grades of coal and special methods of firing.

One session was devoted entirely to railway work, the papers covering the use of special devices on locomotives, and the methods of firing up at roundhouses, these methods being afterward demonstrated at the yard of the Terminal Railroad Association. The use of powdered coal was dealt with in two papers: One on its use for locomotives, by C. W. Corning, of the Chicago & Northwestern R.R.; and one on a special process of carburization and burning of powdered coal by A. G. Kinyon, of Chicago. In the discussion one speaker stated that in furnaces for heating steel the cost for fuel was 40c. per ton of steel with pulverized coal and $2.25 with oil, while the former increased the daily capacity from 100 to 170 tons.

The President for 1916-17 is W. H. Reed, City Smoke Inspector, Chicago; Secretary, Frank A. Chambers, Assistant City Smoke Inspector, Chicago. The next meeting will be held at Columbus, Ohio, in 1917.

*

Derailment on an Embankment caused the wreck of a freight train on the St. Louis, Iron Mountain & Southern Ry., near Levesque, Ark., Sept. 24. Two trainmen were killed and two injured.

A Grade Crossing Accident at Detroit, Mich., Oct. 1, caused the death of 10 persons and injuries to a score of others. A freight train on the Grand Trunk Ry. collided with a street car at Forest Ave. and Dequindre St.

The Pennsylvania R.R. Detroit Extension will not cost over $10,000,000, according to an official announcement of President Rea. Very little new line will be constructed, as existing lines are to be used to enter the city.

A 40-In. Water Main Burst near the eastern pumping station, Baltimore (Md.) water-works, at 11 a.m., Sept. 24. According to newspaper reports it was impossible to operate the large valves near the pumping station, and the flow had to be shut off from distant gates.

An Automobile Racetrack to cost $1,000,000 is to be constructed in Pittsburgh, Penn., according to press reports. The race course is to be a two-mile track for motors, with an inside track for horse racing. J. B. Callahan is President of the Pittsburgh Speedway Co., which is financing the work.

Fire Destroyed almost the entire business section of the village of Phœnix, N. Y., Sept. 24. It was impossible to check the flames, for the water-works pumping station adjoined the power plant in which the fire originated, and was among the first buildings destroyed. The damage is estimated at $1,000,000.

Traffic Survey Field Work for the Rapid Transit Commission of Cincinnati has been completed and the statistical data will be available for the Commission about Oct. 15. S. R. Morley is in charge of the compilation of the statistics and F. S. Krug is chief engineer of the Rapid Transit Commission.

The Electrolytic Sewage Treatment Plant at Decatur, Ill., was visited on Sept. 30 by a party of nearly 100 engineers, municipal officials and others. A special train for Chicago took a party of about 80. This is the 1,000,000-gal. demonstration plant of the Landreth electrolytic-lime process described in a letter from W. S. Shields, consulting engineer for the promoters, in a letter in "Engineering News," of Aug. 24, 1916.

Breaks in Two Water Mains, an 18-in. and a 24-in., occurred in Pittsburgh, Penn., Sept. 17. The larger main burst at the corner of Suismon and James St. about 7 a.m., under a pressure of between 75 and 80 lb. per sq.in. The pipe is said to have been cracked the entire length of the broken section. The other break was on Carson St., near the foundry of the Jones & Laughlin Steel Co. The pressure on this main was about 85 lb. per sq.in. No extensive damage was done in either case.

Nuisances on the Quequechan River at and near Fall River, Mass., are to be investigated by a commission which is to report its findings and make recommendations as to the construction of drains and sewers and other improvements by Apr. 1, 1917. The report will be addressed to the City Council of Fall River. Joseph Turner, of Fall River, has been made Chairman of the Commission, and H. K. Barrows, 6 Beacon St., Boston, is consulting engineer.

Typhoid Fever Deaths in Boston numbered only 12 for the first eight months of 1916 and of the 12 three were nonresidents. There were 158 deaths in the calendar year 1908, 66 in 1914 and 40 in 1915. The typhoid death rate per 100,000 for the period 1906-10 was 16, while for the year 1914 it was 9.2 and for 1915, 5.3. For the current year it is hoped that the rate will not exceed 2.5, which would allow for an increase in the monthly rate during the last remaining part of the year.

Committee on Engineering Coöperation—Conforming to resolutions adopted at the second annual conference of the Committee on Engineering Coöperation, held in Chicago last April, Chairman F. H. Newell has selected Hunter McDonald, Isham Randolph, Morris L. Cooke and C. E. Drayer to act with him as a subcommittee on plan to be presented for formal consideration at the third conference. A draft of a plan is being considered by the subcommittee which expects to hold a meeting for its further discussion probably in October.

The Park Avenue Viaduct, Cincinnati, Ohio, will be dedicated on Oct. 7. The structure is of reinforced concrete and provides a 40-ft. roadway with two 12½-ft. sidewalks, all supported on a three-ribbed arch of 180-ft. span. The viaduct is the connecting link between Walnut Hills and Eden Park. Its cost, exclusive of engineering, was about $132,000. Frank L. Raschig was principal assistant engineer, F. S Krug, chief engineer, and D. P. Foley, contractor. The contractor's plant was described in "Engineering News" Apr. 6, 1916, p. 659, and the structure itself replaced by the new viaduct in May 18, 1916, p. 936.

Flood Control in the Miami River is the subject of a hearing in progress this week before the Conservancy Court at Dayton, Ohio. The plan on which the hearing is being held is that submitted to the Miami Conservancy District by Chief Engineer Arthur E. Morgan and adopted by the Board of Directors May 10, 1916. The court before which the hearing is held consists of nine judges acting under the new Conservancy law. Among the prominent engineers whose testimony will be given before the court at the hearing, in addition to those of members of the Morgan Engineering Company's staff, are Gen. H. M. Chittenden, of Seattle, Gen. W. H. Bixby, of Washington, Prof. D. W. Mead, of Madison, John W. Alvord, of Chicago, Prof. S. M. Woodward, of Iowa City, T W. Jaycox, of Denver, Chas. H. Miller, of Little Rock, H. T Barnes, of Toronto, and F. J. Fischer, of Los Angeles.

Official Load-Line and Bulkhead Rules for use in the construction and operation of American shipping were the subject of a conference at the office of Secretary Redfield, of the Department of Commerce on Sept. 27. At the conclusion of the conference, which was attended by the principal men in the shipbuilding and ship operating industry in the United States Mr. Redfield named a preliminary committee of three to select a permanent committee of seven members to formulate a general policy for load-line and bulkhead rules. These rules when formulated will be passed upon by the Department of Commerce, by the new shipping board, and ultimately by Congress. The members of the committee of three are Stevenson Taylor, President of the American Society of Naval Architects and Marine Engineers, Alfred G. Smith, President of the New York and Cuba Mail S. S. Co., and Homer L. Ferguson. President of the Newport News Shipbuilding and Dry Dock Co.

PERSONALS

Edwin Doepers, formerly an architect of Indianapolis, has been appointed City Engineer of Bloomington, Ind., as a salary of $1,200 per annum.

Charles M. Farrow, recently Assistant County Engineer of Montgomery County, Alabama, has been made County Engineer of Limestone County.

Atwood L. Bliss has been appointed Engineer to assist the Director of Wharves and Docks of Philadelphia, Penn., succeeding Richard A. McSadden.

William H. Cummings, formerly of Providence, R. I., has entered the employment of the Waugh glazing department of the Asbestos Protected Metal Co., Pittsburgh, Penn.

Elmer Irving, Supervisor of the Pennsylvania R.R. at Lancaster, Penn., has been promoted to be Division Engineer of the Trenton division, succeeding A. W. McClellan, transferred

M. J. Graham has been appointed County Road Engineer of Jefferson County, at Beaumont, Tex., succeeding George W White. Mr Graham's salary has been fixed at $3,000 per annum.

O. M. McNeil, a graduate of the University of Colorado, ormerly with the American Bridge Co., has been appointed istructor in Structural Engineering at the University of lichigan.

C. H. Niemeyer, Division Engineer of the Pennsylvania R.R. t Pittsburgh, Penn., has been promoted to be Assistant Engieer of Maintenance-of-Way, with headquarters in Philadelhia, succeeding A. B. Clark, promoted, as noted elsewhere.

Charles T. Harris, formerly Secretary of the Hollow Buildg-Tile Manufacturers' Association of America, has joined **E. lmo Martin** and **John E. Morris** to form the Martin-Morris-larris Co., Cleveland, Ohio, to conduct a business service bueau.

M. H. Cahill, Superintendent of the Cumberland division of he Baltimore & Ohio R.R., has been promoted to be General uperintendent of the Pennsylvania district of the company at ittsburgh, Penn., succeeding E. A. Peck, who has been ranted leave of absence.

William L. Darling, M. Am. Soc. C. E., whose resignation as hief Engineer of the Northern Pacific Ry. was noted in these olumns last week, has opened an office in St. Paul, Minn., as consulting engineer, specializing in railway engineering and onstruction.

Thomas R. Tarn, formerly Division Engineer of the mehanical division of the Bureau of Water-Supply of the City of ittsburgh, Penn., has resigned to become Assistant General lanager of James Rees & Sons Co., marine engine and teamboat builders, Pittsburgh.

A. H. Ayers, recently Principal Assistant Engineer of the quipment department of the New York Central Lines, New ork City, has been appointed Superintendent of Motive Power f the New York, Chicago & St. Louis R.R., with headquarters t Cleveland, Ohio. He is a mechanical engineering graduate f Cornell University, class of 1900, and began his railway xperience as a special apprentice of the Lake Shore & Michgan Southern Ry.

William J. Cunningham, Assistant to the President of the oston & Maine R.R., has been appointed Professor of Transortation at Harvard University. This professorship was stablished to commemorate the work of the late James J. ill and is known as the Hill professorship. Professor Cuningham was born at St. John, N. B., Apr. 29, 1875. His railay experience began in 1892 as a stenographer with the anadian Pacific Ry.

A. H. Clark, formerly Assistant Engineer of Maintenance-f-Way, Pennsylvania, R.R., Philadelphia, Penn., has been ppointed Superintendent of the Renovo division, succeeding he late J. M. James, who died Sept. 17. Mr. Clark graduated rom Lafayette College in civil engineering in 1891. He entered he service of the Pennsylvania R.R. as a rodman in 1891, nd has been with this railway continuously ever since. For ine years, 1901 to 1910, he was Division Engineer of the enovo division.

George A. Kyle, Assoc. M. Am. Soc. C. E., Consulting Engieer, Portland, Ore., has been appointed Engineer in charge f location and construction of the railways to be built in hina by the American International Corporation and the iems-Carey Railway and Canal Co., as noted on p. 672 of this ssue. He will work with officials of the Chinese Government n deciding upon the lines to be built. Mr. Kyle has been ssociated with John Hays Hammond, Mining Engineer, in the and, South Africa, and has had railway building experience n Alaska. Recently he was with the Northern Pacific Ry.

OBITUARY

Robert H. Boynton, Jun. Am. Soc. C. E., City Engineer, of Frankfort, Ind., died Sept. 18. He was born at Batavia, N. Y., May 21, 1886. He was graduated in civil engineering at the niversity of Michigan in 1910. His first engineering experience was with the Missouri Pacific Ry. and with the United States Government. He was appointed City Engineer of Frankfort in 1913.

ENGINEERING SOCIETIES

EFFICIENCY SOCIETY OF AMERICA.
Oct 7-9. Annual meeting at New York City Secy., G. E. Burroughs, Pittsburgh, Penn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct 9-13. Convention in Newark, N. J Secy, Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B Burritt, 8 West 40th St., New York City.

IRRIGATION CONGRESS.
Oct. 14-24. 23rd International Irrigation Congress at El Paso, Tex. Secy., Arthur Hooker, El Paso.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The American Institute of Architects will hold its annual convention in Minneapolis, Dec. 6 to 8. The secretary is Burt L. Fenner, The Octagon, Washington, D. C.

The American Institute of Chemical Engineers will hold its annual meeting in New York City, Jan. 10 to 13. The secretary is J. C. Olsen, Cooper Union, New York City.

The Society of American Bacteriologists will hold its annual meeting in New Haven, Conn., Dec. 26 to 28. The secretary is A. Parker Hitchens, Glenolden, Penn.

The American Wood Preservers' Association will meet in New York City at the Hotel Astor, Jan. 23 to 25. The secretary is F. J. Angier, Mt. Royal Station, Baltimore, Md.

The Bridge Builders and Structural Society will probably hold an annual meeting on Jan. 12, in New York City. The secretary is George E. Gifford, 50 Church St., New York City.

The National Municipal League will hold its annual meeting in Springfield, Mass., Nov. 23 to 25. The secretary is Clinton Rogers Woodruff, 705 North American Building, Philadelphia, Penn.

The Chattanooga Engineering Society has been organized with 92 members. Already there are 40 applications. It is reported that G. W. Knight, of Knight & Quayle, consulting engineers, led the organization movement. The new society will hold two luncheons each month.

The International Irrigation Congress will hold its twenty-third session at El Paso, Tex., Oct. 14 to 21, which includes also the International Farm Congress and the International Soil Products Exposition. On Saturday, Oct 14, the Elephant Butte dam of the Rio Grande project, United States Reclamation Service, will be dedicated. One of the attractions of the congress will be the maneuvers of 60,000 soldiers, who are sojourning in the vicinity of El Paso. The secretary of the congress is Arthur Hooker, El Paso.

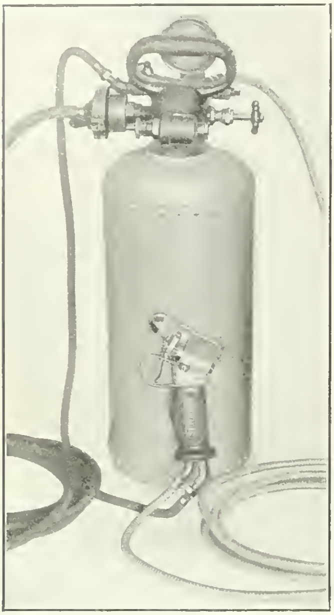
American Railway Bridge and Building Association—The twenty-sixth annual convention, to be held in New Orleans, La., has a three-day program commencing Oct. 17. Subjects of reports and discussions are: Water-supply; floors for shops and roundhouses, etc.; paint and its application to railway structures; caring for and handling creosoted materials; blank forms for bridge and building departments' use; modern methods of driving piles; fireproofing roofs of wooden buildings; efficient methods of handling work and men; station buildings for passenger service only; economical handling of concrete on smaller jobs; and small coaling stations. The headquarters of the convention will be Hotel Grunewald. The secretary is C. A. Lichty, Chicago & Northwestern Ry., Chicago, Ill.

Iowa and Illinois Sections of American Water-Works Association—A joint session will be held Oct. 10 and 11 at Davenport, Iowa, Rock Island and Moline, Ill. The headquarters will be the Hotel Blackhawk, Davenport. The program includes a round-table discussion of water-works practice and experience and several papers of unusual interest, including one on "Experience with Trenching Machines on the French and Russian War Fronts," by A. E. Miller, of Des Moines. Excursions include visits to the filter plant of the Rock Island arsenal, the main pumping station of the Davenport Water Co., the filter plant of the Rock Island water-works and the pumping station and filter plant of the Moline water-works. All water-works men are invited. James P. Donahue, Davenport, is chairman of the local committee.

Appliances and Materials

Compressed-Air "Paint Gun"

A new design of compressed-air paint sprayer has been recently developed by the Spray Engineering Co., of Boston, Mass. It is intended particularly for rapid work and uniform paint, varnish or lacquer coatings on machines and metal parts. A painting outfit comprises the gun itself, connected by hose to the paint container and an air filter. The tank carries the pressure-control attachment and gage. The gun itself looks like a stubby automatic revolver; the control is by a trigger that governs both the air and the material supply. A nose cap adjusts the supply of material, and a rear stem regulates the air. The control head on the paint container shows the pressure on the air line and on the material.



SPRAY PAINT GUN

* * *

Patented Words—Patents have been granted the Permutit Co., New York City, covering several words used in connection with the company's trademark. The words "permutize," "permutized," "zerowater" and "zero hardness" may be used only in referring to the Permutit Co. This company makes a special type of filter for water softening.

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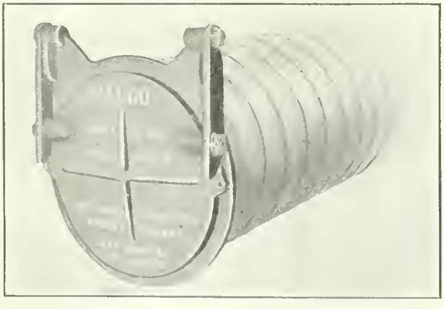
Automatic Flap Valves

Automatic flap valves have long been used in drainage work, particularly in the Mississippi Valley. They are designed to open under a slight pressure from within the pipe and to close automatically with any pressure from without.

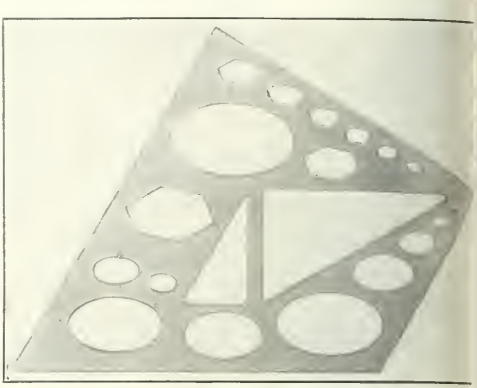


PATENTED FLAP VALVE MADE IN LOS ANGELES

The California Corrugated Culvert Co., of Los Angeles, Calif., has placed on the market a patented cast-iron valve for use on corrugated sheet-metal pipe. The flap is hinged from the upper part of the casting, as shown in the accompanying illustration.

An Isometric Drawing Form

The drawing instrument shown in the accompanying i lustration has been recently put out by the Two Rivers Draw



FORM FOR ISOMETRIC DRAWING

ing Tools Co., of Two Rivers, Wis., as an aid to isometr projection of geometrical forms. It is claimed that a great variety of uses for the forms is found than is obvious at fir

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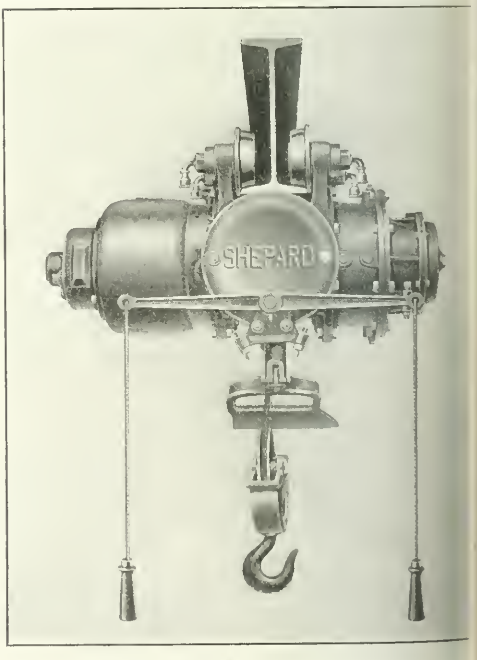
Monorail Traveling Hoist

A small single-speed traveling hoist for monorail lines, b with the same completeness of detail that marks the large cranes, has been designed by the Shepard Electric Crane a Hoist Co., of Montour Falls, N. Y. The general appearance c be found from the accompanying figure. The brake is a co bined mechanical and electrical type that regulates the bra



SHEPARD MONORAIL TRAVELING HOIST

ing action according to the load. The hoist is in four pa —(1) the winding or center section, (2) the motor end, (3) gear and brake end and (4) the controller. Each section i complete unit, and the pieces are bolted together. Three si are made, the capacities being of 500, 1,000 and 2,000 lb.

Engineering News

LUME 76 OCTOBER 12, 1916 NUMBER 15

Garbage and Rubbish Disposal in Los Angeles, Calif.

By Seward C. Simons*

SYNOPSIS—Instead of paying out money for garbage disposal, Los Angeles receives 51c. a ton for all garbage delivered to a Cobwell reduction plant, owned by a company. The company collects and reduces dead animals, charging the owners for the service and turning over to the city a large part of the fees. Combustible rubbish is collected by private contractors, delivered by them to the garbage contractor, who sorts it, sells recovered matter and burns the tailings for plant fuel. Noncombustible refuse is placed on dumps.

Completing its first year of full-scale operation, the bage-disposal plant of the Pacific Reduction Co., in s Angeles, Calif., has justified the predictions that it uld be the most successful undertaking of its kind in the country. The system employed is essentially the Cobwell method. Following the good results in Los Angeles and at the Panama-Pacific Exposition in San Francisco, it is being adopted in other places, having been specified in the recent contract in the City of New York.

Los Angeles has a population of about 550,000, but the garbage from the extreme southern portion of the city, with a population of about 50,000, does not go to the reduction plant. In October, 1913, a contract was entered into with the Pacific Reduction Co. to handle all of the city garbage for a period of ten years, the company agreeing to pay the city 51c. a ton for all garbage delivered to it. While the plant actually started operation in April, 1915, it was not until about July 1 of that year that it handled garbage up to its full capacity. Prior to the operation of this plant the garbage was fed to hogs on ranches maintained about 15 mi. from the city, and it was as a result of complaints as to this method that the city was forced into taking other means for disposal.

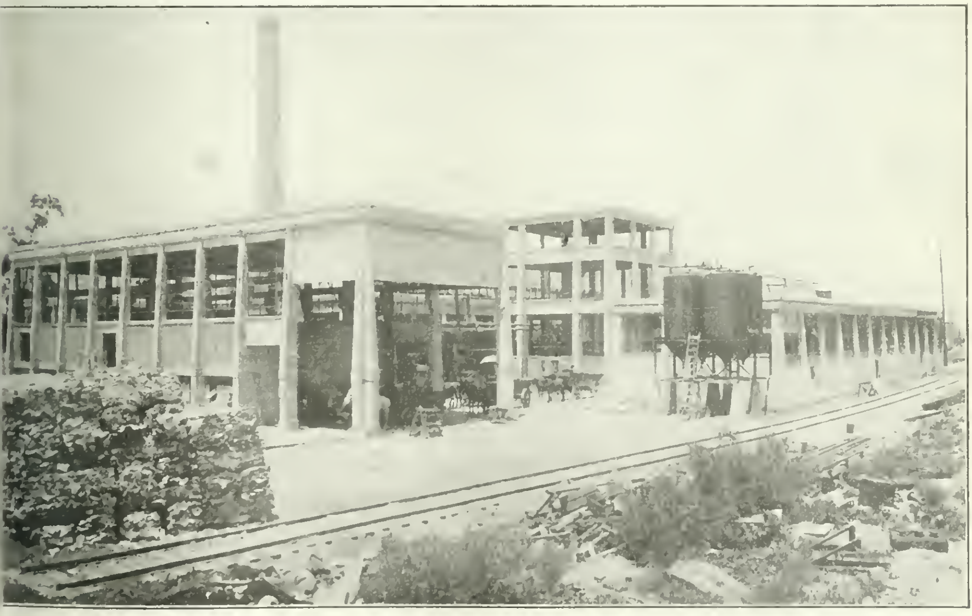


FIG. 1. GENERAL VIEW OF LOS ANGELES GARBAGE-REDUCTION WORKS

On the left, green garbage building in front and reducer building back of it (mostly out of sight); in center, condenser building; on right, four grease storage tanks, with office and warehouse extending back of tanks alongside the track

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*Associate Professor, Throop College of Technology Pasna, Calif.; Secretary of the Municipal League, Los Angeles.

Figures just given out by the city engineer show the following amounts of garbage collected and delivered to the company during the past year:

LOS ANGELES GARBAGE COLLECTIONS AND DELIVERIES IN TONS, 1915-16

1915	Collected	Delivered to Company, Gross
July	11,707.2	2,495.2
August		3,364.2
September	5,510.8	3,161.3
October	4,764.0	3,086.2
November	4,296.4	2,848.1
December	4,173.3	3,315.0
1916		
January	4,279.3	4,290.3
February	4,230.0	4,229.9
March	4,520.6	4,520.6
April	3,975.1	3,975.1
May	3,812.3	3,812.3
June, estimated	4,500.0	4,500.0
Total	55,769.0	44,098.4

This indicates that since Jan. 1, 1916, all the garbage of the city has been taken care of at the plant, the month of June showing about 145 tons a day.

The disposal plant is located in the extreme southeast portion of the city on a site reached by the Atchison, Topeka & Santa Fe and the Salt Lake railroads. Over 5½ acres of ground have been provided, a part of it being used by the city for stables to house the collecting equipment. One objectionable feature in connection with the location is the long haul which is necessitated for the greater part of the city garbage, amounting to as much as 9 mi. at a maximum. No unpleasant odors emanate during the process, although in the vicinity of the garbage plant there is conducted a private tallow refinery, which at times pollutes the atmosphere very objectionably.

The buildings are uniformly of concrete and brick construction, with steel window frames. The stack is 156 ft. high, and is said to be the tallest concrete stack in southern California. Fig. 1 is a general view of the plant and Fig. 2 shows its layout.

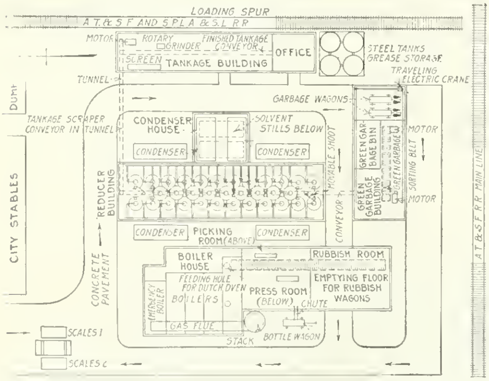

FIG. 2. GENERAL LAYOUT OF PLANT OF PACIFIC REDUCTION CO., LOS ANGELES, CALIF., LOOKING SOUTHEAST

Specially prepared for this article by the author

All the classes of city waste are handled in one manner or another at this plant. The refuse is divided into (1) garbage which is collected by the city, (2) combustible refuse which is collected by private contractors, but delivered to this plant; (3) noncombustible rubbish, which is collected by the city and deposited upon various dumps, a large one being located at this plant; and (4) dead animals collected and disposed of by the Reduction company. Los Angeles does not have to contend with the ash problem to any extent, since oil and gas fuel generally used throughout the city.

About forty wagons, each having a removable steel bo 13 ft. 6 in. long, 3 ft. 5 in. wide, and 2 ft. 6 in. high, w a holding capacity of from 3,800 to 4,500 lb. of garba net, are used by the city in the garbage collecti requiring a force of 86 employees. During last year th were added two 2½-ton motor trucks, with simi movable bodies, which collect the garbage in the more mote districts. The general type of wagon is well shown Figs. 1 and 3. The full wagon is weighed upon the sca (Fig. 2), then driven to the green-garbage building wh the body is picked up by a traveling crane (Fig. ; carried to a dumping bin, automatically emptied, wasl and returned to the running gear, the whole operati taking about four minutes. From the large receiving l the garbage is raked out onto a conveyor, during wh operation tin cans, glass, etc., are removed by hand.

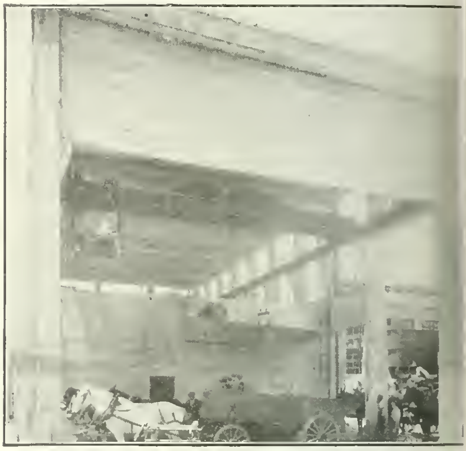

FIG. 3. HOISTING GARBAGE-WAGON BOX

Dead animals are taken care of at the same plant, a are picked up by the crane and deposited in a separ portion of the same building as the green garbage. T Reduction company receives a fee of $3.50 from the own for the collection of each full-size dead animal and $1. for calves, etc. The city receives a payment from t company of $3 for large animals and 80c. for small animals. The animals are skinned carefully, and th reduced exactly as is the garbage, although kept separa throughout.

From the conveyor in the green-garbage building t garbage is carried by a scraper conveyor into a gener distributor running along the upper part of the reduc building. This building is 176x18 ft. in plan, an contains 32 reducers (Fig. 2). Since the photogra (Fig. 4) in the interior was taken, another row of ni reducers has been placed above the lower two rows, maki a clear photograph of the interior practically impossib Through the movable chutes shown the garbage can be f into the various reducers from the conveyor.

The reducer is the central feature of the dispo process known as the Cobwell system, which was design by C. O. Bartlett & Snow Co., of Cleveland. Th apparatus consists of a steam-jacketed cylindrical ste

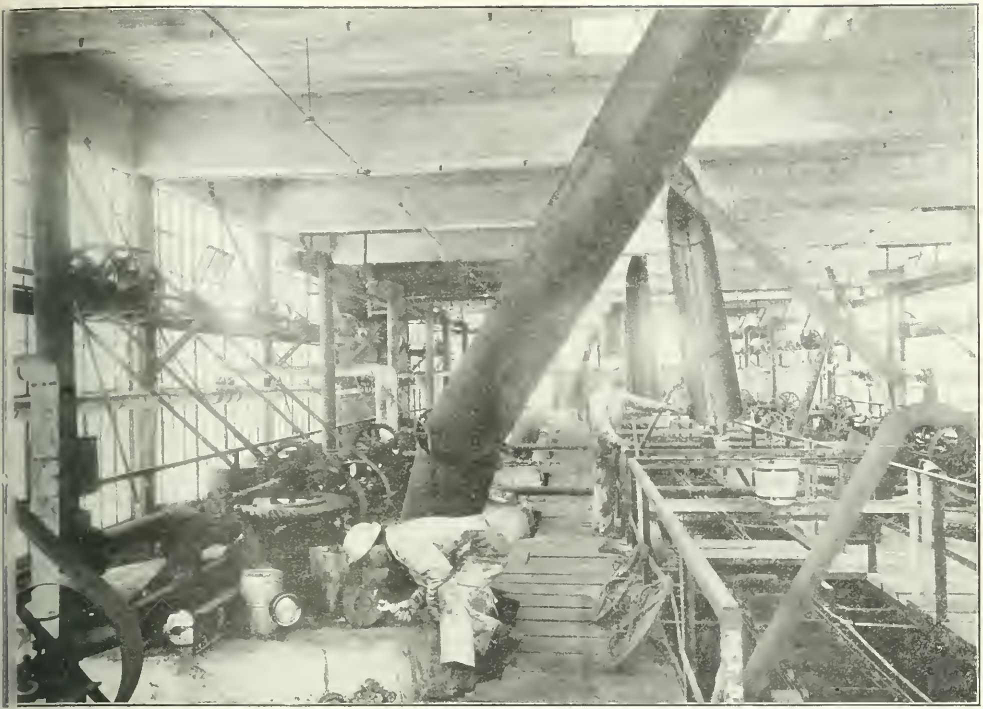

FIG. 4. CHARGING FLOOR OF REDUCER BUILDING, SHOWING FEED PIPES AND MOTOR DRIVES FOR ROTARY AGITATORS

Since the view was taken, nine reducers have been placed on this floor where the railing is shown

mber, about 8 ft. in diameter by 4 ft. high. The rior is fitted with a rotating agitator actuated by gears (g. 4) driven by motors. From five to six tons of g bage are contained in each reducer per charge. Upon placing of this amount within the apparatus a solvent wn as eobolene, which closely resembles naphtha, is a nitted in sufficient quantity to completely cover the g bage, after which steam at a pressure of about 90 lb. dmitted in the jacketed walls and bottom, and the ating device is started. As the mass becomes heated vapors containing both the solvent and evaporated w er pass through a large vapor pipe line to a condenser w re the solvent is separated from the water and returned he reducer. The essential feature is that the water is rized at a lower temperature when evaporated along w a solvent having a low boiling point than otherwise. T s part of the operation is continued until the solvent es over to the condenser free from water. The age is then completely dehydrated.

he solvent at this point contains a large amount of ase which has been liberated from the garbage, and the s of solvent and grease is then drained from the ucer to a still from which the grease can be recovered evaporation of the solvent. The last trace of grease be removed from the tankage by running more ent through the mass and the residual solvent evap ed by additional heat so that very little loss is rienced. The tankage, free from grease and solvent, is automatically emptied from the reducers onto a conveyor. The whole operation consumes from 15 to 19 hr., depending upon the amount of water in the garbage and its general character.

From the reducer the tankage is conveyed to the warehouse where it is screened, ground and sacked (Fig. 5). In its final form the product is not dissimilar in appearance to unroasted ground coffee. About 630 lb. of tankage are produced from each ton of garbage, which shows a much larger yield than that usually found in other garbage-reduction processes.

An average analysis of the tankage shows: Nitrogen, 3.05%; phosphoric acid, 1.96; potash, 1.22; crude fiber, 16.55; carbohydrates, 45.75; grease, 1.71%.

Practically none of the tankage falls below 3% of ammonia. Naturally this product brings a good price upon the market for fertilizer purposes. The company today is receiving $11 a ton for its garbage tankage and about $55 a ton for dead-animal tankage. A considerable portion of the tankage is sold for stock feed. When soaked with water the tankage is highly nourishing, and is readily eaten by hogs and other stock.

Each ton of tankage also produces about 70 lb. of grease. That this is of high quality is proved by the fact that it is sold at from 5½c. to 6⅕c. per lb. in the local market as a soap ingredient. Under the terms of its contract the reduction company guarantees that the grease shall contain less than 10% free fatty acid, and in practice it runs below 7%. It contains 7% glycerin and less than 2% foreign solids and water.

The steam plant required consists of three 500-hp. boilers and one emergency boiler of 300 hp. It is estimated that about 660 lb. of steam are required to produce heat for one reducer charge. From 50 to 60% of the fuel required is furnished by waste rubbish and papers that are left over after a sorting process. The remaining fuel is furnished by crude oil.

In connection with the combustible rubbish it should be said that the company charges 60c. a ton to the private collectors who deliver the refuse to the plant for disposal. The refuse is thrown onto a wide steel belt and passes between rows of sorters where all useful substances are recovered. The tailings are fed into the furnace, as shown in Fig. 6.

By the terms of its contract, the city furnishes the necessary water for the condensing and cooling process. This naturally employs a large amount of water, but not more in proportion than is used in other reduction plants. Thus the water required per ton of garbage reduced at Los Angeles averages 1,700 cu.ft., compared with 2,300 at Boston and 2,600 at New York. As Los Angeles has a large amount of excess available water this is not a drain upon the city, although figured at cost the water probably amounts to more than $8,000 a year.

Through the operation of the plant the city has received an income of about $40,000 during the past year. Deducting the water expense, this amounts to a net income of about $32,000 from the garbage after collection. In spite of the longer haul the collection system has not proved more expensive than in previous years, chiefly because of the more perfect methods now in use. The city engineer's office gives the following average costs per ton for collection: Day collection wagons, $2.39; night collection, wagons, business district, $1.15; trucks, distant collection, $2.75; average (all forms), $1.87.

These figures take in all charges and expenses, including feed and care of stock, rentals and sundry supplies, maintenance, interest and depreciation of equipment and salary of superintendent.

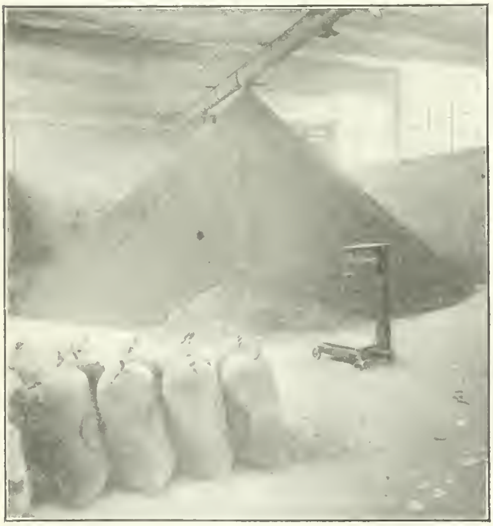

FIG. 5. GARBAGE TANKAGE BAGGED AND READY FOR BAGGING

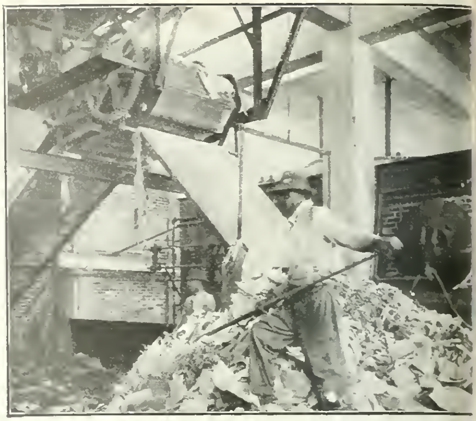

FIG. 6. RUBBISH TAILINGS BEING FED TO FURNACE

It is difficult to estimate the profits made by the redu
tion company. Its initial investment was approximate
$425,000. A total of 52 operators in three shifts a d
are employed, in addition to which there is an admin
trative force, salesmen, etc. The chief engineer is H.
Bighouse, while H. J. Murphy is treasurer.

Noncombustible rubbish is collected by the city in sev
motor trucks. During the year nearly 48,000 cu.yd. ha
been collected at an average cost, according to the ci
engineer, of 94c. per cu.yd. This rubbish has bee
deposited in five dumps located in different sections
the city.

The Board of Public Works of the city and the ci
engineer express themselves as entirely satisfied with t
operation of the plant. An explosion which, but for t
fireproof character of the buildings, might have be
serious, occurred in the reducer building in April. Exce
for the temporary disabling of the reducers, a compar
tively small property loss was sustained. The pla
suffered no ill effects. Without doubt the present meth
of disposal is highly preferable to the old hog-feedin
plan. From a sanitary and æsthetic viewpoint, nothi
further could be desired, while financially it is believ
that Los Angeles has the most profitable arrangement
any city in the United States.

⁂

The Longest Water Conduit in the world is the famo
Coolgardie line in West Australia, built in 1902. Water
pumped from a river in the humid coast region and is carri
through 351 mi. of 30-in. lock-bar steel pipe to Kalgoorlie,
the West Australian gold field, in a district where rain seldo
falls. The pumping engines which force the water throug
this main not only have to overcome the friction head but
raise the water a total height of 1,447 ft. At the time th
pipe line was laid it was thoroughly protected with a mixtu
of coal tar and Trinidad asphaltum applied hot, but within
very few years after completion it was found that sections
the pipe were badly corroded. The annual report of the eng
neer of West Australia in charge of the Water-Supply, Sewera
and Drainage Department is reviewed in "The Enginee
(London) of Aug. 18 and gives interesting particulars rega
ing the further corrosion of this pipe line. The most serio
corrosion has been due to the action of mineral salts in t
soil of certain districts through which the line passes. T
interior of the pipe, however, has become covered in ma
places with tubercles under which corrosion goes on. T
increase in corrosion, from the figures in the report, appea
to be rapid. In the year 1911-12 the number of holes o
curring from external corrosion was only 124. In 1914-
there were 2,078. In the first-named year £17,000 was expen
ed on maintenance. In 1914-15 the expenditure was £51,000.

Building Foundations 150 Feet Under Scranton Armory

SYNOPSIS—A $300,000 building badly cracked by subsidence over old mine workings; old workings opened up and made accessible by 2-ft. bore hole in street; surveys made and masonry pillars built in old workings to prevent further settlement.

One of the buildings mentioned as seriously damaged the subsidences over coal-mine workings in the City Scranton, Penn., described in *Engineering News*, Aug. , 1916, is the 13th Regiment Armory, bounded by rtle St., Adams and Jefferson Ave. A corner of this 00,000 structure was illustrated.

For some months past, the work of putting foundations der this building has been in progress, although the ucture itself is so badly damaged that it may eventu- y be largely rebuilt. This work involves some engi- ering features of an unusual character, including the velopment of a network of underground surveys from base line established with two plumb bobs suspended ly 17½ in. apart, as will be described farther on.

The armory building extends from Adams Ave. to Jef- son Ave. along Myrtle St., a distance of 325 ft., and a width of 175 ft. on the avenues. The title to the d on which it is built came through the Lackawanna n and Coal Co. The building was erected chiefly by public subscription and by the city about 12 or 15 years ago, being subsequently taken over by the state.

The Lackawanna Iron and Coal Co. began mining operations in this vicinity in the fifties. The armory lot is on what was known as the Fairlawn or Lewis Jones tract, where the mining privilege was leased to the Fairlawn Coal Co., Ltd., in 1872. This company mined under a considerable part of the tract, particularly in the seam known as the Clark, which is the most worked seam in this immediate neighborhood. The Fairlawn Coal Co. sold out to the Lackawanna Iron and Coal Co. in 1891.

There are several seams of coal under the armory. The famous Big, or 14-ft., seam, also known as the G seam, outcrops near the armory on Adams Ave., but is not under the building. The uppermost worked seam below the surface at the armory site is the Clark, which runs 7 to 8 ft. thick and lies about 150 ft. below the surface. Under this are the three so-called Dunmore seams. The lowest of these, the No. 3, known as the China seam, is about 150 ft. below the Clark seam.

The accompanying map, Fig. 1, shows the condition in which the Clark seam was abandoned by the Fairlawn Coal Co., the dark portions being the pillars of coal left to support the 150 ft. of rock cover. This plan is based on actual surveys by J. H. Rittenhouse & Son, civil and

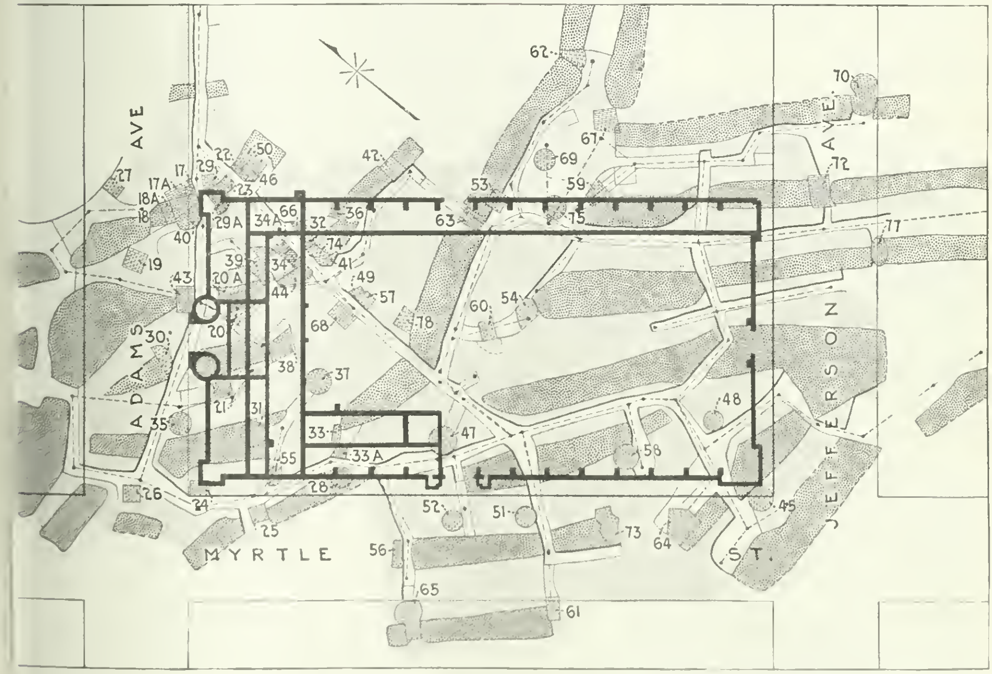

FIG. 1. PLAN OF CLARK COAL SEAM UNDER SCRANTON ARMORY, SHOWING PILLARS OF COAL AND MASONRY PILLARS WHICH HAVE BEEN ADDED TO SUPPORT THE ROOF

Dark portions are pillars of coal

mining engineers of Scranton, who have charge of both the engineering and the construction work on the armory foundations for the state. The condition of things in the No. 2 Dunmore seam, so far as present investigations indicate, appears to be about as bad. Survey lines have been extended under parts of the building by reopening old workings. In the other seams, which have been worked by more conservative methods of mining, there is little likelihood of squeezes or subsidences.

Effect of Subsidences on Armory

The armory is only one of several properties damaged by subsidences in this vicinity, which during the last few years have amounted all told to several feet. Levels taken on the drill-hall floor by Messrs. Rittenhouse showed that the end toward the front of the building has remained nearly level and that this condition continues 80 to 100 ft.; then there is a gradual inclination to the rear end, which is 2 ft. lower than the front. The dropping of the rear 2 ft. broke the side walls in several places.

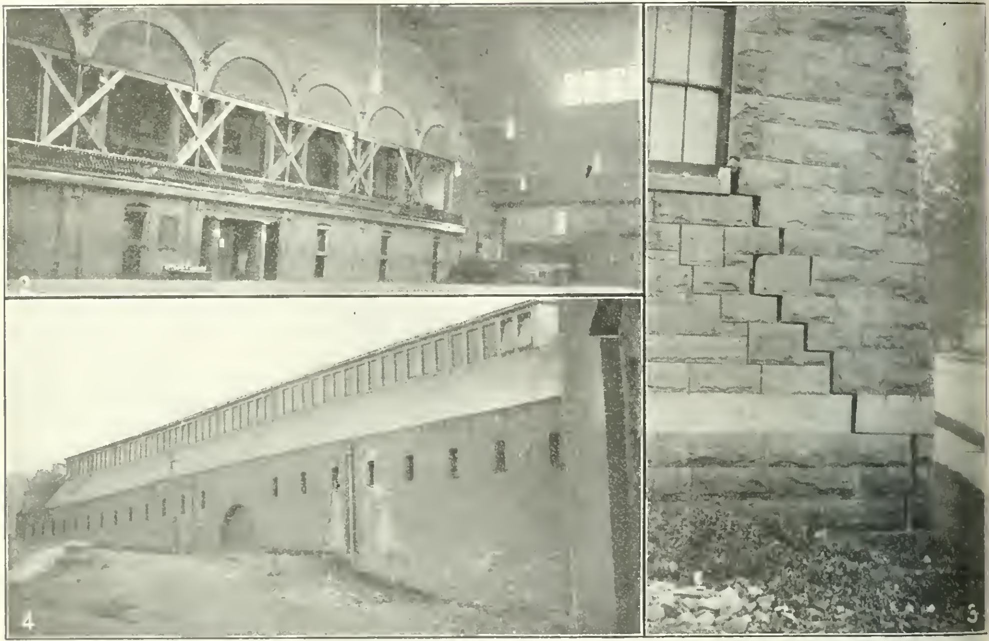
FIGS. 2 TO 4. EXTERIOR AND INTERIOR VIEWS OF DRILL HALL AT SCRANTON, PENN.

Fig. 2—View of interior of drill hall of armory. Fig. 3—North tower, showing settlement cracks. Fig. 4—North wall, showing settlement cracks

The foundations of the armory are cracked and broken in many places. The swimming pool has cracks in the sides, and the doors of the lavatory adjoining cannot be closed, due to settling of the jambs and floors. The stone arch over the Myrtle St. entrance is broken, and part of it has slipped out of line an inch or more. The interior of the front of the armory containing the administration offices is badly damaged, great pieces of plastering having fallen off the ceilings and walls; the woodwork is warped, and this part of the building generally is in such condition as to be considered no longer safe for use. Much other damage, such as broken windows, tilted sills, iron girders pulled away from the roo and out of alignment, cracks and crevices in the floor an walls, etc., is ample evidence of the racked condition o the great structure.

The accompanying views, taken July 22, show som of the injuries to the armory. Fig. 2 is taken inside th drill hall, looking toward the spectators' gallery at th administration end of the building. One of the iron post supporting the roof over this gallery has been broke squarely off, about halfway up. Needless to say, use o the gallery is not permitted. Fig. 3 shows the nort corner tower (see plan, Fig. 1). The drill hall is stil used, as the roof is supported by steel arches on pier independent of the walls, and there appears to be n immediate danger of collapse.

The current practice throughout the city and on th railroads of the valley is to reinforce the pillars of coa under important structures with concrete or masonry pillars or columns. This is generally done by use of th fallen roof rock found in the old workings. Walls o these stones (laid up in cement mortar) are built aroun the coal pillars and in places as crosswalls from pilla to pillar. The spaces between the pillars or walls ar finally filled with loose rock or other material. Th building of concrete piers under some of the bridg foundations of the Delaware, Lackawanna & Wester R.R. at Scranton was described in *Engineering News* Jan. 11, 1912, p. 60.

Messrs. Rittenhouse state that they have tried th method of building concrete retaining walls and filling back of them by flushing in culm or ashes, and that

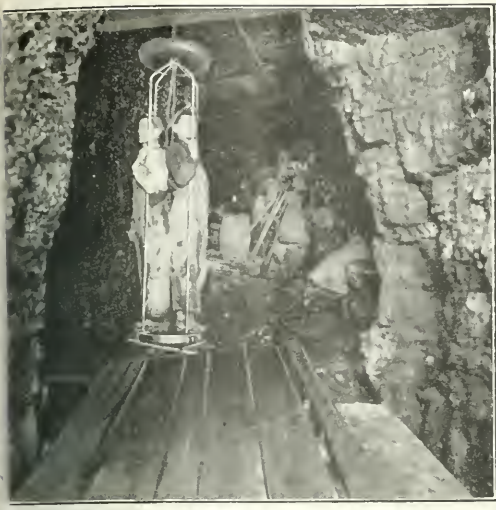

FIG. 5. MINE CAGE FOR ASCENDING 24-IN. BORE HOLE

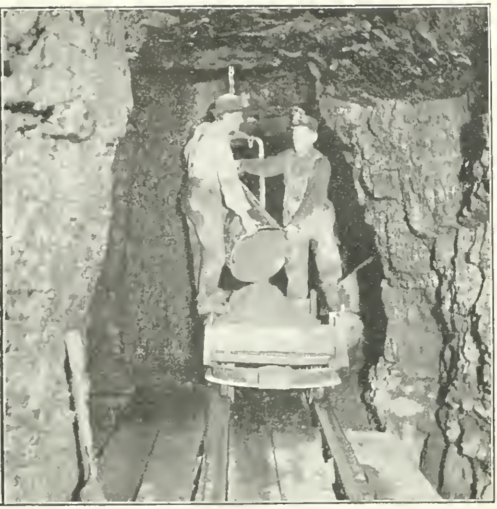

FIG. 6. MORTAR BUCKET AND TRAM CAR AT BOTTOM OF BORE HOLE

is method is not to be relied upon when all subsidence to be prevented or guarded against. In such cases lid masonry pillars sufficient to carry the whole load e essential.

Method of Getting Under the Armory

The Clark seam immediately under the armory is incessible from any present mine working, except in a ry roundabout way through old passages which had be reopened. It was accordingly decided to get at e work by drilling a 24-in. hole in the street (Adams ve.) about 200 ft. north of the armory. A 2-ft. bore le was advisable rather than a larger shaft, because was feared that blasting might start another squeeze elow ground) or subsidence. It was determined that nber, powder, mortar, etc., as well as the workmen uld be lowered through a 24-in. bore hole.

The hole was accordingly drilled through the 150 ft. solid rock cover, and it had the good fortune to end one of the pillars of coal in the Clark seam, as was tended by the engineers. This prevented the end of the drill from punching through the roof of a chamber and probably blocking the bottom of the shaft with fallen débris from the roof. The bottom of the bore hole was reached through the old workings and the connection made.

The bore hole was remarkably straight, proof of which is that it was possible to suspend two plumb lines $17\frac{1}{2}$ in. apart. This was the means of carrying the survey underground. It was found that with such a short base the ordinary plumb-line wires were out of the question, so a special method was developed of accurately prolonging the line. This is shown in Fig. 9.

The 15-lb. plumb bobs were suspended by ordinary iron stove-pipe wire, except for about 2 ft. above the bobs, where in one case a length of No. 6 jack chain was used and in the other case a section of No. 10 jack chain. The plumb bobs were of course immersed in buckets of water. The instrument was set up 15 ft. from the plumb lines; and as the bobs with the chains rotated, the opening in each link went through a complete circle. Since the two halves of each link were at right angles to

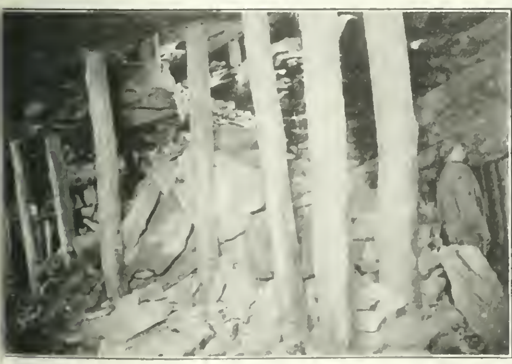

FIG. 7. CONDITIONS UNDER ARMORY AS THEY EXISTED

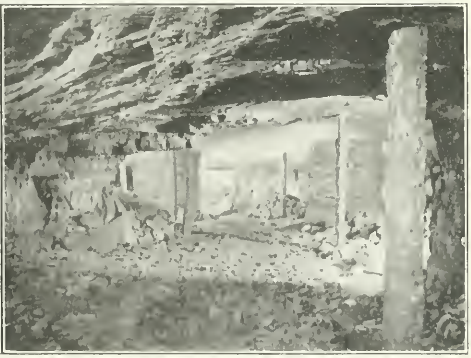

FIG. 8. LARGE CHAMBERS, SHOWING CRUMBLING PILLAR OF COAL ON LEFT

each other, when one opening changed to an ellipse, then to a narrow slit and finally vanished completely, the opening of the other link was changing from a narrow slit to the full opening.

A light was held behind the No. 10 chain so that the instrumentman could see its links through the links of the No. 6 chain. By catching the light through the narrowest slits of both chains simultaneously it was possible to line in the instrument with great accuracy. From this line prolonged, the underground traverse system shown by the dotted lines in Fig. 1 was established. Passageways under the armory were reopened, and about 70 masonry pillars were built, as shown in Fig. 1. These were placed to supplement so far as possible the remaining pillars of coal. The rock for these masonry pillars was gathered up from the old workings. The stones were laid up in cement mortar as tightly against the roof as possible, and judging from the present cracked condition of some of the stones in these columns they were not long in assuming a part of the roof load.

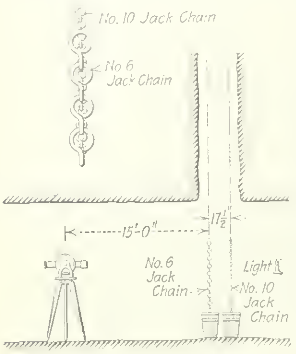

FIG. 9. SKETCH SHOWING METHOD OF SUSPENDING PLUMB BOBS

Taking the site of the armory as an independent unit, a cover of rock 150 ft. thick would exert a pressure of 22,500 lb. per sq.ft. If this pressure is concentrated on about 20% of the area, as is the case in these old workings under the armory, the unit pressure is five times as great, or 112,500 lb. per sq.ft. = 56.25 tons per sq.ft. The masonry pillars probably do not add more than 5% to the area, so that the pressure must still be in the neighborhood of 45 tons per sq.ft.

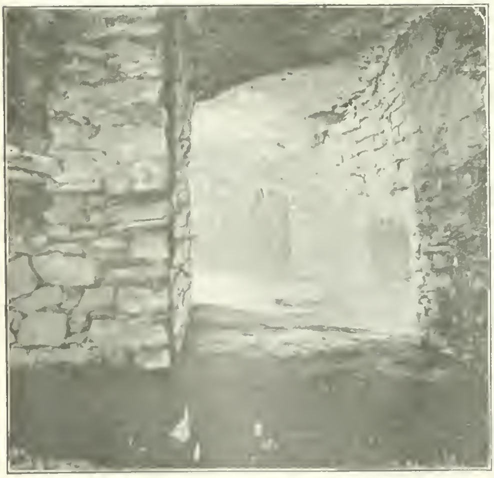

FIG. 10. GOB WALLS AROUND AND BETWEEN MASONRY PILLARS

The space between and around the masonry pillars is filled to the roof with hand-placed stone and débris—gob, as it is called—but this would not come into play as a column until some squeeze or settlement had occurred. All visible pillars have painted numbers, and the passageways are to be left open permanently, so that it will be possible to make inspections of the underground conditions.

Garbage Disposal for Two Illinois Cities

By Samuel A. Greeley*

Reports on refuse collection and disposal have been made by the writer to the two Illinois cities of Danville (35,000) and Galesburg (25,000) after investigations extending over several months. An act passed by the Illinois legislature in 1915 authorizes cities and villages with populations of less than 100,000 to establish and maintain plants for the collection and disposal of garbage and to levy a tax for the purpose not to exceed two mills on the dollar. This makes available in Danville about $18,000 per year and in Galesburg $14,000.

There are approximately 7,000 houses in Danville. Nine private scavengers collect garbage from some 200 customers, charging about 25c. per week. If this rate were applied to all the houses in the city, the annual cost would be over $80,000. The garbage is disposed of by dumping and by feeding to pigs. There are several dumps, and they are particularly unsightly on account of the tin cans and rubbish.

Night soil is removed by licensed private scavengers and is taken to a concrete dumping platform and emptied into the main sewer.

Disposal of Garbage and Refuse

After a careful analysis of local conditions and comparison with accurate records of refuse production in other cities it was estimated that the daily refuse production of Danville in 1920 would be: Garbage, 12.9; ashes, 32.4; rubbish, 6.5; tin cans, 2; manure, 12.5; total, 66.3 tons. Careful estimates were also made of the monthly and daily variations of refuse materials, as shown by Table 1.

Methods of refuse disposal were compared for each of the refuse materials and for mixed refuse. For garbage the methods of disposal considered were burial, feeding to pigs, incineration and reduction. Burial was recommended for the present, the estimated area of land required being 15 acres. With the growth of the city other methods would become advisable, as outlined later.

TABLE 1. MONTHLY PRODUCTION OF GARBAGE IN PERCENTAGE OF TOTAL ANNUAL PRODUCTION

Month	Columbus, Ohio	Dayton, Ohio	Fort Wayne, Ind., Estimated	Racine, Wis.	Danville, Ill., Estimated
January	6.28	6.58	6.20	5.56	6.10
February	5.67	6.82	6.00	5.12	5.90
March	6.36	7.45	6.70	6.22	6.50
April	6.70	7.05	6.70	6.54	6.90
May	7.78	7.20	7.40	7.23	7.40
June	7.82	8.18	8.30	9.22	8.40
July	9.40	10.21	10.10	10.89	10.00
August	12.24	10.74	11.20	11.29	11.20
September ...	12.95	11.08	12.00	12.29	12.40
October	9.20	8.94	9.40	9.04	9.20
November ...	7.83	8.10	8.10	8.35	8.10
December	7.77	7.62	7.90	7.65	7.90
	100.00	99.97	100.00	99.40	100.00

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*Consulting Sanitary Engineer, 64 West Randolph St., Chicago, Ill.

A summary of the estimated costs of different methods f garbage disposal is given in Table 2. The annual osts are for 1920, with 4,000 tons of garbage for the ear. These costs include land, scales, roadways, sewers, 'ater connection, coal siding, etc. A rubbish-sorting lant was estimated to cost $9,020, and the gross revenue as estimated at $6.800 per year.

TABLE 2. SUMMARY OF ESTIMATES OF COST OF GARBAGE DISPOSAL AT DANVILLE, ILL.

Method of Disposal	Number of Plants	Capacity, Tons per 24 Hr.	First Cost, Complete	Annual Cost Oper-ation	Annual Cost Fixed Charges	Annual Cost Total	Revenue	Net Annual Profit
urial	2	12.9	$19,180†	$2,600	$1,215	$3,815	None	....
eeding to pigs	1	...*	44,000	7,300	2,819	10,119	$15,000	$4,881
eduction..	1	36.0	63,250	7,540	5,060	12,500	21,600	None
eduction..	1	24.0	45,000	7,540	3,375	10,915	12,600	1,685
ıcineration	1	40.0‡	31,350	4,480	2,445	6,905	None	....

*Land sufficient for additional capacity; buildings easily lded and pigs bred as required. †Includes land to last ıtil 1920. ‡Includes capacity for rubbish.

REFUSE COLLECTION

Special consideration was given to the collection service a most important phase of the problem. A population ot map of the city was made, from which the wagon stricts were determined. Where possible, each wagon as planned to make one trip per day. The number wagons was then determined for each refuse material ıd for each method of disposal. Thus for disposal of ırbage by burial two collections per week were assumed. he wagon capacities were planned for the maximum ıantity of garbage. On the average each wagon was timated to serve 200 houses per day, a total of 10 ıgons being required. The first cost of wagons and uipment was estimated to be $3,850, and the annual st $11,377.

For garbage disposal by feeding to pigs two collections r week were assumed for the fall, winter and spring ıd three collections per week during the three summer onths. Owing to the longer haul, each wagon was timated to serve an average of 167 houses per day. The st of wagons and equipment was estimated at $5,600 ıd the annual cost at $14,850.

For the separate collections of rubbish a 10-day terval in collections was estimated. The wagon capac- was figured at 8 cu.yd. Two men were to work th each wagon, and the wagons were to make two trips r day. Three wagons were required for the service. milar estimates of the collection service were made for her conditions.

RECOMMENDATIONS FOR REFUSE DISPOSAL

The recommendations resulting from the investigation 're summarized as follows:

1. That an ordinance should be adopted establishing oper sanitary methods for the house treatment of refuse d the stable treatment of manure.

2. That 10 collection wagons be purchased at an estiıted cost of $3.850. Specifications should be prepared and ls received.

3. That a permanent system for garbage collection should established to give regular service twice a week. The ıgons should be owned by the city, and the horses and col'tors should be hired. Collectors should be required to wear aki or duck uniforms.

4. That garbage be disposed of for the present by burial two fields located on each side of the city. Five loads of rbage would be buried daily at each field. The estimated st of weighing scales, roadways, etc., at the burial fields $4,180. Garbage should be given to farmers who call for in proper wagons at these fields, thus reducing the amount garbage to be buried.

5. Proposals should be entertained for disposal of garbage by contract at some isolated location at an annual cost favorable to the city. Such arrangement should include a formal contract in which the character of plant and equipment is clearly defined to be of a type that can be operated on a sanitary basis. The contract, however, should not include collection.

6. A site with an area of about one acre should be purchased along the Chicago & Eastern Illinois Ry. at some location near the center of production of refuse. The site should be used for shipping tins and rubbish to the market. It should be reserved for a future incinerator, when disposal of garbage by burial or otherwise is no longer feasible, due to the increased population and scarcity of land for burial.

7. As the garbage-collection service becomes established, the collection of tins and rubbish should be started, and they should be shipped to the market for sale. After a site is secured, plans and specifications should be drawn up for a loading station for these materials.

The estimated first cost for the collection and disposal of garbage by burial is $9,000, and the annual cost of operation is estimated to be $14,300.

For garbage disposal by burial a trench is dug or ploughed about 3 ft. wide, 6 in. deep. Into this the garbage is dumped from the wagons and spread in a thin layer. A trench for the next day's garbage is dug and the excavation from this used to cover the garbage already spread. About 160 lin.ft. of trench would be required per day at each field for the average daily quantity of garbage of 12.9 tons.

For cold weather two methods are feasible. A sufficient length of trench to last through the winter may be opened before the frost sets in; or the garbage may be spread on the ground and covered with ashes and dirt, the mixture being ploughed into the soil during the spring. The preferable way is to plough enough furrows for garbage burial during the winter and to cover the garbage in the furrows with adjacent earth, ashes or street dirt. No decomposition takes place during the winter, and the covering can be trimmed and reinforced in the early spring.

The equipment should include a scale and scalehouse, with a room and stove for the operator and a place for washing the wagons. During the summer months garbage containing maggots should be soaked in a germicide. Sodium arsenate, creosote or other coal-tar derivatives can be used.

Somewhat similar recommendations were made for Galesburg, except that the work was limited to the collection and disposal of garbage. At Galesburg, options have been secured on burial fields, the rental to be about $100 per year. The council has passed the ordinance and has authorized the purchase of wagons. At Danville, negotiations for burial fields are still pending.

⁂

The Elephant Butte Dam on the Rio Grande River is to be formally dedicated on Oct. 14, at the time of the Irrigation Congress meeting. The dam has been built by the United States Reclamation Service Its completion was recorded in "Engineering News" of May 18, p. 961. An official announcement of the dedication, issued by the Interior Department, states that the dam surpasses any dam ever before constructed in the volume of water stored behind it, as the reservoir when filled "will contain 856 billion gallons, enough water to cover the State of Delaware 2 ft. deep." The compiler of this announcement evidently forgot the Gatun Dam on the Panama Canal. According to the paper by F. D. Willson, Chief Hydrographer of the Panama Canal, at the International Engineering Congress, Gatun Lake, when its surface is 87 ft. above sea level, contains 1,442 billion gallons of water, which, it will be seen, is nearly twice as much as the capacity of the Elephant Butte reservoir. Both of these big bodies of water are modest lakes compared with the great reservoir behind the Assuan Dam on the River Nile, where, as stated in "Engineering News" of May 11, p. 906, the volume of water stored is over 20 times the volume of Gatun Lake.

Large Activated-Sludge Plant at Milwaukee, Wis.

SYNOPSIS—Layout, details of design and rates on operating experience of plant for treating part of the sewage of Milwaukee by aëration in the presence of activated sludge.

Luckily, just as the activated-sludge process of sewage treatment appeared on the American horizon, Milwaukee was in position to give it a thorough-going test at its sewage experiment station. From laboratory apparatus and fair-sized outdoor tanks of the fill-and-draw, and then of the continuous-flow type, the city went on to a 2,000,000-gal. continuous-flow unit, put in operation on Jan. 22, 1916. A description of this large unit follows.

Before describing the plant it may be noted that a factor in its design was the possible conversion of the activated-sludge tanks into digestion chambers for Imhoff tanks in case the new process does not prove to do all that there is reason to hope.

The activated-sludge plant is located on Jones Island, alongside a large outfall sewer of the combined system. It consists of eleven tanks. Eight of these are used in series for aëration of the sewage in the presence of activated sludge; one is a sedimentation tank and two are sludge-aëration tanks. Fig. 1 shows the layout of the plant. Figs. 2 to 5 give details of the various tanks. Of the three views, Figs. 6 and 8, shows the plant under construction, and Fig. 7 shows a group of filtros blocks or air

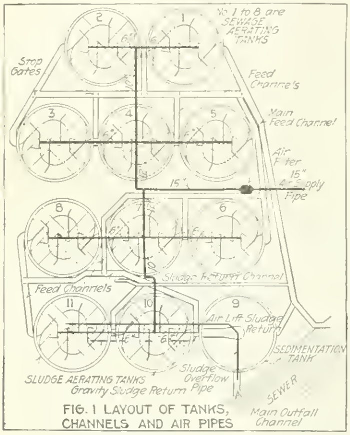


FIG. 1 LAYOUT OF TANKS, CHANNELS AND AIR PIPES

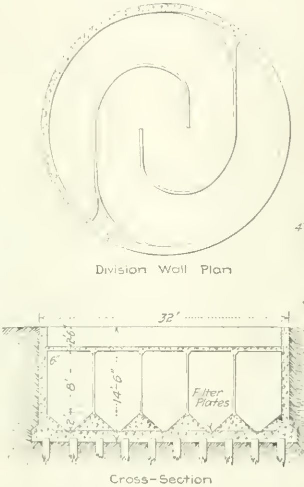


FIG. 2 SEWAGE-AERATING TANKS

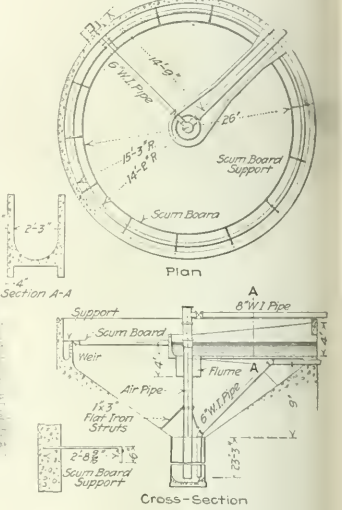
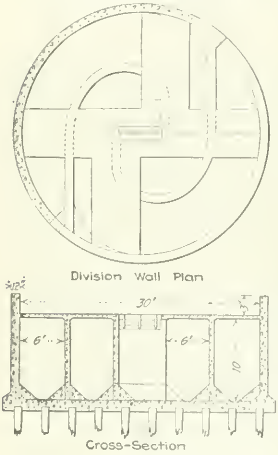
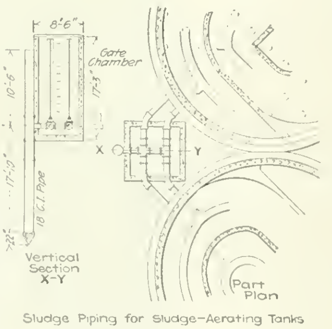


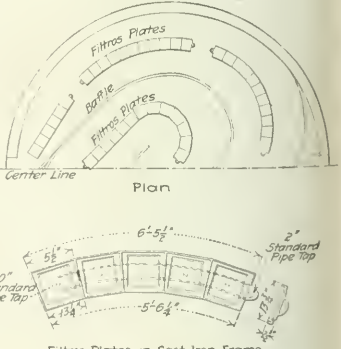
FIG. 3 SEDIMENTATION TANK





Sludge Piping for Sludge-Aerating Tanks

FIG. 4 SLUDGE-AERATING TANKS

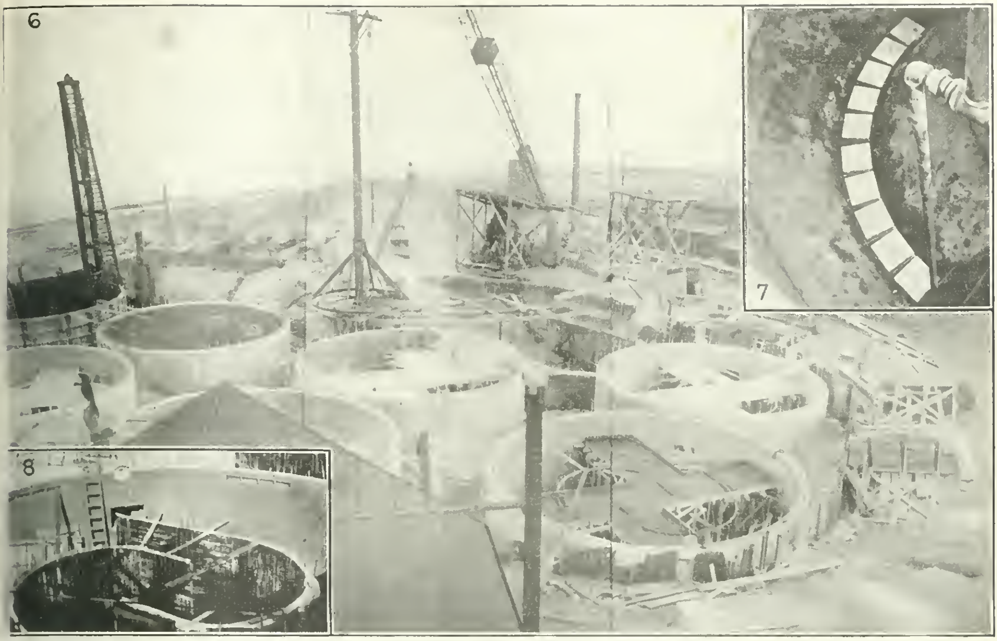


Filtros Plates in Cast-Iron Frame

FIG. 5 AIR-DIFFUSER SYSTEM

FIGS. 1 TO 5. LAYOUT AND DETAILS OF 2,000,000-GAL. ACTIVATED-SLUDGE PLANT, MILWAUKEE, WIS.

Sewage and "seeded" sludge are aërated in tanks 1 to 8, the combined sewage and sludge passing on from one tank to another and then into sedimentation tank 9. From the bottom of a deep well in tank 9 the sludge is discharged by gravity into either sludge-aëration tank 10 or 11. The aërated sludge from these two tanks passes outside the tanks to a 48-in vertical cast-iron pipe set 28¼ ft. in the ground, from which it is lifted by air and returned to the inlet to sewage-aërating tank 1



FIGS. 6 TO 8. CONSTRUCTION AND DETAIL VIEWS OF ACTIVATED-SLUDGE PLANT, MILWAUKEE, WIS.

Fig. 6—General view taken while plant was under construction, showing several tanks with platforms in place above tops of baffles. Fig. 8—Curved baffles to guide sewage flow in aërating tanks. Fig. 7—Looking down on a set of filtros air-diffusers in V-shaped bottom of curved portion of flowing-through chamber; showing air-supply pipe on the right

ffusers in place. The general scheme of operation is ated in descriptive note beneath Figs. 1 to 5 on the eceding page.

Each of the eleven tanks is built of reinforced concrete, ıs an internal diameter of 30 ft. and has side walls exnding 13 ft. above its inner bottom. The total depth of wage and sludge is 10 ft. and the average depth is 9 ft. in e ten tanks used for aëration. The sewage and sludge the sedimentation tank is 35.2 ft. deep.

The holding capacity of each of the eight sewage-aëratg tanks is 45,000 gal., or 360,000 for the group. The en area of each of these tanks is 662.84 sq.ft. and all them, 5,303 sq.ft.

The sedimentation tank has a holding capacity of ,000 gal., not including the 2,260 gal. held by the 18-in. st-iron sludge pipe extending below its bottom.

Normal lake level is at El. —1.4. The sewage level in ınk 1 is at El. +0.8 and the weir in the sedimentation nk is at El. +0.5, giving a fall of 0.3 ft. in water level rough the series of tanks.

By means of the curved baffle or division walls shown in e illustrations, the sewage travels and is subjected to ration for a distance of 912 ft. Air diffusion is effected means of 12x12-in. filtros plates, 78 to each sewage-d sludge-aëration tank. This gives a ratio of diffusing rface to tank surface of 1 to 8.5. The filtros plates are t in cast-iron frames, which afford an air-supply conduit neath the center line of each plate. The estimated air pacity of the filtros plates in the eight sewage-aërating nks is 2 cu.ft. per min., and in the two sludge-aërating nks it is 12 cu.ft., in each case under a 2-in. water essure.

Compressed air is supplied by a Connersville positive blower of the Boston type, with a capacity of 2,400 cu.ft. of free air per minute, compressed to 5 lb. per sq.in. This blower is belted to an alternating-current variable-speed motor of 75 hp. To prevent interruption in service this equipment is in duplicate. The two units cost $2,987, erected, including a frame house.

The volume and rate of air supply is measured by indicating recording integrating General Electric meters, there being one for the eight sewage tanks and another for the two sludge tanks. These meters cost $311 and $305, respectively.

The plant capacity under three different operating-rate schemes is as follows: (1) With 25% activated sludge in the aërating tanks, a 4-hr. running-through period, a velocity of 3.8 ft. per min., and a 27-min. sedimentation period, 1,620,000 gal. a day; (2) 25% activated sludge, 3-hr. running through, 5-ft. velocity and 20-min. sedimentation, 2,160,000 gal.; (3) with 20% activated sludge, 3-hr. running through, 5-ft. velocity and 19-min. sedimentation, 2,304,000 gal. capacity.

The plant has a total ground area of 0.347 acre, or 0.173 acre per 1,000,000 gal. capacity. The contract price for the eleven tanks, including 72 piles 40 ft. long under each tank and all piping, was $55,000. Adding the cost of the motors, blowers and air meters gives $58,606 as the total contract price of a 2,000,000-gal. activated-sludge plant under Milwaukee conditions. The final total estimate was $58,606. To this should be added $2,930 for engineering and inspection, making a grand total of $61,536 or $30,768 per 1,000,000 gal. The bonds bear 4½% interest and require a sinking fund of 5%.

The plant was built by the Milwaukee Sewerage Commission, of which George H. Benzenberg is chairman, T. Chalkley Hatton, chief engineer, and William R. Copeland, chemist and bacteriologist.

RESULTS OBTAINED IN OPERATION

The results of the operation of the Milwaukee activated-sludge plant through the first months of its service was summarized for *Engineering News* by Mr. Hatton on Aug. 15, 1916, as follows:

The plant went into operation on Jan. 22, 1916, and, with few interruptions, has been working under varied schedules up to the present time.

Early in the operation it became apparent that the sedimentation tank was not designed to properly meet the conditions, in that the velocity through the tank was too great and the bottom slope was too little. Instead of a 27-min. sedimentation period the indications are that about 60 min. will be required to permit the finer floc to settle out.

The settled sludge rested upon the sloping bottom to a considerable extent and, unless removed at frequent intervals by using a squeegee, became septic and consumed the dissolved oxygen contained in the influent. In addition to this, sludge accumulated in the 48-in. cast-iron pipe which was not removed by the air lifts, and this also became septic.

Instead of a 45° slope the bottom of the sedimentation tank should not be less than a 60° slope from the horizontal, and the sludge should be removed from a pipe built at the apex of the conical bottom so as to insure its constant and complete removal.

With the sedimentation tank as built it has not been possible to get more than 1,000,000 gal. of clear stable effluent per day through the plant without losing the sludge.

In order to try out horizontal-flow sedimentation, No. 11 tank has been improvised into three compartments, each of which can be operated separately. So far the indications are that an average horizontal velocity of 3 ft. per min. will be sufficient to secure satisfactory sedimentation, but this figure is subject to further determinations.

In operating the large plant throughout the last seven months several important matters have been fully demonstrated, among which may be mentioned: That an increase of air pressure is required due to the partial silting up of the top surface of the diffuser plates, which indicates that provision must be made to clean off these plates at intervals.

That when the temperature of the sewage is 50° F., or under, more air is required to produce an equal effluent from sewage having a temperature of 60° F. or over.

That circular tanks are not so efficient as rectangular tanks either in first cost or in operation and require much more area to treat an equal volume of sewage than do rectangular tanks.

That the mixed sewage and activated sludge must not be run through conduits as the tendency is for the sludge to settle out immediately in the conduits and become septic. The sedimentation tank must be connected to the aërating tanks without conduits.

That the settled sludge must be constantly and completely removed from the sedimentation tanks to prevent septic action.

Placing Foundations for Coke Plant Near New York

Work was started last April on the construction of a by-product coke plant on the Hackensack meadows, near Jersey City. The site of this plant, comprising about 35 acres, lies just north of the Delaware, Lackawanna & Western R.R. tracks on the west bank of the Hackensack River and just across the river from the power plant of the Public Service Co., of New Jersey. The gas manufactured in this byproduct coke plant will be piped by way of a tunnel under the Hackensack River to the gas holders of the Public Service Co., on the opposite bank. From there it will be pumped by means of a new pipe line to Newark and there distributed. This plant is being built by H. Koppers Co., of Pittsburgh, Penn., for the Seaboard Byproduct Coke Co., of New Jersey, and will consist of 110 Koppers byproduct coke ovens, together with a complete system for the recovery of coal byproducts.

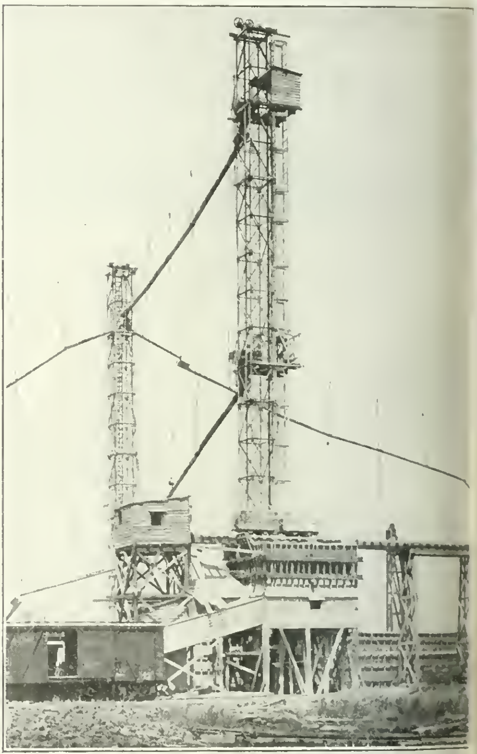


FIG. 1. MIXING PLANT AND HOIST TOWERS

The ground is very poor for foundation purposes, being made up of a considerable depth of silt underlai by strata of sand and gravel. Bedrock or hardpan is foun very deep. A peculiarity of the soil, however, is that afte piles have been put down and left a while it is practically impossible either to withdraw them or drive the farther. The packing of the material by a number of pile seems to bind them very tightly in place. On account this peculiarity of the soil only the heaviest loads ar

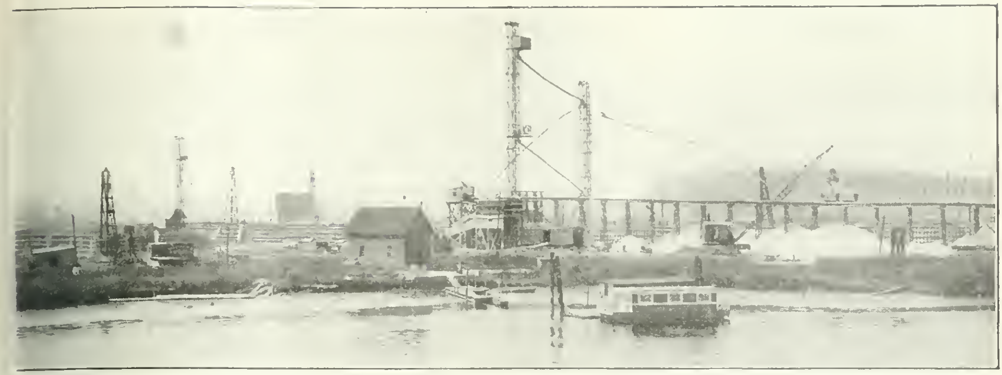


FIG. 2. GENERAL VIEW OF CONCRETE-DISTRIBUTING PLANT OF H. KOPPERS CO. AT JERSEY CITY

rried on piles driven to rock. The total number of iles required for the foundation work in this plant will e about 15,000.

The first operation for foundation work was to put down iling for the oven batteries and the two 200-ft. stacks. he remainder of the piles for the byproduct building, nks, etc., are being put down as needed. As soon as the iles for the ovens and stacks were in place, the concrete lant was erected. This is an extensive system and is own by the views.

The concrete materials are delivered to a dock by barges the Hackensack River. The materials are unloaded to an elevated hopper at a temporary wharf, by means a stiff-leg derrick equipped with a grab bucket. This pper is built over a narrow-gage track running on a mber trestle from the dock to the main hoist tower. Two cars coupled together are operated on this trestle by means of an endless cable. The cars are loaded under the hopper, which is provided with two outlets, and are then hauled up the trestle incline and dumped either in bins at the mixing plant or into storage piles along the way. When sand or crushed stone is required from the storage piles, it is loaded into the two cars by the locomotive crane, shown in Fig. 2, and then conveyed directly to the mixing bins.

The mixing plant consists of a $\frac{3}{4}$-yd. Lakewood mixer with the necessary sand and stone bins and a cement hoist connected to the mixing platform by means of a belt conveyor. Water is piped directly to the mixer platform. The mixer discharges into a bucket elevator operating in a 135-ft. Lakewood steel hoist tower. From this tower, concrete is conveyed by chutes either directly to

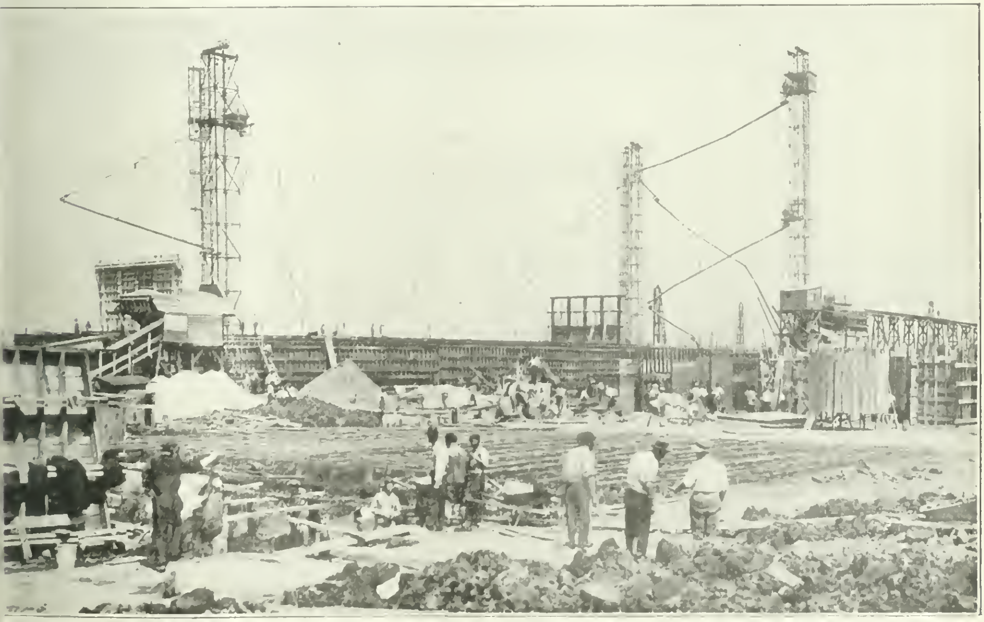


FIG. 3. GENERAL VIEW OF SEABOARD BYPRODUCT COKE CO. OF NEW JERSEY

forms, or it is relayed to the forms through a second tower 105 ft. high and about 100 ft. distant from the first tower.

Concreting is carried on night and day. Davis floodlight projectors furnish excellent lighting for the night work. Quarters have been erected for about a hundred laborers who live right on the job.

Concreting was started on July 1 and is going forward at the rate of 400 cu.yd. per day from one central plant. The total concrete work will amount to 35,000 cu.yd., with about 700 tons of reinforcement. A standard flat-car has just been equipped with another ¾-yd. concrete mixer with tower to do the concreting that is beyond the economical reach of the central plant. This work is carried on under the direction of T. S. Fillebrown, Erecting Engineer for H. Koppers Co.

* * *

Resurfacing Concrete Pavement with Reinforced Concrete

The practice of resurfacing worn-out concrete pavements on country roads is too new to have accumulated much in the way of actual experience. Bituminous carpets have been tried, and brick pavements have been suggested for resurfacing, but so far as now appears, the Board of Road Commissioners of Wayne County, Michigan, is the first highway authority to try resurfacing concrete pavement with new concrete.

The road selected for the experiment was built in 1910 as a two-course pavement. It was 6½ in. thick and 16 ft. wide, laid on a crowned subgrade. The 4-in. bottom course was 1:2½:5 mix, using crushed limestone for the coarse aggregate. The wearing course, 2½ in. thick, was 1:2:3 mix, crushed fieldstone being used. The pavement was laid in 25-ft. sections with ¼-in. tar-paper strips for joints.

The surface was struck off with a templet and was somewhat irregular in finish, as the same care and thoroughness that are found in the present practice were not exercised at that time with regard to finishing. The edges of the road were rounded off with about a ¾-in. radius (a practice since abandoned).

A traffic census in 1912 showed about 7,500 vehicles a week, of which 40% were horse drawn. The territory has been built up rapidly since this traffic count was taken, and an actual count at the present time would undoubtedly show a very material increase in the number of vehicles passing the section where the road is reconstructed.

Road Widened and Resurfaced

To accommodate better this increased traffic, it was decided to widen the road to 20 ft. In order to do this the rounded edge was broken off, and concrete was added on each side of the old road to bring it to the required width. A 1:2:4 mix, 6 in. thick, of washed and screened pebbles and washed and screened sand—of the same quality as the present specifications require—was used.

All the Tarvia surfacing and filling used to cover the cracks were removed. The cracks and holes were then filled with concrete to make an even surface 20 ft. wide. The expansion joints were mostly worn down. Where a joint was spalled to a considerable extent, the old concrete was broken away sufficiently to give a bond for the new concrete on both sides of the joint. Expansion felt was then placed in the joint and the whole surface brought to an even grade.

On top of this base was placed a 3-in. layer of 1:1½:2½ concrete—using Marquette (Mich.) traprock, graded in size from ¼ to 1 in. for the coarse aggregate, and washed and screened bank sand for the fine aggregate This surfacing is in no place less than 3 in. thick an is reinforced with No. 26 triangular-mesh wire.

No attempt was made to bond the top course to the ol base with a rigid bond. The surface of the old concret was first sprinkled with water, then a hot mixture o Tarvia A and Tarvia X was sprinkled over it, using a ordinary hand sprinkling can. This was done immedi ately before placing the new wearing surface. The Tarvia falling on the moist concrete, spread out in a very thi layer and was immediately chilled, thus forming an eve coat over the old surface.

The expansion joints in the new top course were mad to coincide exactly with the expansion joints in the bottom course. A piece of wood 3x4 in. by 20 ft. long was lai over the old joint and the concrete deposited as thoug no joint was to be made. A Baker automatic finishin machine was used to finish the surface. Afterward, th piece of wood was removed and armor plates, suspende from installing bars, with expansion felt between, wer set in place, the felt of the new joint meeting the tar pape of the old joint.

No Adhesion of Old to New Concrete

This method of entirely separating the old base from the new surface was decided to be better than pouring th top course directly on the old surface, as a slight move ment due to difference of expansion or heaving woul result in cracks in the top course if they were rigidl bonded together. The Tarvia, although very thinl spread, permits a slight movement of each course withou interfering with the other.

Before trying this type of construction small slabs o concrete were made, a coat of Tarvia was put on top an another course of concrete deposited. It was found n only impossible to separate the two layers, but a blo sufficient to crack the top course also cracked the botto one.

This section of the road has been in use for abo three months, and a few cracks have developed. A yea from now a positive statement as to the success of th pavement may be forthcoming.

The above data were furnished by Edward N. Hine a member of the Board of Wayne County Commissioner who writes that he wishes it understood that the wor described is considered entirely experimental.

* * *

Accidents on State Highways do not make the state liabl for damages, even though the accident was due to negligenc of employees of the State Highway Department, according t a decision just rendered in Pennsylvania. Under the Pennsylvania constitution, in order to bring a suit for damage against the state, an enabling act must be passed by th state legislature. William D. Dietrich, of Indiana, Penn was authorized by an act passed June 8, 1915, to bring su against the state to recover damages for injuries suffere while driving on a state highway. The attorney-general the state filed a demurrer, claiming that the action could n be maintained. In the Court of Common Pleas, Judge L. Davis decided that the state was not liable for the wrongf acts of its officers or agents, such as those in charge of highway work, unless it had voluntarily assumed such liabilit An act permitting the injured party to bring suit merel placed his cause in shape so that it could be passed upon b the court

Motor Trucks Ruin Improved Granite-Block Pavement

A remarkable example of the destruction by the action motor trucks of a pavement especially designed for avy traffic is to be seen on West 42d St., New York City. The motor trucks that carry broken rock from the subay excavations to the waterfront run down 42d St. They e four-wheel rubber-tired tractors hauling steel-tired o-wheel trailers, the whole vehicle with its load of rockled skips weighing some 19 tons. On the block from h to 10th Ave. the traffic is not dense, there is a slight wn grade, and the loaded trucks frequently obtain eeds estimated at 15 to 20 mi. per hour. The terrific pact of these vehicles was sufficient in only some four onths to crush a number of the granite paving blocks powder and leave holes in the pavement, necessitating aying 79% of it on the north side of the street, the side d by the loaded trucks.

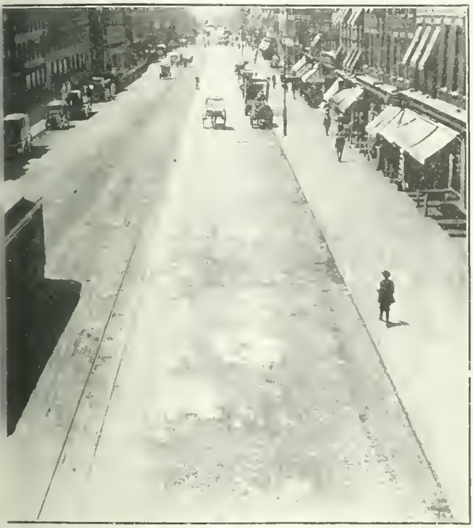


FIG. 1 WEST 42ND ST., NEW YORK CITY, SHOWING DAMAGE TO PAVEMENT

This stretch of pavement was laid in 1912 under the rough of Manhattan specifications for improved gran-block pavement.[1] H. W. Durham was then chief engir of the Bureau of Highways. The pavement is similar many others laid about the same time and since, which showing excellent wearing qualities. It ought to have n good, in the estimation of experts, for at least 25 rs' service. The failure of the pavement by grinding and splitting of the granite blocks was unlooked for d most extraordinary. It furnishes ample proof that a y engineering department can hardly hope to design a vement that will stand up under such traffic.

The half of the pavement north of the street-car tracks this block has an area of 1,850 sq.yd. On Apr. 15 of present year the pavement was carefully gone over, minor repairs were made, which put it in first class dition. Between Apr. 15 and Aug. 24 this north-side pavement suffered damage that required, between Aug. 24 and Sept. 16, the relaying of 1,470 sq.yd., or 79% of the whole area. New blocks were required for 12% of the area relaid. The cost was not less than $2,000.

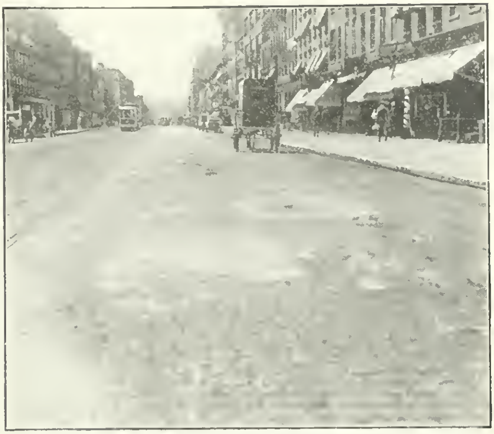


FIG. 2. NEARER VIEW OF HOLES IN GRANITE-BLOCK PAVEMENT

The evidence shows practically conclusively that the damage was done by the extraordinarily large motor trucks used to haul to the North River waterfront the material excavated for the new Broadway subway. The loading and handling of these trucks were briefly described in *Engineering News*, Feb. 17, 1916, p. 324. An accompanying view shows one of these trucks. About two-thirds of the load of the six large steel rock skips carried comes on the steel-tired wheels.

The speed of these heavily loaded vehicles on an open stretch of level pavement, such as that on West 42d St. between 9th and 10th Ave. is almost unbelievable. An estimate of 15 to 20 mi. an hour has been made by several trustworthy observers. The effect of 12,000-lb. wheel loads on 8-in. steel tires at this rate of speed is ruinous to any pavement. The impact of the wheels jumping from one slight hump to another crushed and split the granite blocks to fragments, as is shown in Fig. 1, notwithstanding whatever cushioning effect the sand bedding may have had.

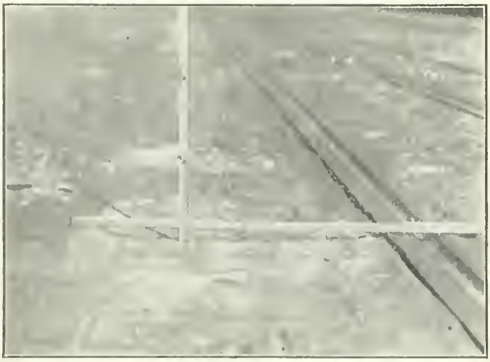


FIG. 3 WHEEL RUTS ALONG STREET-CAR RAIL

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[1] Square-cornered 6-in. granite blocks, 1-in. sand cushion 6-in. concrete foundation. Blocks laid with not more than in. joints, bituminous filled.

The theory has been advanced that the pavement would have suffered less had it been of smooth cement-grouted-joint type. This is probably true to a certain extent, yet ever so small a depression or hump would have started the hammering on adjacent blocks, and the result sooner or later would have been the same, for one depression inevitably leads to another. It does not appear that the quality of the granite was a contributing cause, for paving blocks in 10th Ave., which is of the toughest and hardest granite used in New York City paving work, have begun to go in exactly the same way.

It is evident that the speed of these vehicles is a larger factor in the destruction of the pavement than the wheel loads, extraordinarily heavy though they are. Other crosstown streets used by the same vehicles are narrower and do not permit of the speed possible on 42d St., and the pavements on these streets show less damage. Moreover, during the period referred to the larger part of the traffic apparently went via 42d St.

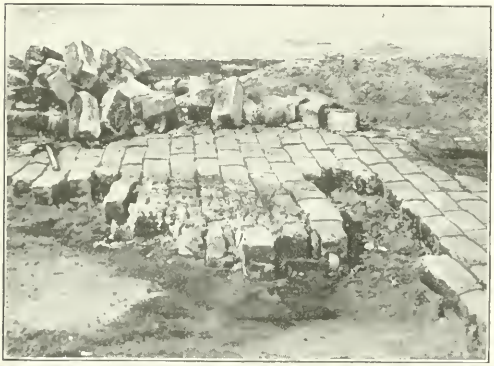
FIG. 4. SHOWING HOW BLOCKS ARE BROKEN AND CRUSHED

Investigation showed that the concrete foundation under the blocks had not been injured, but had remained intact. The failure of the pavement is wholly one of crushing of the granite-block wearing surface under traffic—an unheard-of thing up to this time.

In making repairs, as many of the old blocks as were sound were reused, but about 12% of new blocks was required to take the place of those crushed. The blocks were relaid on a 1:4 cement mortar bedding, according to the present practice of the Bureau of Highways, und E. W. Stern, chief engineer.

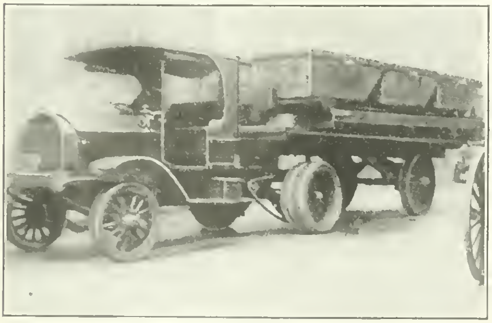
FIG. 5. TYPE OF MOTOR TRUCK WHICH DOES THE DAMAGE

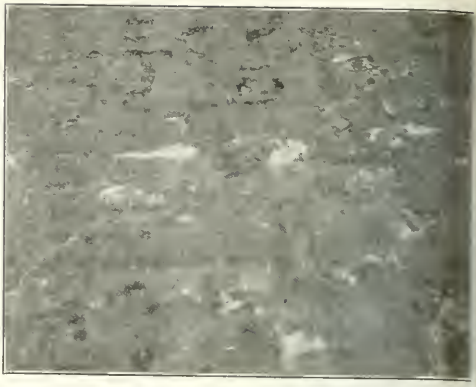
FIG. 6. ASPHALT-CARPETED SURFACE, SHOWING ABRASION ON BLOCKS BELOW

The joints were refilled with asphaltic grout, and carpet coating of the same material was spread over t surface of the pavement for the purpose of cushioning th effect of any future hammering. The result has not bee wholly satisfactory, as Fig. 6 shows. The heavily load steel-tired wheels are picking up the asphalt carpetin and the white powder of crushed granite has alread (Sept. 21) begun to appear on the relaid blocks.

The corporation counsel of the City of New York ha advised against an attempt to collect damages, on th ground that the pavement is not new, and that it ma not be legally proved that the damage was done by th particular trucks in question. New York, like most oth American cities, has no special ordinance limiting whe loads or motor-truck speeds, to prevent damage to pav ments. There are instances, however, where the city ha collected damages for manhole covers broken by exce sively heavy loads.

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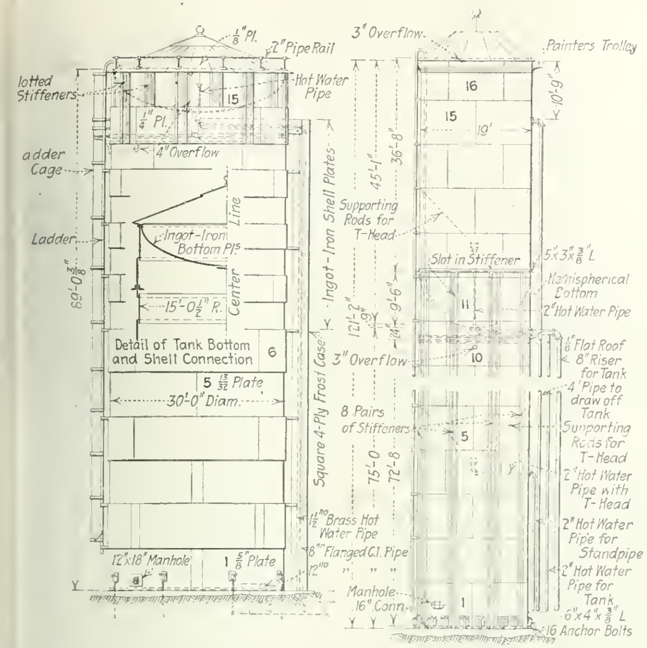
Combination Standpipes and Elevated Water Tanks

A standpipe having an interior diaphragm or botto so that its lower portion may be used for ordinary stora while its upper portion is converted into an elevated pressure tank for fire-protection sprinkler service is an inte esting type of structure, of which two examples are de scribed below. Both of these were designed and built i 1915 by the Chicago Bridge and Iron Works, of Chicag

The combined standpipe and tank, shown at the left i Fig. 1 and in Fig. 3, is at South Poland, Maine. It wa built for Hiram Ricker & Sons, bottlers of the Polan spring water. It is 30 ft. in diameter, with a total heigh of 90 ft. The tank portion is shallow, being formed b a segmental bottom of the builder's standard type at tached to the inside of the upper edge of the top course o shell plates. The capacity of this sprinkler tank is 26,00 gal., while that of the standpipe proper is 400,000 gal.

The load of the tank is carried directly by the shell o the standpipe, stiffeners being riveted only on the to courses, as shown in Fig. 2. A peculiar feature is tha the stiffeners are slotted in order to provide opening through which the upper portions of the seams of th



'GS. 1 AND 2. DETAILS OF TWO COMBINATION STANDPIPES AND TANKS

Fig. 1 (Left)—Construction of combined standpipe and tank at South Poland, aine, showing detail of tank bottom. Fig. 2 (Right)—Combined standpipe and nk at Maywood, Ill., showing tank bottom and pipe connections

nk bottom could be reached for riveting. The lower rtions of these seams are accessible from the inside of e standpipe. Another feature is the use of a safety lder, having a cage on the outer side to prevent men om falling.

The water-supply is led to the tank through an outside in. pipe that runs horizontally across the top of the andpipe to its connection at the center of the tank bot- m. A platform in the standpipe affords access to this pe connection. The overflow outlet of the standpipe so placed that the water cannot rise to the level of the atform. There is also a hot-water pipe leading into the nk. Both pipes are inclosed in a frostproof casing. e 8-in pipe serves for both inlet and outlet.

A very novel and interesting feature in this structure the use of Armco rustless ingot-iron plates for the nk bottom and for the upper courses (about 30 ft.) of e standpipe shell. As these plates are not rolled in de sizes, these courses are only about 1½ ft. high, ile the lower portion of the standpipe has 7½-ft. urses of steel plate. The owners decided on this use of ecial metal for the reasons that the air beneath the tank ttom will be laden with moisture and that the upper rt of the standpipe will be alternately wet and dry, cording to the varying level of the water. The struc- re was given two coats of graphite paint, one at the ops and the other after erection. The frostproof casing ceived two field coats of graphite paint.

The combination standpipe and tank shown at the ght of Fig. 3 and in Fig. 2 has a much larger oportion of its contents utilized as a sprinkler tank. It is at the plant of the American Can Co., at Maywood, Ill. The diameter is 19 ft., and the total height is 121 ft. The standpipe portion is 75 ft. high (72 ft. 8 in. to water level), with a capacity of 154,000 gal. The tank portion is 45 ft. high, with a capacity of 90,000 gal. It has a standard hemispherical bottom, as shown in Fig. 2. For each portion there is a 2-in. pipe for hot water, this being of brass inside the tank and standpipe. Owing to the much greater tank load in this case, the standpipe is reinforced for its full height by stiffeners extending from an outside 5x3-in. angle-iron ring at the level of the base of the tank to the base of the standpipe. These stiffeners, eight in number, are composed of pairs of angles 3x2½x$\frac{5}{16}$ in. They are slotted at the top for riveting the tank-bottom seams, as in the other structure. Between the bottom of the tank and the standpipe overflow outlet is a flat roof of $\frac{1}{8}$-in. plates supported by 6-in. channels spaced 24 to 36 in. c. to c. and having their ends resting on an interior angle-iron ring.

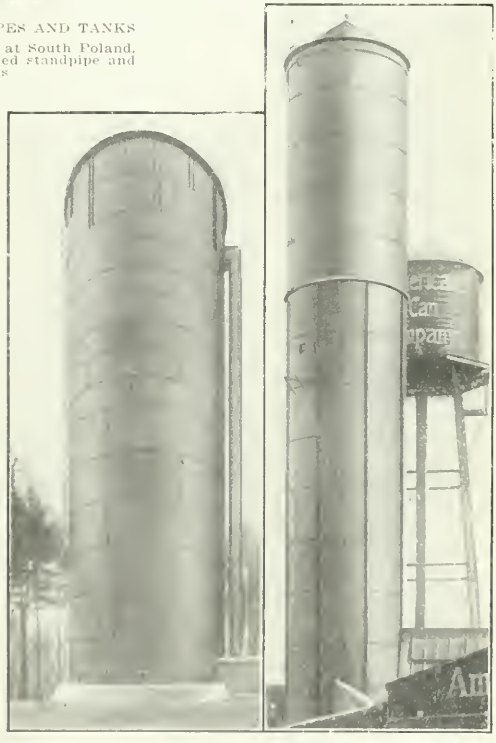


FIG. 3. COMBINATION STANDPIPES AND ELEVATED SPRINKLER TANKS

The one at the left is at South Poland, Maine. The other is at Maywood, Ill.

Stirrup Spacing Diagrams

By Frank S. Bailey*

The diagrams here shown give the spacing of vertical stirrups in reinforced-concrete beams for both the U- and the W-shaped stirrup, for rods of $\frac{5}{16}$, $\frac{3}{8}$ and $\frac{1}{2}$-in. diameter and for steel tensile values of 16,000 and 18,000 lb. per sq.in. They are based on the Joint Committee specifications according to the formula

$$S = \frac{\frac{3}{2} a_s f_s jd}{V}$$

in which

S = Spacing of vertical stirrups in inches;

a_s = Total sectional area of steel in stirrup in square inches;

f_s = Allowable fiber stress in stirrup per square inch;

j = Ratio of lever arm of resisting couple t depth d;

d = Depth of beam to center of steel in inches;

V = Total shear in pounds.

The formula is based upon the assumption that tw thirds of the total shear produces stress in the stirru and that one-third is taken care of by the concrete. I the safe unit shearing stress in the concrete is take at 40 lb. per sq.in., then the cross-section of the bea must be so proportioned that $v = \frac{V}{bjd}$ shall not excee three times 40 lb., or 120 lb. (v = shearing unit stre and b = breadth of beam in inches). The minimu spacing of stirrups will be required at the end of the bea where the largest shear occurs. The distance from t edge of the supporting column or wall to the first stirru in the beam may be taken as one-half the minimu spacing; that is the practice with one firm which does great deal of construction. Another firm uses the fo

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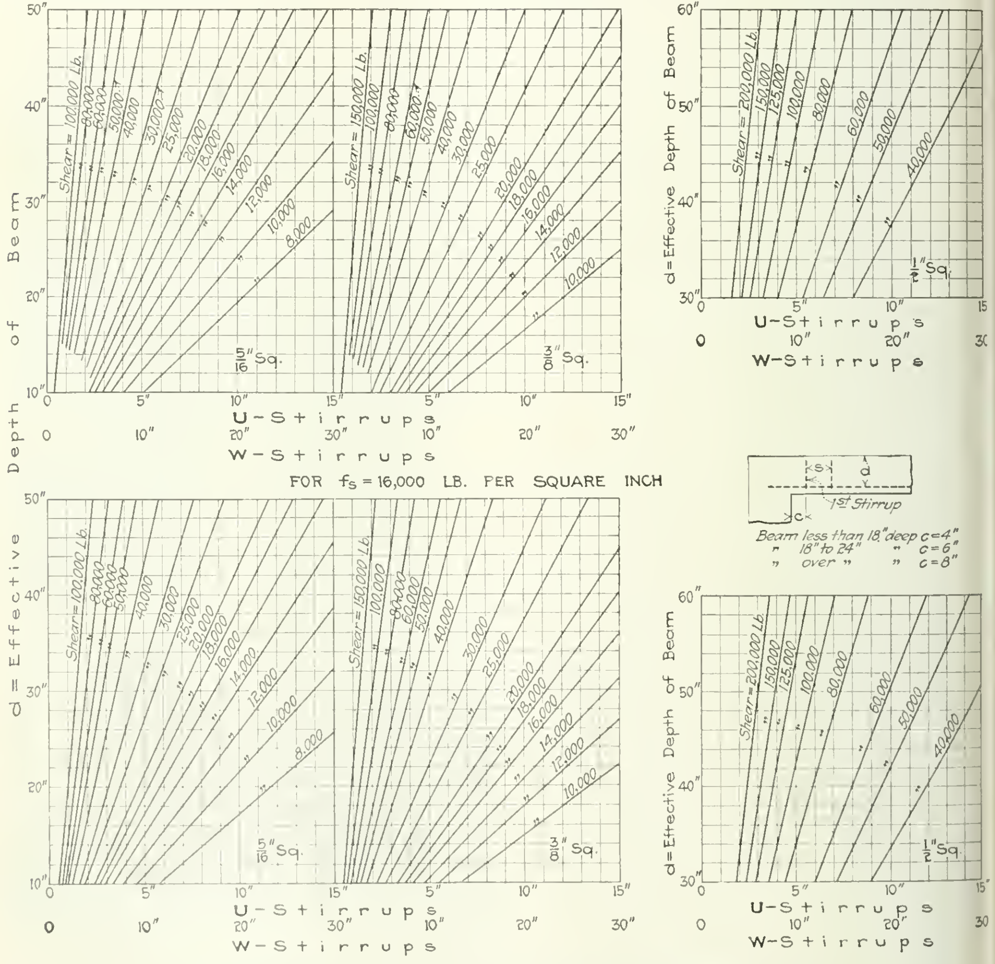
*Stone & Webster Engineering Corporation, 112 Charles River Road, Cambridge, Mass.



FOR f_s = 16,000 LB. PER SQUARE INCH

FOR f_s = 18,000 LB. PER SQUARE INCH

DIAGRAMS GIVING STIRRUP SPACING IN REINFORCED-CONCRETE BEAMS ving rule: For beams 18 in. or less deep, distance to st stirrup equals 4 in.; 24 in. deep, 6 in.; over 24 in. ep, 8 in. One well known textbook advises placing the st stirrup 2 in. from the support in all cases.

In beams uniformly loaded, as the shear varies from a ximum at the support to zero at the center, the spacing any part of the beam is easily found after the mini- m spacing at the support is known. Thus if m = spacing at the support and l = the length of clear n then at a distance $\frac{l}{8}$ from the support the spacing l be $^4/_3\ m$, at a distance $\frac{l}{4}$ the spacing will be $2\ m$, ile at a distance $\frac{l}{2}$ no stirrups are needed. It is rec- mended by the Joint Committee that the longitudinal cing of stirrups should not exceed three-fourths the th of the beam. Where concentrated loads occur it necessary to know the shear at these points.

To illustrate the reading of the diagram, suppose a al shear of 40,000 lb. is to be provided for by a beam in. wide, where the concrete can be safely stressed to lb. per sq.in. and the steel to 18,000 lb. per sq.in. The t shear for concrete and steel together therefore must limited to 150 lb. per sq.in. (concrete taking one- d total shear) or $150 = \frac{40{,}000}{12 \times \frac{7}{8} \times d}$ and $d = \frac{40{,}000}{1 \times 12 \times \frac{7}{8}} = 25.4$ *in.*

alling $d = 26$ in. and assuming $\frac{5}{16}$-in. square stirrups he W type will be used, we start at the side of the dia- m at an effective depth of 26 in., go horizontally to the gonal line "shear = 40,000 lb.", then vertically down the bottom where it is seen that $\frac{5}{16}$-in. W stirrups uld be spaced about 6 in. apart.

f a larger shear than 40,000 lb. were to be designed the section of the beam would have to be changed—being made wider or deeper—and if a shear of 20,000 only had to be taken care of, a considerably smaller ion could be used—if the shear alone were the only or to be considered. On a lightly loaded beam of span the section necessary for resisting the bending nent is often the controlling factor.

* * *

New Method of Deriving Weir Formulas

By Theodore R. Running[*]

new method of determining the rate of flow of water r weirs has been tried in the hydraulic laboratory of University of Michigan with gratifying results. The n advantage in the new method is that it requires only ngle experiment for determining the rate of flow of er over a weir for different heads and is applicable to rs of high as well as of low heads.

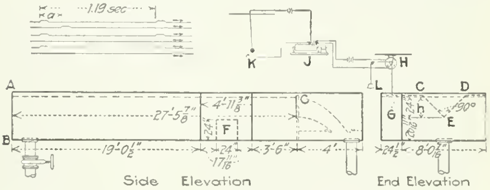
he experiment described below was carried out with the stance of C. N. Ward, H. R. Leach, T. A. Nagler and F. Sherzer, all graduate students in the College of gineering, University of Michigan. To the critical gment and valuable suggestions of H. W. King, Pro- or of Hydraulic Engineering in the University of higan, the writer is particularly indebted.

Fig. 1 shows the relation of the different parts of the tank and other apparatus used in the experiment. The tank *ABC* had a right-angle V-notch weir fitted into the end at *C*. The weir was made from a ¼-in. steel plate, beveled to a sharp edge, though not a knife-edge. Inside of the weir was a closely fitting gate that prevented the water from flowing out until ready to begin the experiment. Water was pumped into the tank through the pipe at *B*. Precautions were taken to prevent leakage through this pipe after the pumping was discontinued. A stilling box with float *G* was connected with the tank by the opening *F*.

The recording apparatus consisted of a chronograph *J*, connected electrically with a seconds pendulum at *K* and with a fixed dial *H*. A fine wire was wound several times around a shaft to which was attached a hand that completed the circuit at four points on the dial *H*. One end of the wire was attached to the float, and a counterweight *L* at the other end prevented the slipping of the wire on the shaft. The distance between two contacts on the dial represented a lowering of the water surface of 0.108 ft.

The pendulum was accurately rated (single vibration 1.19 sec.) and made electric contact through a drop of mercury at *K*. Contact of the pendulum with the mercury was indicated on the record by a short side movement of the pen (caused by a small electromagnet). Contact on the dial was recorded by another pen.

Part of the record as taken from the chronograph is shown in Fig. 2. This diagram is self-explanatory; it may be stated, however, that fractional parts of a second were determined by measuring the distance *a*, which represents the time between the beginning of contact on the dial and the beginning of the last contact of the pendulum, and dividing it by the distance representing one second. Time was read from the record correct to hundredths of a second, and head correct to thousandths of a foot.



FIGS. 1 AND 2. TANK ARRANGED FOR EXPERIMENTS AND PART OF CHRONOGRAPH RECORD

After filling the tank with water and before beginning the experiment it was necessary to determine the height of the water surface above the lowest point of the weir. This was done with a great deal of care. The error in this determination was less than 0.001 ft.

The pendulum and chronograph were now set going, and the weir gate was quickly removed. The lowering water surface carried with it the float, which in turn brought about contacts on the dial. After the water had lowered to within about 1 in. of the lowest point on the weir, the chronograph was stopped and the record removed. From the record the following sets of values were obtained, h being head in feet and t time in seconds:

Values of h	Values of t	Values of h	Values of t
1.661	9.12	0.905	49.22
1.553	10.75	0.797	63.08
1.445	11.94	0.689	85.82
1.337	16.02	0.581	116.60
1.229	21.56	0.473	165.67
1.121	27.75	0.365	253.14
1.013	37.28	0.257	437.28

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[*] Associate Professor of Mathematics, University of Mich- n.

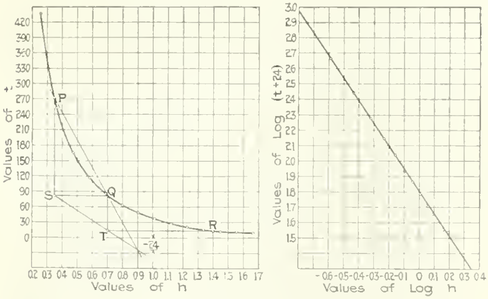
The point from which t was measured on the record was arbitrary and, as will be seen later, affected in no way whatever the final result. It was essential, however, that h represent as accurately as possible the height of the water surface above the lowest point of the weir. The corresponding values of h and t were plotted in Fig. 3. For the purpose of determining the law connecting t and h the following sets of values were read from the figure:

h	t	Δt
0.3	342	—163
0.45	179	—90
0.675	89	—51
1.012	38	—28
1.518	10	....

In the foregoing table the values of h were taken in a geometrical series: and since the first differences (Δt) of the corresponding values of t form very nearly a geometrical series, we conclude that the relation between the variables is expressed to a close approximation (within the limits of the experiment) by the equation

$$t = a + bh^c$$

where a, b and c are constants to be determined by the data. These constants are first determined approximately. Fig. 3 gives a graphical determination of a. The process is as follows: Select any three points P, Q and R whose abscissas form a geometrical series, and locate two other points S and T, as indicated in the figure. The two lines PQ and ST intersect in a point whose ordinate is a. For, let the coördinates of the points be the following:



FIGS. 3 AND 4. PLOTTED RESULTS OF WEIR FORMULA EXPERIMENTS

$$P = (h_1, a + bh_1^c);$$
$$Q = (rh_1, a + bh_1^c r^c);$$
$$R = (r^2h_1, a + bh_1^c r^{2c});$$
$$S = (h_1, a + bh_1^c r^c);$$
$$T = (rh_1, a + bh_1^c r^{2c});$$

The equation of the line through the points P and Q is

$$t = \frac{bh_1^c(r^c - 1)}{h_1(r - 1)}h + a + bh_1^c - \frac{bh_1^c(r^c - 1)}{r - 1} \quad (1)$$

The equation of the line through the points S and T is

$$t = \frac{bh_1^c r^c(r^c - 1)}{h_1(r - 1)}h + a + bh_1^c r^c - \frac{bh_1^c r^c(r^c - 1)}{r - 1} \quad (2)$$

Multiplying (1) by r^c and subtracting (2) from the result, we have

$$(r^c - 1)t = (r^c - 1)a \text{ and } t = a$$

From Fig. 3 we see that a is approximately -24. In Fig. 4 the logarithms of the values of $t + 24$ are plotted to the logarithms of the values of h as abscissas. The equation of the straight line that most nearly passes through all of the points is

$$log\ (t + 24) = log\ 64 - 1.46\ log\ h.$$

The irregularity of the points near the high heads is undoubtedly due to the disturbance caused by the sudden removal of the gate. The approximate formula then is

$$t = -24 + 64h^{-1.46}$$

Correcting the values of a, b and c by the method of least squares, we obtain

$$t = -24.438 + 63.647\,h^{-1.459} \quad (3)$$

The differential equation that expresses the fluctuation of water level is

$$Qdt = -Sdh \quad (4)$$

where Q is rate of outflow per second of time, and S is area in square feet of the horizontal section of the tank.

By differentiating (3) we obtain

$$dt = -(63.647)\ (1.459)h^{-2.459}\,dh \quad (5)$$

Multiplying this equation by S and dividing by $(63.647)(1.459)h^{-2.459}$ we have

$$\frac{S}{(63.647)\ (1.459)}h^{2.459}\,dt = -Sdh \quad (6)$$

Since the right-hand members of equations (4) and (6) are identical, the left-hand members must be. The area of the mean horizontal section of the tank used in the experiment (including the stilling box) was 231.021 sq.ft. The left-hand member of (6) gives for the formula for the particular weir used in the experiment

$$Q = 2.488\,h^{2.459} \quad (7)$$

or less approximately

$$Q = 2.49\,h^{2.46} \quad (8)$$

Since the cross-section of the tank is about 33 sq.ft., the velocity of approach for the maximum value of Q is less than 1/3 ft. per sec. The correction for this velocity of approach is very small and need not be considered here.

For comparison the table below may be of interest. The column headed Q_1 gives the values of Q computed by formula (8), and the column headed Q_2 gives the corresponding values of Q which Professor King obtained experimentally with the same weir by another method and which he has kindly permitted the writer to use.

h	Q₁	Q₂	h	Q₁	Q₂
0.159	0.027	0.029	1.014	2.580	2.614
0.370	0.216	0.214	1.202	3.919	4.030
0.529	0.521	0.523	1.324	4.971	5.089
0.618	0.764	0.785	1.433	6.037	6.119
0.682	0.973	0.986	1.790	10.440	10.539
0.826	1.558	1.576			

It is noticed that, with one exception, the values of Q are larger than the corresponding values of Q_1. Thi can be accounted for, to some extent perhaps, by the fac that in the experiments from which the values Q_2 wer derived the pump was working continuously and the wate thus entering through the pipe at B would give to th water in the tank a slightly greater velocity of approacl than that of the water in the experiment from which th values of Q were obtained.

Another element that may help to account for th difference in the corresponding values of Q is the possibl lagging of the water in passing from the smaller into th larger tank through the opening at F. Through such large opening, however, the lagging would be slight a most.

It may be well to point out that the method describe is very well adapted for experiments on the flow of wate through pipes.

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A Standard Capacity for Lime Barrels was fixed by an ac of Congress approved on Aug. 23. The law specifies tw sizes of barrel—a small barrel to contain 180 lb. net, and larger barrel containing 280 lb. net. Lime may, however, b sold in smaller containers than the small barrel, provided th net weight is stenciled upon the package.

Municipal Docks at Astoria

By J. P. Newell*

SYNOPSIS—Two piers just completed in municipal-dock enterprise on north Pacific Coast. Structural design of piers fine example of modern timber and earth-fill wharf. Unusual detail in lagging to hold fill. Pier sheds of timber, concrete and clay tile, specially designed to be fireproof.

The Port of Astoria, Astoria, Ore., at the mouth of the (umbia River, has been engaged for the past two years i constructing municipal terminals for the accommoda- ı of ocean-going traffic. Two piers 1,300 ft. long e been built, inclosing a slip 400 ft. wide at the en- t nce and 250 ft. at the rear end. Some features of the struction are believed to be novel and of interest to incers.

The general type is that of a pile structure inclosing earth-fill (Fig. 3). The bulkhead is 7,000 ft. in length a the entire area inclosed is 13 acres, filled to grade ı material dredged from slips and channel. The orig- depth of water at mean low tide varied from 0 t 23 ft., averaging 15 ft. The slips have been dredged t a depth of 30 ft., but an extra depth of 5 ft. is con- plated at a later date. The first dredging was done ıg the toe of the slope to permit the lagging to be ed.

he method of holding the sand-fill in place is shown in F . 3. Against rows of piles 10 to 16 ft. apart, panels n le up of 6x12-in. lagging were placed in steps so as to form a 1 on 2 slope, the lower edge of each panel being 2 ft. lower than the top of the one next below it. Hemlock planks were used for lagging, with 3x16-in. fir stay lath spiked on about 4 ft. apart. Panels 100 ft. long were built in place against the piles at the water surface. Guide piles were tried at first to hold the panels during the sinking but on account of the tendency to move endwise it was found better to use yokes, each composed of two $\frac{3}{4}$-in. bolts and an 8x8-in. by 6 ft. timber, ample room being left to allow for irregularities in the spacing of the piles. At least four yokes were used for each panel, and they were placed alternately at the top and bottom edges.

The chief difficulty in sinking was caused by rapid flow of the tides, which vary from 4 to 12 ft., with a maximum velocity of 4 mi. per hr. The sinking was accomplished by means of a piledriver at each end of the panel. A "push-down stick," 8 in. square and about 50 ft. long, with scabs bolted on the lower end to make a fork, was framed in the leads, the hammer being removed. The pile line was attached to the top of the stick and run through a block at the bottom of the leads and thence to the drum. A shorter stick for each driver was set up at an intermediate point and held in place by a turn of a line around a pile. For these the blocks were fastened at the water surface and the lines carried to the niggerheads on the drivers. By means of these lines the panels were pushed down to the proper depth and held there by stay lath bolted to the piles.

Except for an occasional stay lath broken by drift logs, but little difficulty was found in holding the panels below

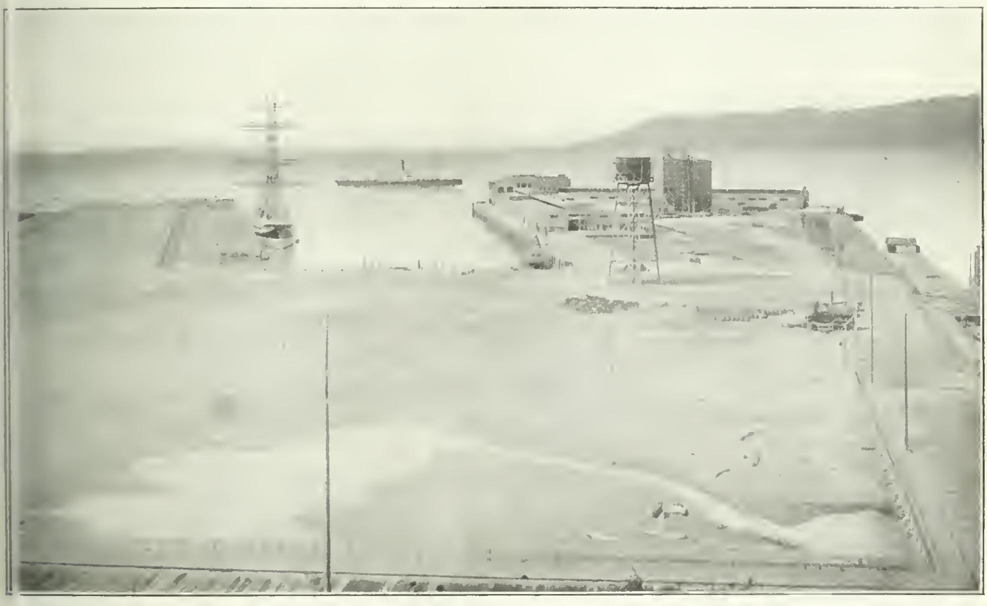

FIG. 1. LOOKING OUT UPON THE NEARLY COMPLETED MUNICIPAL DOCKS AT ASTORIA, ORE.

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*Newell, Gossett and Walsh, Civil Engineers, Spalding B ilding, Portland, Ore.

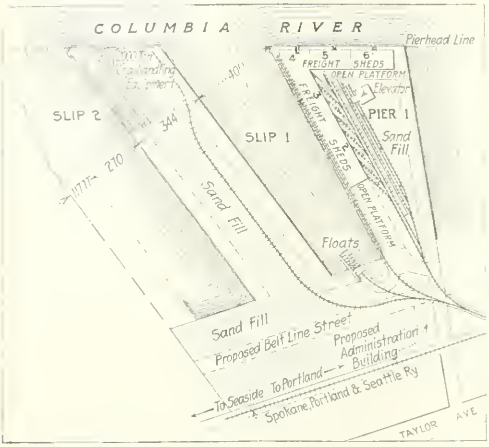


FIG. 2. GENERAL PLAN OF ASTORIA MUNICIPAL DOCKS

low water, but with those between high and low tide considerable trouble was experienced. The southwest gales sometimes reached a velocity of 60 mi. per hr., with a sweep across 2 or 3 mi. of open water before reaching the dock site. The lagging had to withstand the force of the waves thus created until it could be supported by the backfilling.

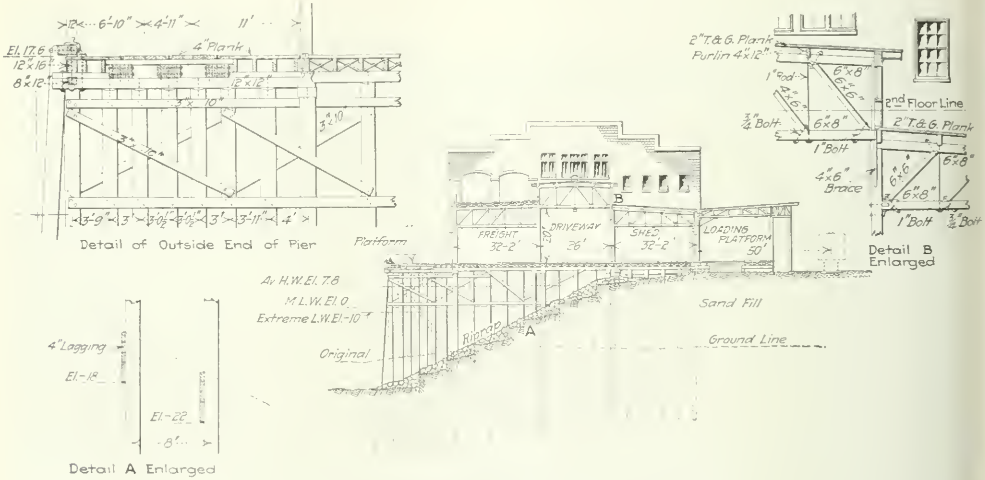


FIG. 3. DETAILS OF PIER AND SHED AT ASTORIA DOCKS

As soon as the lagging had been placed a sufficient distance ahead, material from the slip was pumped in behind it. A suction dredge with 24-in. pipe was used, and 1,250,000 yd. was deposited in the piers. Dredging operations extended from September, 1914, to May, 1915. The material handled was mostly fine heavy sand, but the remainder was sand mixed with finely divided clay, making, when pumped, a nearly fluid mass. Below low water there was very little difficulty in holding the dredged material. Above low water the presence of clay caused frequent blowouts with considerable loss of material. With clean sand the 2-ft. seal between successive panels was sufficient, but the clayey material would find its wa out through even the smallest opening. Cracks were battened with inch boards and burlap, but in spite of al precautions breaks occurred which had to be stopped with brush and sacks. An additional foot of seal would have reduced these troubles, but the extra expense would not have been justified. Wave action caused some damag by washing out sand over the top of the lagging, and it was found necessary to follow up closely with the riprap.

The slopes were covered with rock from 1 to 4 ft. deep In sheltered places the riprap was carried down to onl about 5 ft. under low water, the lagging being relied on to protect the fill below that level. Rock from egg siz to 2 ft. in diameter was used, the object being to mak the densest possible covering in order to protect the fin sand underneath. About 35,000 yd. was required.

Details of Track Layout

Special attention has been paid to track facilities. I the rear of the building the tracks are arranged in shor spurs holding two cars each, with platforms between This enables cars to be "spotted" with the least possible in terference with the loading of other cars.

The herringbone tracks serve only for freight passin through the building. A three-rail track is provided alon the front side of the dock for freight passing direct between cars and ships. This arrangement permits car to be placed close to the edge of the dock or at a sufficien distance back to make room for handling slings. It give most of the advantages of a double track, with a saving o space and consequent distance of trucking.

Building Construction

The building on Pier 1 occupies the side and the end the pier and is 1,085 ft. in length by 90 ft. in widt The frame is of timber; all inclosing walls and the ti fire walls are built of Denison interlocking hollow til The roof is carried on transverse wooden trusses, the wal ends being supported on reinforced-concrete columns which are in turn incased with 4-in. tile. The curtai walls between columns are 8 in. in thickness, reinforce

G. 4. INTERIOR OF ONE OF THE ASTORIA PIER SHEDS

th $\frac{5}{8}$-in. horizontal rods every 3 ft. in height, grouted the joints. All fire walls are 12 in. thick and extend ft. above roof lines.

A driveway, with a clear width of 26 ft., extends the tire length of the building. The bent centers are 15 6 in. apart. Doors and windows are placed in each al- nate bay. The doors are a standard type of roller el door, with a clear width of opening of 12 ft. The structure has been designed to carry 750 lb. per sq.ft. e windows are all of steel sash set directly in the tile- rk, eliminating the common objections found in the of wooden frames. The steel sash has been glazed oughout with $\frac{1}{4}$-in. ribbed glass. Owing to the con- uous monitor windows and the use of white paint on the erior, the dock is exceptionally well lighted.

The electric wiring has been run in conduit, with all lets located on the truss chords. Control cabinets located on the fire walls, and additional switches con- niently placed govern small groups of light for loading rposes.

Fire Protection Specially Considered

The building is well equipped with fire-fighting appa- us. In addition to a dry-pipe sprinkler system the erior is protected by $2\frac{1}{2}$-in. standpipes with hose at- hed. Outside fire hydrants are located at regular inter- s, and all hose and hydrant connections are the same the city standard.

n addition to the special fire protection there are six 3- water lines carried to the face of the dock to provide ter-supply for ships; these are terminated by a Siamese ranch having a fire-hose coupling. A 50,000-gal. tank used as an auxiliary supply to the main water-supply m the city mains.

The sprinkler system proper, not including supply ins, includes 2,550 heads and cost \$12,000. The hy- nts, standpipes, water-mains and tank were let under arate contracts and aggregate an additional \$8,500. s equipment, together with the type of building, has le possible a very low rate of insurance on the build- as well as on commodities placed in storage, the rage rate being 10c. on a 3-yr. policy.

Ramp Equipment

n anticipation of the transfer business six small slips e been provided with adjustable ramps for the handling freight to and from river boats and barges. The ramp tforms have been equipped with an especially designed booster chain to carry the loaded trucks up the incline. Two flat top chains are used, running on rollers in channel-iron guides placed on the same centers as the wheels of the trucks used on the dock. The chains are driven by sprocket wheels mounted on the hinge shaft and have semi-attached steps that engage the truck wheels until the top of the incline is reached, when they automatically drop and pass through the opening in the floor with less than $\frac{1}{4}$-in. clearance, eliminating the frequent accidents heretofore met with in the use of the various types of boosters on the market.

The railroad tracks are carried across the slips by movable platforms that are raised and suspended above the openings when the slips are in use. The raising of the platform, the adjustment of the ramp and the driving of the booster chain are accomplished by means of a $7\frac{1}{2}$-hp. alternating-current motor placed under the dock floor, as shown in Fig. 5, controlled by a drum-type controller with reversing handle connected with reversing variable-speed motor. The three levers controlling the various operations are interlocking and engage friction clutches under the dock floor. A speed of 280 ft. per min. for the travel of chain was found to be the most efficient.

The cost of a ramp complete, including steel trussed beams, all mechanical equipment and power transmission, was \$3,000.

A satisfactory improvement has been made in the cleats by the extension of the back part to a bearing on a timber a foot below the stringpiece on which the cleat rests. This prevents bending or shearing strains on the bolts.

Data on Unit and Total Costs

The price paid for dredging was 12c. per yd., but this figure was made possible only by the fact that the work was measured in excavation, so that losses due to washouts did not fall on the contractor. The bulkheads were built and maintained under a separate contract. The work was handled in such a manner that, when a blowout occurred, the delivery of material was changed to some distant point until repairs could be effected. The dredge was in practically continuous operation, delays owing to lack of a place to deliver material aggregating not over three days for the entire eight months of operation.

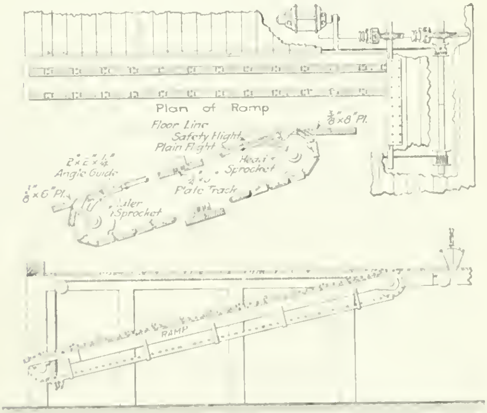


FIG. 5. DETAILS OF FREIGHT HANDLER "BOOSTER" ON ASTORIA PIER

Stormy weather and accidents to machinery resulted in interruptions amounting to about 30 days. Shifting dredge, changing pipe lines, moving pontoons, and failure of the power company to supply current caused delays equal to about one-third of the time from beginning to end of construction. The work was reasonably profitable to the contractor. The substructure up to the joists was let in one contract at the following prices:

Straight piles, $2 each, plus 10c. per ft.
Brace piles, $5 each, plus 10c. per ft.
Miscellaneous lumber, $20 per M
Caps, $15 per M
Lagging, $20 per M
Wrought iron, 5c. per lb.
Cast iron, 4½c. per lb.
All material paid for in place

The going price for timber at the mills was $12 per M for dimension stuff. Contractors at the time of letting were willing to take work at very low figures in order to keep their outfits busy. The above prices are about 20% too low, the loss being considerable on caps and lagging, making allowance for reasonable profit. The proper schedule of prices at that time would have been as follows:

Straight piles, $2.50 each, plus 11c. per ft.
Brace piles, $5 each, plus 11c. per ft.
Miscellaneous lumber, $22.
Caps, $18.
Lagging, $26
Wrought iron, 6c.
Cast iron, 4½c.

The contract prices for the superstructure were: Timber in decking and platforms, $18.50 per M; iron, 4c. per lb.; building complete above deck, $68,000. These prices were 10% too low for reasonable profit.

The contractor for the substructure was the J. A. McEachern Co., of Seattle; for the superstructure, C. L. Houston, of Astoria, Ore.; for the dredging and filling, Tacoma Dredging Co., of Tacoma. The booster was designed and constructed by Helser & Unden, of Portland, Ore. F. J. Walsh, of Newell, Gossett & Walsh, Portland, Ore., was Chief Engineer; R. R. Bartlett, Assistant Engineer in charge of designing; and K. E. Hodgman, Assistant Engineer in charge of fieldwork.

* * *

New Line of Union Pacific R.R. Through Echo Canyon, Utah

A piece of railway construction which is notable and interesting from several points of view, is the building of the second track on the Wyoming division of the Union Pacific R.R. from Emory eastward to Wahsatch, the summit of the Wahsatch Mountains, near the boundary of Utah and Wyoming. This work is through the famous Echo Cañon, and is one of the two places on the Wyoming division of the Union Pacific where the reduction of the gradients to a maximum of 0.82% or 43.3 ft. per mi. is not feasible. The other place is from Cheyenne westward to Buford.

The stretch from Emory to Wahsatch up the head waters of Echo Creek, about 13½ mi. long, which is now under construction, presents some interesting problems in railway location. This is a part of the original line located in 1864 by Samuel B. Reed, who selected the Weber and Echo Cañon route as the most feasible outlet from the Great Salt Lake Basin to the East, after many explorations and reconnoissances made under trying conditions. He went overland by stage to Salt Lake City and worked eastward.

The double-tracking of the line through this mountain pass is a part of the extensive program of betterment adopted by the Union Pacific management in 1898. Th construction work was inaugurated some time later b J. B. Berry, then chief engineer of the company. most complete study of the problem was made from th previous surveys and explorations and from new surveys These studies were continued down to the commencemen of the work on this section last fall.

A profile of the original line (with some subsequen improvements) is shown in the upper part of the oppo site page and the profile of the new second track a the lower part. A study of these will prove interesting, if it is borne in mind that the new line show great improvement over the old in other ways tha grade reductions (see accompanying table): althoug the actual decrease in total ascent is only 17½ ft. and the saving in distance is practically nothing, th saving in total curvature is more than a half. The ne line has a fairly uniform grade of 1.14% (compensated

COMPARATIVE SUMMARY OF OLD AND NEW LINES O UNION PACIFIC R.R., WAHSATCH TO EMORY, UTAH

Physical Characteristics	Via Present Operated Line	Via New Line	Differenc Saving
Distance	16.159 mi.	15.817 mi.	0.342 m
Maximum curve	6° 00′	3° 00′	3° 0
Total curvature (angle)...	1,321° 43′	564° 04′	757° 3
Total curvature (length)..	7.654 mi.	5.703 mi.	1.951 m
Per cent. of line on curve..	47.3%	36.1%	11.2
Maximum grade, eastbound	1.77%	1.14%	0.59
Total ascents, eastbound..	905.40	887.92	17.48
Maximum grade	93.0	60.0	33.0

or 60 ft. per mi., while the grades on the old line o the approach to the summit average about 1.7% with maximum of 1.77% or 93 ft. per mi.

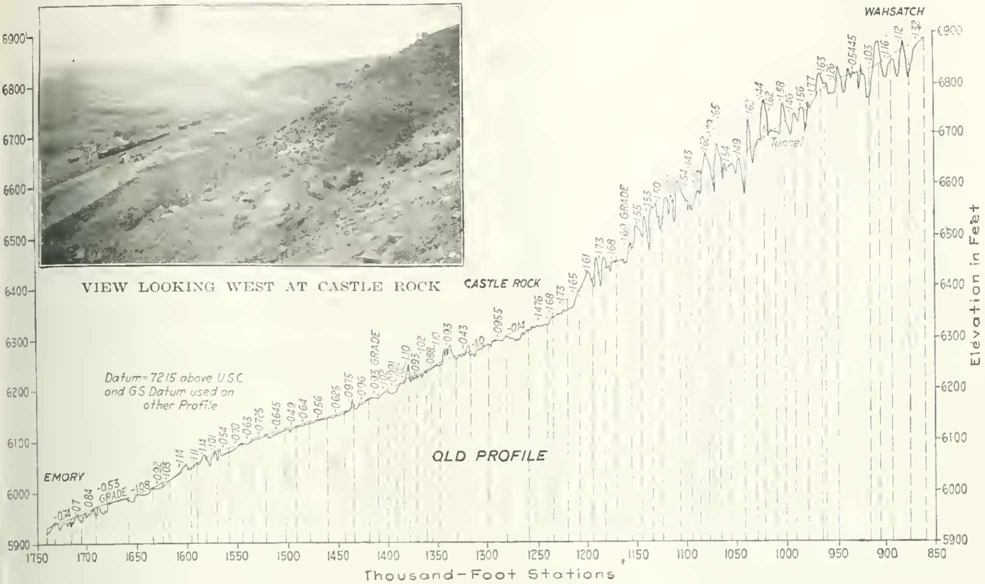
This was accomplished, however, only at large expens as may be judged from the very heavy grading on th new line as shown on the profile. There are three tun nels in this 17-mi. stretch, and several fills of a hal million cubic yards or more each, one of which has maximum height of nearly 130 ft. The cost of these 13 mi. is in excess of $3,000,000, which proves the trut of the statement made by Mr. Berry in 1904 that th great reduction in curvature and grades would not stan as a criticism of the work of the pioneer engineers wh made the original location. The original lines locate under the direction of the late Gen. Grenville M. Dodg chief engineer, was allowed by law a maximum gradie of 116 ft. per mi., yet the grades were actually held dow to a maximum of about 90 ft.

As shown in the plan the new second track never more than 2,000 ft. from the old track. It li mostly on the north or opposite side of the cañon, bu crosses the old line at two places.

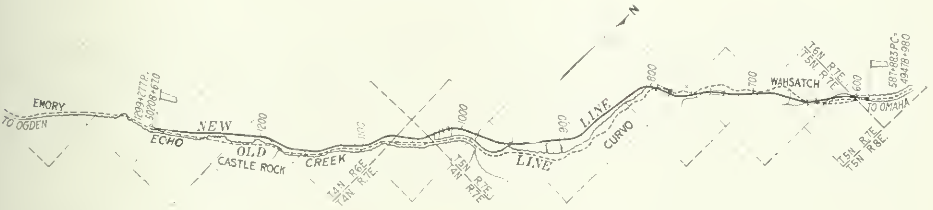
Much of the country is picturesque and in the caño between the two tracks is a portion of the now famou Lincoln Highway. The accompanying views show th progress of the work on June 1, in the vicinity of Cast Rock, Utah. The chief engineer of the Union Paci R.R. is R. L. Huntley, to whom *Engineering News* indebted for the plan and profiles.

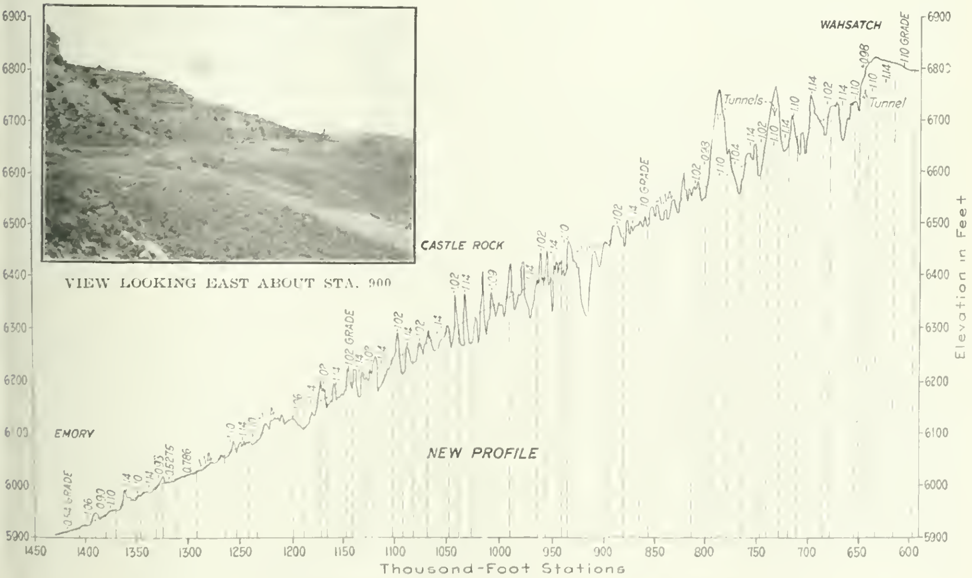
* * *

Inspection of Cast-Iron Pipe for the Chicago water-work in 1915 cost $12,450, or 27.8c. per ton for the 44,769 tons teste The percentage of pipe rejected was 34.4%. The cost of in spection was much larger than in previous years, owin chiefly to the fact that a large number of foundries are the field, requiring many more inspectors, while the tonna of pipe purchased did not increase in proportion. All in spection work of the Department of Public Works is don by the Testing Division under the supervision of L. S. Mars engineering chemist in charge.



VIEW LOOKING WEST AT CASTLE ROCK





VIEW LOOKING EAST ABOUT STA. 900

DOUBLE-TRACKING THE UNION PACIFIC R.R. IN UTAH

Notes from Field and Office

Successful use of Cameron pump to pump grout behind tunnel lining—Drawings of falsework to support bridge whil recapping piers—Florida drill barge—One cause of rust—Feeding the mixer in a tunnel through a drill hole from the surface—Concrete pavement on gumbo—Cantilever grandstand roof—A specific speed diagram

Tunnel Grouting with Pumps

By L. G. Warren*

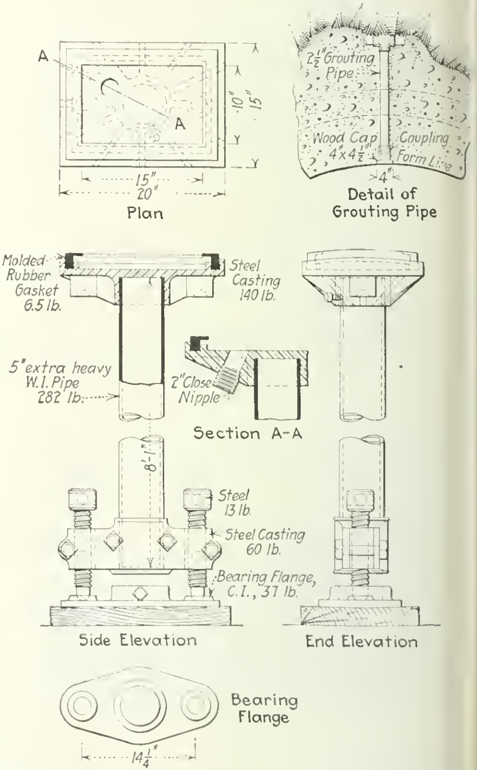
In grouting the concrete tunnel shell of the shore tunnel, Linwood Ave. intake, Milwaukee, Wis., a reciprocating pump operated by air was used with great success. The original intention was to use a Caniff grouting machine and grout proportions of 1 cement to 2 of sand. However, early in the work, in grouting back of the timber bracing and shell of Shaft 1 a trial was made of a No. 4-A Cameron pump operated by air and pumping neat cement grout. In this case the grouting behind the upper portion of the timbering entirely closed the water-bearing area and greatly aided the subsequent shaft-sinking operations, and the grouting behind the shaft concrete made the shaft absolutely water-tight. This success with the pumping method led to the almost exclusive use of the pump for grouting in the tunnel.

Several other reasons were of influence in deciding on the use of a pump in place of a pneumatic grouting machine: The pump reduces the volume of entrained air forced with the grout as compared with an air-ejection tank grouting machine; it removes the danger of disturbing and rupturing the excavation roof behind the concrete—as may occur in gravel, sand or other soft soils—by the high-pressure blast of air coming from a tank grouting machine; it secures a more uniform flow of grout; it eliminates the periodic batch placing that a single tank machine effects; and, finally, it reduces the possibility of rupturing the concrete shell with unbalanced air pressures.

The results thus far secured with the pumping of grout in the tunnel include steady flow of grout, greater area and distance covered from one grouting pipe, very small volume of entrained air, great speed of placing and the ready possibility of continuous operation.

Neat cement grout mixed to liquid consistency has been used throughout. The procedure in grouting a drift after completing the tunnel shell to the face is to place a double bulkhead of 3 in. or 6 in. of timber and 9 to 12 in. of concrete against the face, allowing this to set, and then grouting through short pipes previously set in the tunnel shell. The bulkhead, while it is an extra expense and delay, is justified by securing a high pressure of grout and assuring the sealing of the concrete shell against loss of compressed air. The high grout pressure obtained gives a very tight result.

The grouting pump was placed on the tunnel floor with an open barrel as a grout reservoir attached by 2-in. pipe to the suction of the pump. Above the barrel an ordinary mortar box was placed, with opening covered by a screen arranged to discharge into the barrel. A 1-in. water pipe discharged continuously into the mixing box. Two laborers unloaded cement in bags from the tunnel cars and dumped the cement into the mixing box. Tw other laborers continuously mixed the cement and mor tar by hoes. The grout as fast as mixed flowed from th mixing box into the barrel and from here was drawn in the pump and ejected through the discharge pipe. Th operation thus was continuous mixing and placing. Th required force consisted of the four laborers and one for man, the latter supervising the pump operations as we



GROUT PIPE AND GROUTING PAD USED IN MILWAUKE TUNNEL

as directing the laborers in handling the material a mixing.

When leakage of grout showed through the concre shell in the form of very small streams, they were plugg with small sharpened wooden plugs. However, as lo as the leakage was clear water, it was allowed to ru Only when grout showed in the water was it plugg Clear water always showed before the grout started escape. When leakage developed over a large area that plugging would not be successful, a grouting p s used. This was a board padded with waste, held against the leaking area by a trench jack. The grouting pad gave satisfactory results.

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*Resident Engineer, Shore Tunnel Milwaukee, Wis.

Bran was mixed (one handful of bran to one bag of cement) with the liquid grout in the barrel reservoir to a as an aid to the wooden plugs and grouting pad in s pping leaks. The bran was a valuable agent in closing small leaks.

The maximum hourly rate of placing neat grout by the mp method has been 86 bags, and the average rate 72 gs. Placing bags behind 4,405 lin.ft. of tunnel shell h averaged 4.605 bags per foot. The maximum travel the grout over the concrete arch from one pipe was 5 lin.ft. and the average travel 60 ft.

That the grouting resulted in a tight seal of the tun- shell was evidenced well by a particular case in the s th heading of Shaft 2. After removal of the tempor y face bulkhead placed for grouting purposes the tunnel ssure dropped only one-half pound in one hour—from 1½ lb. to 19 lb.—with all compressors out of action. This occurred three days after grouting the heading, then 90 ft. from the air lock.

Grouting is begun whenever a heading shows high loss ompressed air; then the shell is completed up to the f e, the face bulkhead erected and grout pumping ted. With one exception, grouting has given relief fm the loss of compressed air. Without the aid of uting to seal the porous soil against excessive air l, mining progress would be greatly reduced.

While the grout travels a long distance backward along t tunnel shell, its forward travel into the soil in the f is slight. Although grouting has been done within 2 ft. of a gravel and sand face, the grout refuses to etrate the sand to any depth and does not penetrate gravel more than 3 in. The sand in the gravel stops travel almost at once.

Only in two cases did the grout penetrate the face m erial. One of these cases was that of grouting through t arch 37 ft. from the face bulkhead. Here grouting w continued until the pump was stalled by the back pressure, and at this same time it was noticed that the timber bulkhead at the face started to distort. On advancing the heading after the bulkheads were removed, it was found that grout had penetrated the gravel and boulder deposit in the face and roof, coming down from the roof a depth of 2 ft. and traveling for a total distance of 17 lin.ft. ahead of the bulkhead. Thus the grout had a total length of forward travel of 54 ft., of which 37 ft. was behind the arch. In this case, however, the face material was proved to be very porous by the fact that previous to grouting a heavy escape of compressed air had occurred through the roof and face of the excavation. In another case the grout traveled in sandy gravel deposit a distance of 7 ft. ahead of the grouting bulkhead.

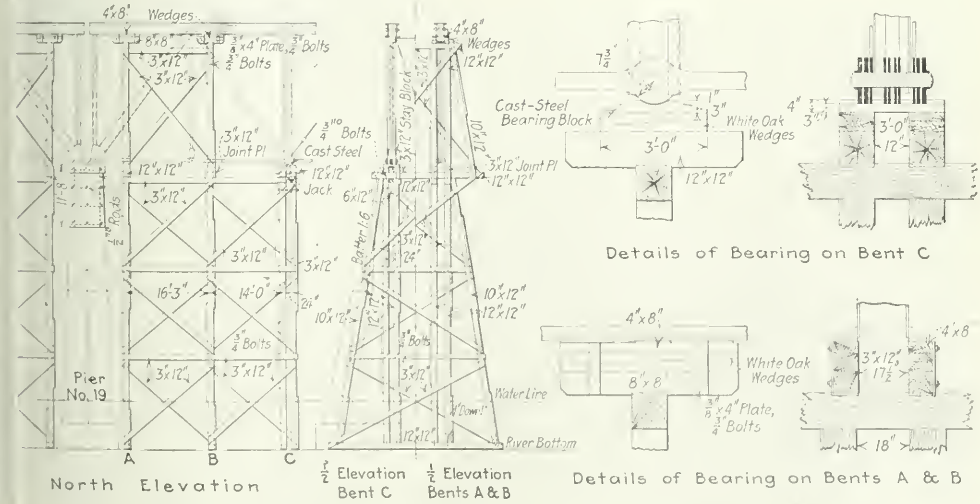
Interesting data have been secured as to the endurance of pump lining and packing in grouting with neat cement grout. Brass lining sleeves average a life of 1,000 bags of cement. Pump packing requires replacing after the pump has delivered 500 bags. A steel lining sleeve was tried as a substitute for the brass sleeve; it gave longer life than the brass and quite satisfactory operation.

⁂

Capping Old Bridge Piers Under Railway Traffic

Deterioration of the stone piers of the old single-track through Pratt truss bridge of the Philadelphia & Reading Ry., over the Susquehanna River at Harrisburg, has made necessary the capping of the weakened piers. This work has been going on for some three years and is not permitted to interfere with the normal traffic of the road.

Timber falsework built up from the river bed, as shown in the sketch, supports the trusses during the rebuilding of a pier. When the load has been taken on the falsework, the top of the pier is torn off down to sound stone. A form is then built around the top, and ½-in. reinforcement rods are placed as shown. The concrete is a 1:2:4 mixture.



FALSEWORK FOR SUPPORTING TRUSSES DURING REBUILDING OF PIERS OF READING BRIDGE AT HARRISBURG

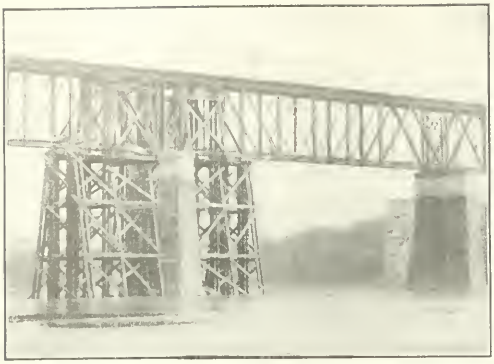


FIG. 2. TRUSSES ON FALSEWORK DURING CAPPING

Materials are supplied by work train. This runs out on the bridge to the particular pier under reconstruction. and the materials are delivered on a platform near the top of the falsework tower.

The work is proceeding under the general direction of Samuel T. Wagner, Chief Engineer of the railway.

⁂

Drill Barge on Canal Work in the Everglades

By Charles C. Phelps*

A 60x20-ft. drill barge that assisted in the excavation for one of the Everglades drainage canals in Florida is illustrated in the view. The work was started on July 1. 1910, and was completed recently.

At first the boat carried two drills mounted in wooden towers, but later a third drill tower was added. The drills, which were operated by steam at 80-lb. pressure, are of the Ingersoll-Rand "H-64" type, stroke 8 in., cylinder $5\frac{1}{2}$ in., approximately 250 strokes per min. Steam and water were supplied by means of telescopic, or slip-joint, piping.

The drill towers are moved on greased ways by means of a hydraulic ram. To move a tower, a clamp operated by a lever on the tower is made to grasp a wire rope running from one end of the ram under the drills and connecting with the other end of the ram. Each tower is equipped with a vertical hydraulic ram that is used for raising and lowering the drilling machines. Ord narily from six to nine holes were drilled before shifti the barge.

The mud covering the rock had been removed befo drilling was undertaken. It was unnecessary to keep jet of water in constant flow to wash out the cuttin from the drill holes. but occasionally a jet was requir to wash out the accumulation.

The depth of water in the canal was from 4 to 9 prior to dredging and 6 to 15 ft. afterward. The dr bits varied in diameter from $3\frac{1}{2}$ to 4 in. The work w single-shift. and the rate of drilling differed consid ably, according to the character of the rock. It w observed, however, while making one cut 60 ft. wi through 200 ft. of solid rock that 200 holes 7 ft. in dep were drilled, loaded and blasted in 12 hr., with the th drills in operation. This figure reduces to 39 ft. hole per hour per drill. The spacing in this case tween holes was 6x8 ft., and as many as 200 were blas at a single shot.

The contractors were the Bowers Southern Dredgi Co. and the Furst Clark Construction Co.

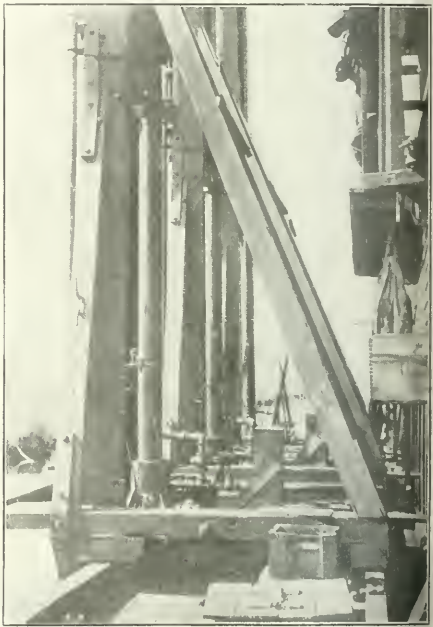


FIG. 2. REAR VIEW OF THE THREE DRILL TOWER

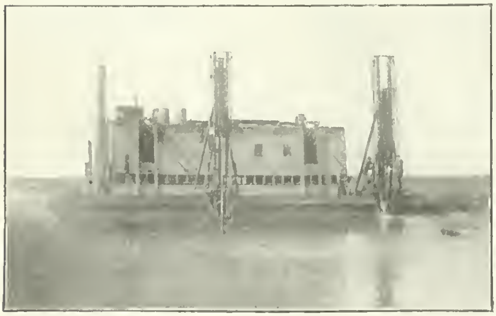


FIG. 1. BARGE EQUIPPED WITH TWO DRILLS
Working at Fort Lauderdale, Fla.

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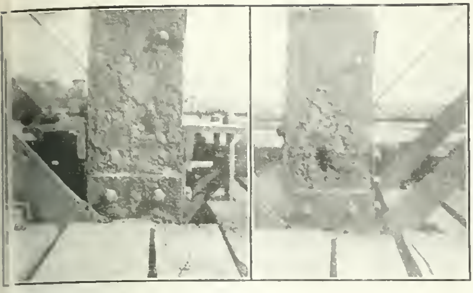
*Ingersoll-Rand Co., 12 Broadway, New York City.

⁂

Corrosion of Bridge Member Near Footwalk

The canine menace to steel bridges was referred in *Engineering News*, Apr. 27, p. 817, in the case o foot-bridge in Passaic, N. J.

Another example of the corrosion of bridge-truss me bers due to the thoughtlessness of dogs is offered in case of a bridge across the Little Miami River, at M ford, Ohio. The rusting of two of the posts is sho in the view; the planks visible being a portion of



RUSTING OF STEEL TRUSS MEMBERS

f twalk. It is significant that rust has not attacked t bridge to a serious extent elsewhere and that until r ntly two saloons were located at one end of the bridge. This bridge carries both the highway and the inter- u an tracks. At the time the latter were added the c nnels were reinforced by a plate placed inside. At t present time the original portion is almost rusted ty.

aterials Chuted Through Drill Holes to Mixer in Tunnel

By W. W. Horner*

n *Engineering News*, Aug. 31, 1916, p. 410, there was d ribed the use of 10-in. well holes to check the align- n nt on the Mill Creek tunnel in St. Louis. The accom- p ying diagram and photographs illustrate the use which t contractors made of these holes to establish an excep- t ally efficient concreting plant.

here was over 200,000 cu.yd. of solid rock removed f n this tunnel. This rock was handled by motor trucks f n the shaft head by two large crushing and storage p its on the railroad. From these plants stone required the concrete lining of the tunnel was returned to the surface hoppers on the work by trucks, and the remainder was either marketed within the city or shipped out in cars.

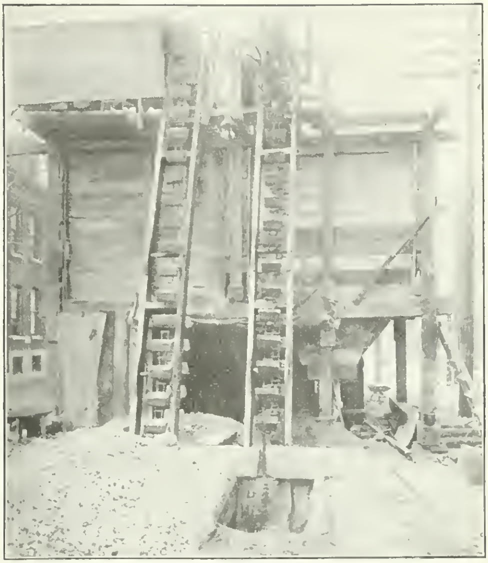


FIG. 1. MATERIAL-HANDLING PLANT OVER WELL-HOLE

As shown in Fig. 1, an automatic material-handling plant was set up over the top of a well hole, with two dumping pits, one for sand and one for stone, whence elevators raised the materials to bins. Each of the bins was hopper-bottomed, and between the hoppers were hung two measuring buckets on trunnions. The small hopper leading into the well hole was sunk into the ground between the buckets. This hopper was provided with a gate in the bottom, controlled by a lever. The labor required on the surface was one man shoveling onto the elevator.

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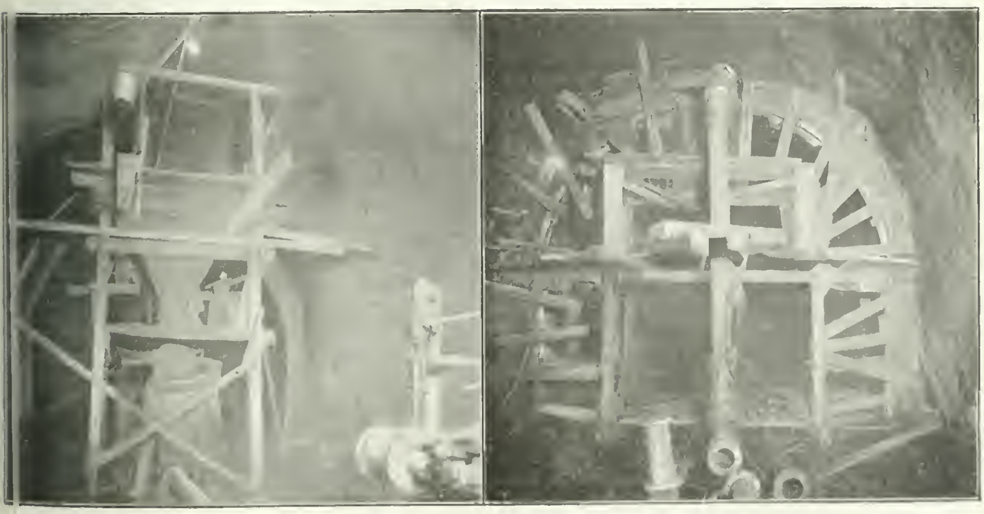
*Engineer of Streets and Sewers, St. Louis, Mo.



FIGS. 2 AND 3. PNEUMATIC MIXER AND DISCHARGE END OF BLOWING PIPE

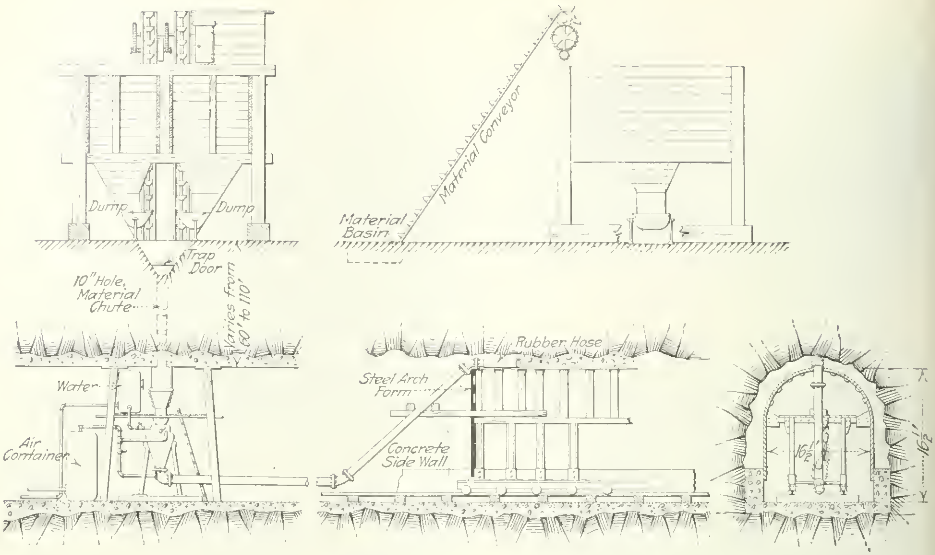


FIG. 4. SKETCH OF CONCRETING PLANT, MILL CREEK SEWER TUNNEL

one man each on the measuring buckets for stone and sand and one cementman. The last three men filled the hopper over the well hole by dumping in cement and by allowing stone and sand to run from the bins into the measuring buckets, which were simply tipped into the well-hole hopper. At a signal from the tunnel, the whole batch of material was released into the well hole.

The concrete for the invert and 2 ft. of side wall was mixed in a standard concrete mixer, located under the well in the tunnel, the batch discharged from the surface going directly into the mixer. From this mixer the concrete was pushed in small dump-cars to the point of placing, where the side walls and the floor on each side of the track were concreted and, after shifting the track to the finished floor at one side, the remaining strip in the center was placed.

All concrete for the upper portion of the side walls and the arch (which was about 75% of the whole) was mixed and placed by the pneumatic process. In this case the concrete gun was placed under the well hole, as shown in Fig. 2, and the material dropped directly into the gun hopper. Steel forms were used for the arch and the discharge pipe from the gun was carried up to the crown of the arch, ending in an 8-ft. length of reinforced rubber hose. It is interesting to note that this piece of hose, costing over $100, could stand only about a week's use.

The longest distance that the concrete was blown was 700 ft., but this maximum was due to the spacing of well holes rather than to the ability of the gun to carry the concrete. It was actually found that the concrete was much better when the forms were a considerable distance from the gun. The amount of water used in mixing had a very direct effect on the quality of the concrete. The gage glass of the water tank was therefore watched carefully. It was found also that satisfactory operation required a large air-storage tank immediately adjacent to the gun.

When using the pneumatic process the labor required was as follows: Four men on top, one man on the gun, one man on the water-supply, one man at the hose nozzl two men in the forms distributing and ramming the co crete. The forms were 40 ft. long and required abou 60 cu.yd. of concrete.

Several forms were operated from each blowing i stallation. The best continuous run was 19 forms, 760 lin.ft. of arch, concreted in 13 shifts. Fig. 3 sho the form in place and the discharge end of the concre line.

⁂

Two-Course Concrete Paving on Gumbo Soil

By Ernest L. Meyers*

Approximately 11,000 sq.yd. of two-course concre pavement was laid in University Park, Dallas, Tex., fro October, 1915, to March, 1916. The pavement was co structed with a base of 1 : 7 pit-run gravel concrete a with a wearing surface of 1½ in. of very rich concret having limestone and sand aggregates. The princip features of interest are the preparation of the subgra and the materials used in the wearing surface.

The soil in this locality is a black adhesive loam know as "black waxy." It is sticky when wet and cracks bad when dry. If rolled when damp, it is easily compacte but when saturated, it again swells to its original volu causing the paving over to heave and crack badly.

To avoid the effect of this heaving action, no rolli was allowed on a wet subgrade. If the subgrade h been rolled previous to a rain, it was not again rolled, b was dressed by hand to the required grade and, wh necessary, was lightly hand-tamped.

The pavement is divided into three sections as rega foundation treatment: (1) Approximately 1,300 sq.y was excavated 2 in. below grade and backfilled with grav nd rolled. The concrete was then laid upon this base. 2) Approximately 1,500 sq.yd. of the pavement was aid upon the natural subgrade and was reinforced with ,o. 26 American Steel and Wire Co. wire mesh. (3) The alance of the pavement was laid on the natural subgrade ithout reinforcement of any kind. However, the subrade was much better under this portion of the pavement, as rock was less than 2 ft. down.

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*Meyers & Noyes, Engineers, Dallas, Tex.

The $1\frac{1}{2}$-in. wearing surface was composed of one part ment, one part sand, one part fine stone and dust passg the $\frac{1}{4}$-in. screen and two parts of hard limestone passg a 1-in. screen. This mixture followed very closely curve of maximum density.

The gravel-concrete base was mixed in a batch mixer d was of such a consistency that light tamping was reiired to flush the mortar to the surface. A second batch ixer was used for the wearing surface, which was kept as near as practicable with the laying of the base and as completed on all the base course before stopping work r the day. The concrete was covered with earth and pt moist for two weeks after completion.

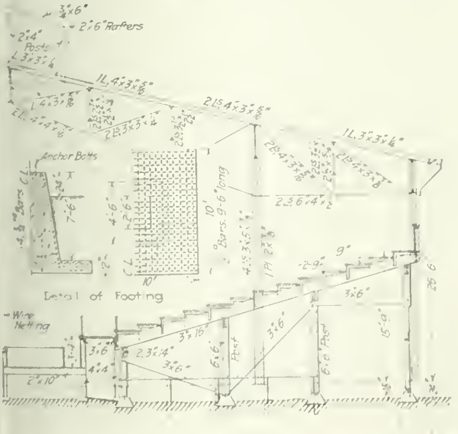
Up to the present there has been no noticeable heaving settlement of this pavement. Two cracks have developed—one lengthwise of the street, extending about twoirds of the length of the 25-ft. block of pavement laid the natural subgrade without reinforcement, and one diagonal crack in the portion having the gravel foundaon. A heavy drill derrick blew down in a windstorm d fell across the pavement at this point and may have used this crack.

Traffic has been very light on this pavement, and as t no definite information can be had as to its wearing alities. Several cuts have been made in it to repair iking water mains, and the concrete has been found to dense and hard.

* * *

Cantilever Grandstand Roof with Tension in Posts

An interesting detail in structural steel design is the thod of roofing the grand-stand of the Majestic Park se-ball field in Salt Lake City, Utah. This roof is so designed that the rear posts are really anchors to keep the roof trusses from tilting on the interior supporting columns.



ROOF OF GRANDSTAND, MAJESTIC PARK, SALT LAKE CITY

The grandstand is in the form of an arc of a circle of 126 ft. 9 in. radius. The stand is 48 ft. wide and 9 truss-bays long, the chord-length of a bay being 32 ft. on the inner edge and 14 ft. on the outer edge. There are 10 radial trusses. A cross-section through the stand is shown in the accompanying illustration. Diagonal lateral bracing between the roof trusses is provided in the two end and middle bays only.

A detail of the anchorage footing of the rear post is also shown. It is of concrete, reinforced with $\frac{1}{2}$-in. rods to carry the downward earth reaction on the $2\frac{3}{4}$-ft. shelf surrounding the bottom of the pedestal. This shelf is buried 7 ft. underground to provide sufficient anchorage load. The footings for the interior columns are of similar design but with reinforcement arranged for downward load.

The architects for this grandstand were Scott and Welch, Salt Lake City.

* * *

Specific-Speed Diagram for Hydraulic Turbines

The simple alignment diagram reproduced in the accompanying figure has been devised by C. D. Babcock, of Troy, N. Y., for finding the specific speeds of hydraulic turbines. It is believed to be smaller and handier than the older diagrams in use by turbine designers. The results are read in either English or metric units directly from the diagram, without computation.

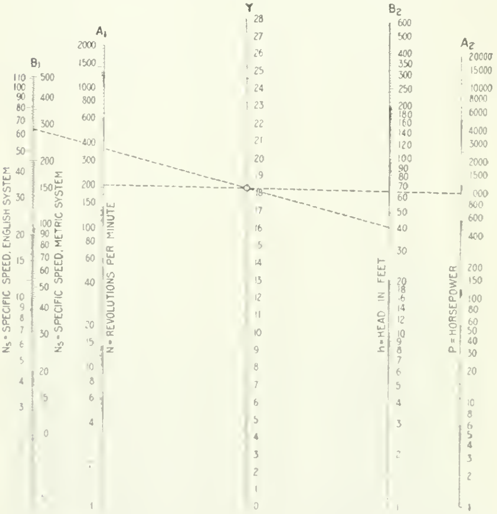
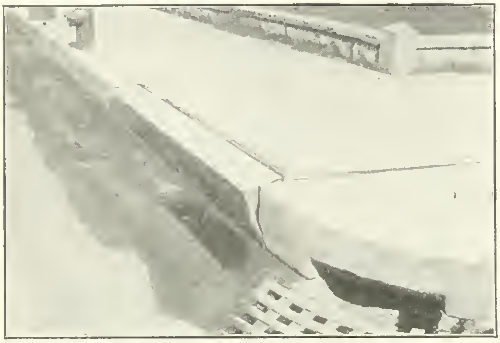


DIAGRAM FOR FINDING SPECIFIC SPEEDS OF TURBINES

The use of the diagram is nearly self-explanatory; a point is found on the Y-axis, or center line, where intersects a straight line connecting the given values of horsepower and speed, A_1 and A_2 axes; this intersection point is joined to the given value of head, h, axis, and the line projected cuts the specific-speed line, B_1 axis, at the desired value.

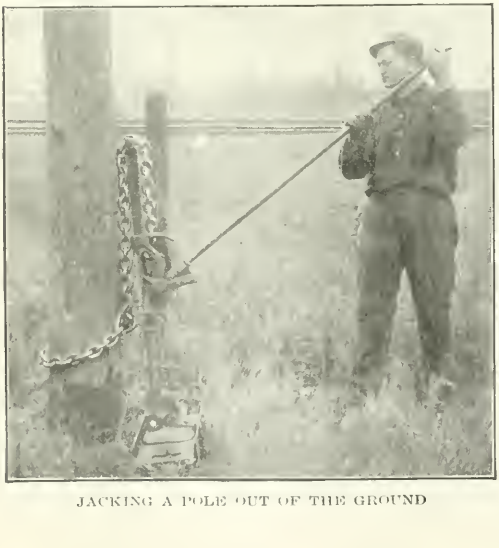
FINE AGGREGATE

Expanding Concrete Breaks Curbs—The accompanying view shows a street corner in Florence, S. C. Practically at every corner in the city, where the pavement and the sidewalks reach through the full block, there is this same trouble. In some places the gutter has been pushed under the curb; in other places the curb has been pushed back at the bottom and has cracked the cement sidewalk about 1 ft. back from the face of the curb. These sidewalks were built about 1907 and gave very little or no trouble from expansion until the summer of 1912, when they began to crack, and since then the cracking has grown worse every summer. As far as can be found at present, there were no expansion joints; and in places where the walks were full width, they were built integral with the concrete curb and gutter, all being poured at once. In 1912 the city had the streets paved with bitulithic laid on a 4-in. concrete base. There were no expansion joints, either transverse or longitudinal, in this concrete base. Since the street pavement was laid, there has been no chance for the walks or the pavements to expand without breaking something, and this view shows the result.—M'Kean Maffitt, Florence, S. C.



WHAT HAPPENED TO CONCRETE CURB WITH NO EXPANSION JOINT NEXT TO THE PAVEMENT

Jacks Make Pole-Line Work Easy—Special jacks are now being used for pulling and straightening power- and telephone-line poles by the Doherty Organization, the American Telephone and Telegraph Co. and other public-utility concerns. The accompanying illustration shows one such jack (of the "Simplex" type made by Templeton, Kenly & Co., of Chica in use for lifting. Digging around the pole is entirely eli inated. An I-beam base is placed beside the pole, the jack upon it, a chain slung around the pole and pulled ti through a pear-shaped link. Only a few minutes is requi for the entire operation—the record for pulling a 40-ft. p is 8 min. Where poles have been set in concrete or in a pa street or alley, they have been pulled without damage paving or curbing. For straightening poles the chain is used; the I-beam base is placed a short distance from pole, the jack placed thereon and, by means of its pivot base, inclined at approximately 45°. The top of the rack bites into the pole and a few strokes of the lever force pole into true vertical position.



JACKING A POLE OUT OF THE GROUND

Steel-Lined Material Chute — Concrete materials have be chuted down to Shaft 2 of the Shore Tunnel of the r Milwaukee water-works intake, as the shaft headhouse lies the foot of a bluff. An unloading platform at the top of bluff enables cement, stone and sand to be piled or dum and sent down the chute. The chute is at an angle of and is 90 ft. long. It is 46 in. wide by 21 in. deep, and is m of 2-in. plank, with bottom lining of 18-gage sheet st The chute forks at its lower end and here has a swing gate, so that cement can be diverted to the cement sto shed or sand and stone to the mixer platform. At the two 3x3-ft. openings in the unloading platform give acces the chute. All materials except wet sand prove to flow rea on the 30° angle. With wet sand it is necessary to hav man to help it slide.

MATERIAL CHUTE, LAKE PARK, MILWAUKEE

A Portable Plank Roadway 6 mi. in length is being structed across the sand-hill country about midway betw the Imperial irrigation district and Yuma, Ariz., as a par the state highway being built by the California High Commission. These sand hills are composed of very fine form-grained sand similar to that used in an hour glass so fine and dry that when a handful is picked up ne all the sand escapes from the fist. The roadway will ft. wide with double-width turnouts every 1,000 ft., where cars can sidetrack to allow others to pass on the main The roadway is built of 4-in. planks spiked to three strin underneath. Half-inch carriage bolts are cinched up tigh means of nuts and washers under the bottom of the string The individual units are 12 ft. long, weighing about 1,50 each, and are rigidly joined together by bolts and iron str The plankway will be coated with hot road oil and covered with coarse sand or fine gravel. A small force of and teams will be maintained in the vicinity of the pl road to clear away small drifts as soon as they occur. Sh it be found that a sand hill of considerable size is advan across the road, a short piece of the roadway will be ta up and shifted to one side to avoid the drift.

Recent Hammer-Drill Tests showed that a 20-in. hole c be drilled in 2 min. 7 sec., using a 1¾-in. starter, and car 16 in. deeper in 1 min. 30 sec. with a 1⅝-in. bit, the total b a 36-in. hole drilled in 3 min. 37 sec. A second test gave following results:

	Length of Drill	Size of Bit	Depth Drilled	Time
Starter	2 ft. 6 in.	2¼-in.	24 in.	2 min. 10
Second	4 ft. 6 in.	2 -in.	26 in.	2 min. 15
Third	7 ft.	1⅞-in.	34 in.	3 min. 10
Fourth	10 ft.	1¾-in.	36 in.	4 min.
Total			120 in.	11 min. 35

These data were obtained by the Chicago Pneumatic Co., whose drills were under test.

Editorials

An Engineering Problem Without a Precedent

One matter on which a good many engineers the world er have speculated, in connection with the loss of the ispended span for the Quebec Bridge, is the question hether it is within the range of engineering possibilities raise this span from the bottom of the river, in ater about 200 ft. deep. Of course, the structure, it lies on the river bottom, is so broken and strained its fall that even if it were recovered it would valuable only for scrap. No one would propose sing any of the members of the fallen structure in a new idge, even though the parts might appear from external ispection to be uninjured when recovered; and the great ze of the span would make it out of the question to ilize any of the material in other structures. The scrap lue of the nearly 5,000 tons of steel lying at the bottom the St. Lawrence River is high, as the bulk of it is ckel steel. But when one comes to consider practical ays and means of hoisting the fallen span from the great pth of water in which it lies, he very soon concludes that e cost would far exceed the value of the recovered aterial.

It would be difficult to prove that it is beyond the sources of engineering to recover the fallen steel, but do it within limits of cost that would make it a commercial enterprise appears to be out of the question. No ting tackle has ever been made in the world capable of isting such a weight as this suspended span, except the ckle that was actually in use at the Quebec Bridge for evating it from the river to its position. In the ordinary ting operations carried on by engineers, reliance is aced on wire-rope tackle. The most powerful hoisting achines ever built are floating cranes with a maximum ting power of about 250 tons. The weight of the uebec suspended span, however, was about 20 times as eat as this.

As will be recalled, the chains by which the span was ng hoisted into position were made from plates 30 in. ide and 1⅛ in. thick. Eight of these plates were quired to lift one end of the bridge. Evidently chains at least equal strength would be required to hoist the llen span from the water. Of course, chains of such rength could be made, and means could perhaps be found r securing them to the hull of a vessel, although the oblem of applying so huge a concentrated load to a ating structure is in itself unprecedented. The difficulty would then arise, however, of attaching the lower d of the chains to the wrecked truss. It is conceivable, course, that something might be designed in the shape a gigantic hook or grapple that might be maneuvered to position under some joint of the wreckage with the d of divers, even at the great depth at which they would ve to work. When it came to the actual lifting, however, it is probable that the whole mass of connected steel, the main trusses at least, would hang together as the fting proceeded until failure occurred in some overstrained joint, and then a large part of the imposed load might be suddenly released as breakage occurred. The stresses and shock that this sort of work would induce in the gigantic lifting tackle may be imagined.

The Engineer, of London, in discussing the accident remarks:

> The span has in all probability fallen more or less in position; and if it is found on inspection to be indeed worth salving, it is not impossible that the arms of the cantilevers may serve as cranes to raise it from the bottom.

Those who experienced the shock and vibration that occurred on the cantilevers when the load of the suspended span was suddenly released will look with little favor on the above suggestion.

Apparently the only feasible plan for recovering the metal in the fallen span would be to find some means of cutting the wreckage into pieces within the capacity of ordinary lifting tackle. Were the wreckage above water, this might be done by the oxyacetylene torch and possibly by the use of high explosives, but in the great depth of water where the wreck lies and realizing the extent to which the parts are tangled and bent by the fall, there seems little prospect that any plan for cutting apart the wreckage could be made practically successful.

The above by no means exhausts the list of difficulties that would have to be overcome in order to recover the lost span; but it indicates at least the small prospect that anyone will undertake the task.

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A New Method of Finishing Concrete Roads

A well-known engineer interested in road construction spent a week's time and traveled nearly 3,000 mi. to inspect concrete-road construction in progress in half a dozen different states, including a number of jobs that are supposed to represent the latest and best practice. His report upon his return was that the most important development in concrete-road construction that he had anywhere seen was the method of smoothing off the concrete surface with a canvas belt, in use on the roads of Wayne County, Michigan.

An article in the last issue of this journal described this process as now used, but the idea is so simple that it almost explains itself. It will be obvious to any engineer experienced in concrete-road construction that this method of finishing represents a very considerable saving over the standard method of floating the surface with hand floats from portable bridges. This saving in expense is important. In many localities the question what type of road to adopt is simmering down nowadays to the question whether it is cheaper and better to build a concrete road or to lay a concrete foundation and then take the money that would be required for the extra cement and extra labor necessary to make the concrete foundation good enough to stand traffic on its surface, and by adding a little more money pay the cost of an asphalt surface on the concrete foundation.

There is another reason why the canvas-belt method of finishing may prove of great importance to the concrete-road industry. With the present mode of finishing concrete roads by hand floating, small inequalities are almost inevitably worked into the surface, which produce a slight shake and jar in a car running over the road at high speed, so that the road is not quite as pleasant for automobile pleasure traffic as is a first-rate bituminous macadam road or a good gravel road, when either of these latter roads is in perfect condition. If, however, concrete is mixed fairly dry and is formed to the true cross-section of the road by the strikeboard, it should then become possible with the canvas-belt method of finishing to produce a uniform surface on the finished road, free from humps and hollows. This surface ought to be durable, moreover, for any surplus water or laitance brought to the surface by the friction of the canvas belt should drain off, so that the road will set hard and firm.

⁂

Time To Stop Road Destruction by Motor Trucks

At a convention of one of the national road associations last winter, a speaker representing motor-vehicle interests declared that it was the business of engineers to build roads so substantial that motor vehicles could run over them without any limitation of speed or load. Unfortunately for the taxpayers, this extreme declaration of policy is actually being carried into practice by some builders and users of motor vehicles. Almost without exception they are now at liberty to haul over public highways vehicles of any weight they choose, run at any speed that the combined effect of the motor and the grade will produce.

Attention has frequently been called in these columns to the millions of dollars of damage that is being done to expensive roads by motor trucks, but the flippant answer of the truck builder and truck owner has been that the roads should be built to stand the traffic. The absurdity of this idea has been repeatedly shown; but a complete and final demonstration of its impossibility is furnished by the article published elsewhere in this issue describing the destruction, within the short period of four months, of a modern granite-block pavement in New York City by the impact of very heavy steel-tired motor-drawn vehicles run at high speeds. Of course, everyone knows that it is impracticable as a financial proposition to lay granite-block pavements on country roads at a cost of $4 to $5 per sq.yd. The experience in New York elsewhere described, however, shows that even if this were a financial possibility, such roads would not fulfill the requirement referred to above—a road that would stand traffic of any weight at any speed.

It must be obvious that if cities and counties and states are to escape financial bankruptcy as a result of the enormous expense of road maintenance, they must take drastic measures to stop the destruction of roads by motor-truck traffic. Limitations to weights and speeds must be drawn somewhere; and enough experience has now accumulated regarding the destructive effect of motor-truck traffic so that it is entirely possible to frame a law that will protect from undue injury the roads which the taxpayers furnish the money to build and maintain, and that at the same time will not interfere with legitimate use by motor vehicles.

Three years ago an ordinance was introduced in York City requiring licenses to be obtained by vehicle using the streets of the city, the license fees graduated according to the load in pounds per inch of tire. For vehicles carrying loads per inch wid tire of 750 lb. or less, the license fee was $1. The then rapidly increased so that for loads of 850 to lb. the license fee was $12, and for 950 to 1,00 the license fee was $50.

For vehicles designed to carry loads per whe 6,000 to 10,000 lb., graduated license fees were varying from $75 for wheel loads of 6,000 to 6,5 up to $1,000 for wheel loads from 9,500 to 10,0 The ordinance was not pressed for passage becau the opinion rendered by the Corporation Counsel th account of the special regulations of motor-vehicle fic put in force by the state, the city could not e such an ordinance.

This, however, it should be noted, was after all a lawyer's opinion. The pressure of public necess insistent. City administrations everywhere are f face with the great difficulty of obtaining sour revenue to keep pace with the constant increase penses. A system of graduated license fees on v using the public highways could compel those w the roads to pay for the wear and tear they caus at the same time so penalize the use of motor tru exceptional weight, speed and destructiveness that it be no longer profitable to operate them.

⁂

Meters To Save Philadelph

For a half century the successive engineers resp for the water-supply of Philadelphia have pleade might almost say fought, bled and died—for the tion of measures to stop the waste of water for Philadelphia has been notorious. Their efforts promise to bear fruit, as may be seen by the stat in the last part of this issue.

It appears that the intense opposition to mete has been manifested by the public and reflected by cils, has at last given way to conviction that meters will conserve the present supply of water that is purified by works built at vast expense with the p understanding that they would be adequate for y come.

The method to be pursued at Philadelphia is t vious remedy for conditions that exist not only but in other cities. Large consumers are to be con to buy water through meters. Small consume be forced to do the same if they waste water, a be encouraged to adopt meters in any event, thr proper adjustment of charges for unmetered a metered water.

Simplicity would dictate the wiping out of th schedule of flat rates and putting all consumers metered basis as soon as meters could be secur adopted; but in dealing with the mass of small cons including all in the domestic class, it is best to haste slowly. In the end self-interest will preva of course the people must be shown what their t terests are. With the large consumers, few in r but using and wasting a huge total volume of prompt compulsion is imperative.

Canadian Engineers Object to Appointment of Aliens

Engineers who have had the responsibility of serving on the governing board of a national engineering society can usually recall instances when measures were brought before the board, urged for passage by some specious argument and finally adopted; yet afterward the majority of the members, on sober second thought, would regret the action that had been taken.

It is probable that some such record could be made in connection with the extraordinary circular recently issued by the Canadian Society of Civil Engineers protesting against the appointment of Prof. George F. Swain as engineer of the commission that is to advise the Canadian Government on certain matters of railway policy.

The protest was of course not made on any personal ground. Professor Swain is an engineer of international eminence and is a member of the Canadian society. That society has made its public protest on the ground that the appointment should have gone to a Canadian engineer. It says:

> We wish to record our strong condemnation of the policy of placing in the hands of aliens the engineering work of a commission appointed by the Canadian Government to investigate Canadian railways for which the Canadian community has paid.
>
> The inferences to be drawn from the employment of aliens in the above connection are that the Federal Government considers:
>
> 1. That the Canadian engineers who built the railways are not competent to report upon them.
>
> 2. That the Canadian universities, in many cases enjoying Government subsidies, are not producing competent engineers; and
>
> 3. That the Canadian Society of Civil Engineers, although embracing a membership of about three thousand, is not considered worthy of consultation on an important engineering question.

The circular then proceeds with the statement that Canadian engineers probably do not get such appointments because they do not assert themselves nor demand recognition and that the council of the Canadian society proposes to initiate a campaign to secure for Canadian engineers due recognition.

The Canadian Society of Civil Engineers is an organization which has had a splendid history. Included among its membership are many men whose record of important work achieved entitles them to rank with the leaders of the profession in the United States or any other country. Unfortunately, there has been in the society more or less of a tendency to make the organization's main purpose the monopolization of the engineering business. We need only refer to the legislation which the society has secured in Quebec, limiting the practice of civil engineering in that province to members of the society. Such legislation stands on a par with that attempted by some of the local engineering societies in the Western States, whereby a system of state licenses to engineers was to be established, the license fee being fixed at $500 for engineers resident outside the state.

It is almost unnecessary to say in these columns that the building of geographical fences in the engineering profession is against its best interest as well as against the best interests of the public. What the public wants in its engineering work is the man who can deliver the goods, regardless of his nationality or the place where he may happen for the time being to have his residence. When it is attempted to lay down the rule that engineers should be employed because they live in a certain city or state where the work is to be done, we are practically accepting the theory that the work is done to furnish jobs for those who want them.

It is of course true that at times when a professional adviser has to be chosen there is a certain tendency to overlook the merits of home talent and choose a man whose reputation is magnified because he comes from a great distance. Protest against errors of that sort is justifiable; but any organization of engineers should beware of placing itself before the public as seeking to claim appointments for its members. There could be no surer way of forfeiting public confidence and respect.

Our contemporary, the *Canadian Engineer*, takes a sound view of the matter when it says: "The Canadian engineering profession cannot afford to be too narrow in its views of such matters. It cannot adopt the closed-shop method."

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Should Street-Car Bridges Be Designed for Derailment

Typical accident conditions existed at the site of the West Third St. bridge wreck in Cleveland. A steep down grade with a sharp curve at the foot—this combination has caused many a wreck. To Cleveland citizens the West Third St. hill was familiar enough to make them forget the probability of accident, and a long record of freedom from mishap gave additional reassurance. But the well-known law of chance, that the probable event will very likely happen some time, even if long deferred, finally operated, by means of a motorman who let his car get out of control.

What made the Cleveland accident bad was the presence of the bridge at the danger point. This bridge was vulnerable, not because it was old, and light, and probably in great need of renewal, but because it was an ordinary, unprotected bridge. Doubtless both the city and the street railway people knew—or might have known if they stopped to think—that a car accident on the hill would be sure to wreck the bridge and thereby multiply the seriousness of the accident. They put their reliance on preventing car accidents; when the right time came this reliance failed.

Railway analogies, drawn from many decades of experience, are illuminating with respect to safe practice in rail transportation. They put guard rails on bridges for instance, rather than rely on absolute freedom from derailment. Where viaduct columns are placed near railway tracks, they build fender piers around the foot of the bent, to make the viaduct safe even when a train wreck occurs directly under it. So in bridge design, they have developed their floor details and various other elements of the construction largely on the basis of derailment requirements.

It may prove feasible to base the design of a bridge like the West Third St. structure on derailment conditions as the governing consideration. A distinct gain of safety might be secured by building such a bridge that even a runaway car could not break it down—to fall, perhaps, on a train loaded with people, just then passing under it. It would be rather beyond precedent to go to such refinement and expenses in a mere street bridge; but would it not make a safer bridge?

Letters to the Editor

A Thin Arch Dam in Australia

Sir—In your issue of Feb. 10 there appears an article on the Upper Otay Dam, San Diego, Calif., describing the passage of the recent floods over that structure. The article states that "There have been constructed in Australia, to form irrigation reservoirs, some arch dams that are even thinner than the Upper Otay dam." The Medlow Dam, New South Wales, designed under the direction of the late L. A. B. Wade, is believed to have the thinnest profile in the world, the thickness at a depth of 62 ft., being only 8.96 ft. This dam, however, is built in a narrow gorge, the radius being 60 ft., and the maximum stress on the concrete being only 12 tons per sq.ft.

A concrete arch dam designed by the writer, and built under his general supervision, was recently constructed on Sorell Creek, Tasmania, Australia. The dam has a crest length of 155 ft., and an upstream radius of 110 ft. The thickness is 2 ft. at the top and 6 ft. at a depth of 30 ft., and the stress on the concrete is 15 tons per sq.ft. The height from crest to bedrock is 50 ft., the lower 20 ft., however, is very short and is practically a cut-off wall carried through a dike of decayed rock. A raised crest in the center limits the passage of floods to a length of 50 ft. at either end of the dam.

THE SORELL REINFORCED-CONCRETE ARCH DAM IN TASMANIA

The capacity of the reservoir is only 66 acre-feet, and the dam was just completed and the concrete still green when heavy rains fell. The reservoir was filled in three hours and a depth of 2½ ft. of water flowed over the bywashes for two days without injury to the structure. During the next three months several floods passed over the dam. The design stress of 15 tons per sq.ft. is conservative, but was adopted as neither foreman nor men with previous experience of this class of work were obtainable.

The arch dam has been used in several cases in A tralia as a solution of foundation problems. When short length of faulty rock occurs a short length of a dam has been built connecting two wings of gravity ty a cut-off being carried down to sound rock beneath arch. Where the site is suitable the writer regards arch dam as a most satisfactory type, as danger fr uplift and sliding are practically eliminated; moreov greater economy is often obtainable.

W. Nimmo,

Engineer-in-Chief's Office, Department of Public Wor

Hobart, Tasmania, Aug. 21, 1916.

Why Put a Gravel Cover on th Concrete Floor of a Bridge

Sir—In answer to your correspondent C. E. V.'s let on p. 468 of your issue for Sept. 7, under the headi "Why Put a Gravel Cover on the Concrete Floor o Bridge?" I will state that the advantages are as follo

1. The gravel covering is less expensive than the ex thickness of concrete floor and weighs no more.

2. Troweling the top of the slab is not neces when a gravel covering is to be placed, making a furt saving in cost.

3. Chuck holes at the end of the bridge are avoi where the surface material on the bridge is the same that on the road. Where two different types of surfa meet, chuck holes will develop under traffic.

4. The gravel covering is of great assistance in pr erly curing the concrete slab.

I have not as yet seen a single case where the gr covering raveled under traffic. It wears out no fa than the surfacing on the road and can be maintai along with the road-maintenance work.

C. E. Nagel.

Deputy State Enginee

St. Paul, Minn., Sept. 15, 1916.

Types of Road Surfacing fo Loose-Sand Foundation

Sir—I note in *Engineering News* of Sept. 28 an quiry relative to the construction of a concrete road a loose-sand foundation. I would like to add ano type of road to those suggested in your tail-note. If is not available, I would suggest a crushed-stone or m dam road on a straw carpet.

To build a road of this type, the sand subgrad first shaped to the desired cross-section, with side dr of ample capacity. After the subgrade has been crow and smoothed, a carpet or mat is prepared of baled st to a depth of 4 to 5 in. Baled straw is used rather loose straw, as the mat can be more readily laid. first course of 2½- to ¾-in. crushed stone is then pl to a depth of 6 in. The second course consists of 3 i ¾-in. or finer stone screenings. The courses may rolled, but a light roller should be used to avoid "wavi

The straw carpet serves as a foundation for the stone ntil the road is bonded. With the perfect drainage hat a sand subgrade offers, the straw will not rot until he stone has cemented and bonded together. While his type of road is not fitted for trunk-line traffic, it ffers a solution for the problem of a moderate-priced ›ad on a loose sandy soil.

I have seen roads of this kind built of crushed lime-one in the white-sand soil of northern Michigan; it ot only makes a fine smooth surface but wears well, nd maintenance charges are low.

The total cost of a road of this type, including grad-ıg, should be between $3,500 and $5,000 per mi., de-ending on width of metal, length of haul for material, bor costs, etc. R. L. Longshore,

Assistant County Engineer, Adams County, Indiana.

Decatur, Ind., Oct. 2, 1916.

[The use of straw or grass mats on loose soils is nearly old as macadam-road construction. The purpose of ıe mat is merely to keep the broken stone or gravel ırfacing from being rolled or worked into the subsoil, fore the macadam surfacing is bonded into a unit. N. Shaler, in his "American Highways" (1896), recom-ended muslin cloth as a substitute for straw in certain stances.—Editor.]

Long Island Concrete Roads

Sir—In looking over your remarks following the let-r in regard to the concrete roads on Long Island on ndy soil in *Engineering News*, Sept. 28, p. 616, you ıke mention that the concrete is poor and shows wheel ıcks.

I was on Long Island a few weeks ago in company with e engineers of the Highway Department and noticed e ruts. They are caused by driving in the same track th cars equipped with tire chains, during the winter ıen snow is on the road; and it is a good road that will t show marks under that treatment, and with the eed they drive down there. Oscar Hasbrouck,

Engineer of Convict Labor.

Hudson, N. Y., Sept. 29, 1916.

ıre Boats for Lake and Ocean Traffic Practicable?

Sir—Referring to your review of the report of Sanford ans on the Great Lakes traffic, in *Engineering News* Sept. 28, toward the end it is stated that the Lake ssels might be operated on the ocean during the winter. considered this matter in connection with the design the Georgian Bay canal, and it is still a very interesting oject. It is generally considered that the highly special-d ore boat used on the Lakes is too long, too lightly ılt and not of deep enough draft for the ocean. The gines astern and ballast-tank system would not quite ıt, and the condensing apparatus would have to be ferent.

On the completion of the Soulanges canal in 1900, eral Clyde-built boats 250 ft. long, 13 ft. beam and ft. draft came out to ply on the Great Lakes. The st difficulty was that the steering gear was too slow for ıal and Lake channel work; next, the hatches were not ıced to suit the loading and unloading machinery of ke ports. The wage rate of the salt-water crew was less than half the rates paid on the Lake; consequently, the men promptly deserted. The rules of navigation on the Lakes are different and also the bell signals, while the modernized Lake chart might puzzle some of the old sea dogs.

In general, the Lake traffic is a highly organized and highly specialized business; 80% of it consists of carrying iron ore from Superior to Erie and coal back. The ore carrying, however, is materially different from the system used in the ore traffic between Spain and Great Britain. The old "hog" type of vessel was tried on salt water, but proved very unpopular with the crews. The seas pounding on the whale-back deck prevented sleep and also regular meals, and eventually the construction was found to be too weak.

The St. Lawrence indents America as deeply as the Mediterranean penetrates the eastern hemisphere, and ocean vessels must some day ply regularly up to Superior. The St. Lawrence valley is surely destined to be the greatest traffic artery in the world. J. R. Coutlee,

Engineer-in-charge, Ottawa River Storage.

Ottawa, Ont., Oct. 2, 1916.

Vocational Guidance for the Engineering Student

Sir—Commenting on the article in *Engineering News* of Aug. 31, by Prof. W. M. Wilson, on "Misfits in Education" and on the accompanying editorial, the writer agrees with Professor Wilson that the strictly engineering work should be postponed to at least the second year in college; but, with the editor, he thinks that Professor Wilson's remedy is not radical enough.

Some colleges already have a uniform course for all freshmen and do not begin to take the department work until later in the college course. The writer agrees with Professor Wilson that some courses should be introduced into the schedule giving the characteristics and requirements of the professions. At least one college has done this to some extent in the form of smoker-talks and lectures from business and professional men as well as members of the faculty.

It is not proposed to attempt a new solution of the question of misfits in education, but to call attention to a system which has been in successful operation for about 45 years, with slight modification, and which the writer believes tends to eliminate a great many of the misfits before it is too late for them to turn to some other kind of work.

Instead of beginning the engineering work in the second collegiate year it is far better from all standpoints to begin the engineering work in the fourth, or senior, year. The system which has been adopted and found most successful in educating engineers (not experts in some narrow engineering field) is based on three years in a college of arts and sciences, a fourth year substituted for the senior year in the college and devoted entirely to the fundamentals of engineering, and a graduate year devoted to more advanced engineering work. During the three preparatory years in college, courses in physics, chemistry, drawing, descriptive geometry, mathematics, etc., are required, the remaining time being devoted to cultural subjects—English, history, economics, languages, etc., to fulfill the college requirements for graduation. A grade is required for entrance to the engineering school which is slightly higher than the average college grade, and an entrance examination is also required, thus giving an opportunity to pick the engineering students to some extent.

As a result, less than half of the men who start out in freshman year to be engineers reach the engineering school. Those who do not reach it have not been narrowed by their college work, but can take up any other course for which they are better fitted. Of those who take the fourth year in the engineering school and are graduated from the college, about three-fourths return for the graduate year. There are about four months between the two years' work in which the prospective engineer can get a great deal of outside experience, and many men stay out a year or more before returning for the graduate year in the school.

In addition to the engineering school there is connected with the institution a School of Administration and Finance, requiring three years of college-preparatory work, and a medical course requiring two years' preparation, so it may be seen that the system is very flexible.

Experience in teaching in a prominent state college typical of the usual four-year course and in teaching under the system above described has proved to the writer that specialization should never be attempted in the four-year technical college course, but only the very fundamentals of engineering should be taught. This gives none too much time for the essential foundation work. Any man who wishes to specialize should do so in a graduate course.

In addition to the advantages of gaining picked men better fitted for their life work, other advantages of beginning engineering work in the fourth year are: Freedom from athletic and other diversions; a better *esprit de corps;* a greater willingness to work, on the part of the student, together with the ability to do more work and to do it more thoroughly; opportunity to eliminate the one hour a week course (the abomination of abominations) and to make a schedule of courses giving better sequence and fewer courses at a time; opportunity of from four months to two or three years of practical experience before taking the final year; and lastly, opportunity to take more cultural and general studies.

In regard to the last point, every engineer who has not done so should study one of the reports on engineering education, by Dr. C. R. Mann, of the Carnegie Foundation, wherein he states the fundamental defect of engineering education at the present time to be narrowness, particularly with respect to English, economics and other cultural subjects.

SYDNEY LEE RUGGLES,
Instructor, Thayer School of Civil Engineering.
Hanover, N. H., Sept. 19, 1916.

*

Petition by the Unorganized Railway Employees

Sir—With reference to the railway wage controversy, the unorganized men have called for a report of how their petition to the President and Congress was handled by Mr. Walden and me, who are heading the movement, and how it was received at the White House. So we are issuing the inclosed statement to them.

I may add that the 80% are very much opposed to the legislation as enacted and to President Wilson's recommendations to Congress, which altogether ignore thei rights, and expect to present at the next session of Co gress a strenuous appeal for a full and just investigatio of the whole railway wage situation.

ROBERT T. FRAZIER,
Assistant Engineer, N., C. & St. L. Ry.
608 So. Dearborn St., Chicago, Oct. 7, 1916.

[The statement accompanying Mr. Frazier's letter r cites that the petition signed by 105,000 railway employe asking that legislation be enacted to provide for arbitr tion of all differences between railway companies and the employees was taken to Washington by Mr. Frazier a Mr. Walden who daily visited the White House and soug to see President Wilson during the three weeks while h time was chiefly given over to the railway situation. Th were unable to see the President and on Aug. 30, follo ing his message to Congress, Mr. Frazier wrote him adv ing him that the petitions he bore had been signed 111,000 railway employees, and that if the legislati recommended by Congress was enacted, the remaini 80% of the railway employees must of necessity organ and present their demands upon the railways.

On Aug. 31, the President replied regretting his i bility to grant a personal interview and stating that recommendation of legislation affecting trainmen o was "because of the lack of constitutional power to d with any of the employees except those actually enga in interstate transportation."—Editor.]

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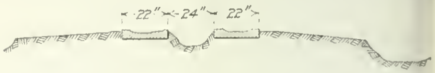
Use of Paved Wheelways on Roads of Holland

Sir—Paved wheel-track ways on roads, similar those proposed by F. T. Warner on page 469 of y issue for Sept. 7, have been extensively used through the marshy sections of Holland. They are in g favor with the rural population, for the soft center p makes them ideal roads for one-horse vehicles. T wheelways have been in existence for at least 100 ye Some of them were built by order of Napoleon, wanted them for cannon transportation in case of English-Russian invasion in the north of Holland.

The roadway wears rapidly in the center, and the sides recede from the hardened tracks; therefore roads are not suitable for swiftly traveling motor The deep gutter formed between the tracks is usu filled with water, notwithstanding attempts at thoro drainage. A typical cross-section of the roads aft few years' use is shown in the accompanying sketch, w out exaggeration.



BRICK-PAVED WHEELWAYS IN HOLLAND

It is not at all necessary to make the trackway the thickness proposed by Mr. Warner, as a 1½-in. l of hard-burned bricks has withstood the moderate cular traffic of Holland for a lifetime.

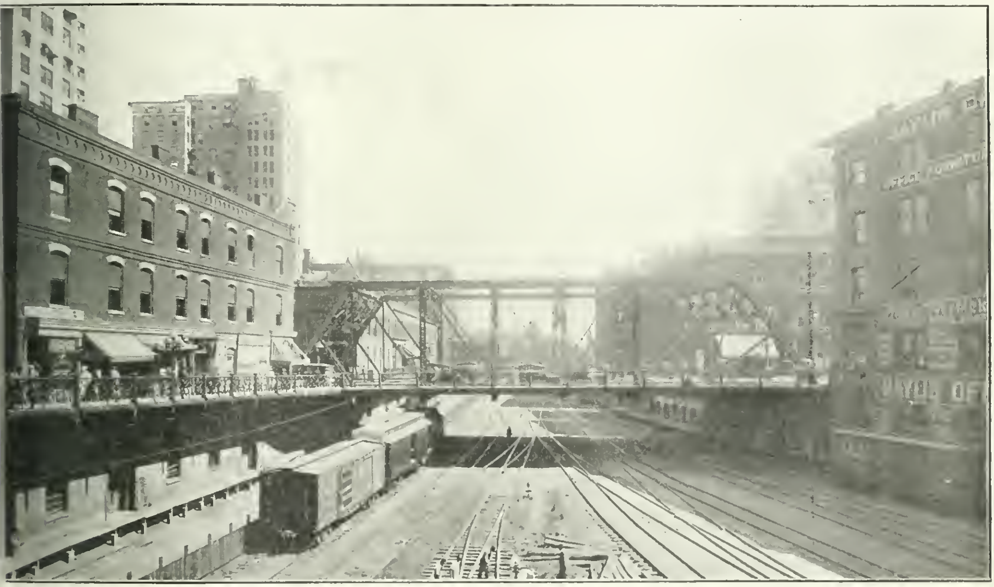
On agricultural estates throughout the East Indi saw roadways made of two concrete slabs incased in st tural-steel frames to make the trackways transport

JAN SPAANDE
Brooklyn, N. Y., Sept. 9, 1916.

ew Railway Terminals Planned for Atlanta, Ga.

An investigation of the railway terminal facilities of tlanta has recently been made for the city officials of tlanta by the firm of Barclay Parsons & Klapp, of New ork City, and radical changes have been recommended. here are at present two passenger stations in Atlanta, lf a mile apart, one called the Union Station, built in 71, the other known as the Terminal Station, built in 04. The older station has only four tracks, and the site too small to permit enlargement. The Terminal Station s already reached about the limit of its capacity. Freight rds used by several of the railway lines are located in e heart of the city, where their operation is a detriment surrounding property.

The plan for remodeling these terminal facilities orked out by Barclay Parsons & Klapp contemplates e abandonment of the present passenger stations and e construction of a new terminal station for the use all railways entering the city, on a site capable of largement so that it will be adequate for the city's needs r at least 50 to 75 years to come. It is proposed to andon the present freight yards in the heart of the city d build new yards in locations convenient for the manu-turing and wholesale districts. The old freight yards be filled in and converted into parks.



RAILWAY TRACKS AND YARDS IN ATLANTA BUSINESS DISTRICT
View taken from Forsyth St. Bridge looking east toward old Union Station

Previous plans have been discussed in Atlanta for moving the nuisance attendant upon the present freight d passenger yards by covering the tracks with a concrete f and creating a park upon this roof. In commenting this proposed plan, the engineers point out that it uld be practically impossible properly to ventilate the ace beneath such a roof, so long as the railways use am locomotives. This difficulty would be overcome by the adoption of electric motive power to haul all trains moved within an area probably a mile in diameter, but the engineers believe that the cost of such electrification would be prohibitive.

In the plan recommended by the engineers it is proposed to bring trains under the proposed parks to the new passenger terminal through single-track tunnels. With this method of operation it would be practicable to secure good ventilation, since the air moves with the train.

The estimate of cost for carrying out the entire project is $6,500,000. This estimate includes the cost of purchasing the present Terminal Station, all the necessary land, the construction of the tunnels, the filling in of the ground, the development of the plaza as a park and the removal of the present station to a site about 90 ft. east of its present location. It also includes the money necessary to create new team tracks and freight depots to take the place of those abandoned in carrying out the project. To finance this work it is recommended that the city issue 50-year bonds to cover the cost and that the railways agree to rent the new terminal facilities for an amount sufficient to pay the interest on the bonds and sinking-fund contributions sufficient to retire them at maturity.

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Low-Priced Asphalt Pavements—According to Eric Wold, City Engineer of Burlingame, Calif., in an article in the July issue of "Western Engineering," recent prices for pavements of 1½ in. of asphaltic-concrete surfacing (Topeka specifications) on a 4-in. cement-concrete base, are remarkably low this year. A contract was let to the Federal Construction Co., San Francisco, for 181,000 sq.yd. of this pavement for 78c. per sq.yd. The contract included storm sewers, sanitary sewers, curbing, etc., amounting in all to nearly a quarter of a million dollars. The prices of materials were as follows: Cement delivered on the street $2.10 per bbl., crushed gravel $1 per ton, asphalt at the plant in tank-car lots $8 per ton, limestone dust $5 per ton. Keen competition and efficiency in handling materials as well as the size of the job are said to be instrumental in producing the low prices.

New Winnipeg Aqueduct Cracks from Foundation Settlement

SYNOPSIS—A Board of Engineers has just made a report on the cracks which have formed in the new hundred-mile concrete aqueduct which is being built by the City of Winnipeg. The Board finds the cracks to be due to settlement of the aqueduct in sections where it was founded on compressible soil. The method of repairing the cracked sections is described and the plan adopted for obviating similar trouble on the sections of the aqueduct built this season. Notwithstanding the additional expense involved in repairing the cracked sections and in strengthening other portions of the work, the entire project will be carried to completion within the engineer's original estimate of cost.

The City of Winnipeg, Manitoba, is constructing a concrete aqueduct nearly 100 mi. in length to bring a supply of nearly 100,000,000 gal. a day from the Lake-of-the-Woods. A general description of the work was given in *Engineering News* of Feb. 4, 1915, p. 230. About 15 mi. of this aqueduct was completed last year and after its completion cracking occurred on considerable portions.

On Feb. 25, 1916, the Board of Commissioners in charge of the construction of the aqueduct, after receiving a report on the cracking from their consulting engineer, James H. Fuertes, and chief engineer, W. G. Chace, requested a board of engineers consisting of Col. H. N. Ruttan of Winnipeg, J. G. Sullivan of Winnipeg, and R. S. Lea of Montreal, to investigate the whole matter of defects in the aqueduct and report to the commission. This board of engineers on Sept. 26 presented its report to the commission.

For a great portion of its length the new aqueduct is built on the hydraulic grade line and is of horse-shoe shape. At certain river crossings, the aqueduct is of circular form to stand internal pressure. The horse-shoe shaped sections are intended to flow only partially full. The aqueduct is of the cut-and-cover type, and the standard depth of cover specified is 4 ft. over the top of the arch. The minimum top width of the embankment is 8 ft. with side slopes of 1¾ : 1.

The dimensions of the aqueduct vary on different sections according to the slope. There are ten different standard sizes, the smallest being 5 ft. 4¾ in. high and 6 ft. 4¾ in. wide, and the largest 9 ft. high and 10 ft. 9 in. wide. The principal defects have occurred in a section in which the aqueduct is built with a slope of 1.58 ft. per mi. and is 7 ft. 4⅝ in. by 8 ft. 9 in.

Cracks Appear in the Invert

The defects which have developed in the construction in some of the sections of the aqueduct since their completion last season consist of cracks, nearly all of them in the invert. Out of 65,390 ft. of aqueduct completed last year, invert cracks have developed in about 11,380 ft. There is usually a single crack along the middle of the invert; but in a few cases where badly cracked sections occur, there are cracks in the sidewalls of the arch well.

These cracks have been closely watched since their fir appearance by the use of "tell-tales" consisting of smoot pats of cement troweled across the crack. The last sig of movement was observed at the beginning of Apr In 4,850 ft. of aqueduct the cracks are from $\frac{1}{16}$ in. ¼ in. width. About 4,000 ft. have cracks of $^1/_{64}$ $\frac{1}{16}$ in. width, and the remainder has merely hair crac only discoverable by very careful examination. In son arches where the invert cracks are wide, correspondi cracks have occurred on the crown of the arch. Wi the exception of a few cracks which are traced to te perature changes, careless backfilling, accidents in moving forms, etc., all the cracks are believed to due to settlement of the invert.

Design and Construction of the Aqueduct

The aqueduct is built of concrete in the proportions 1:2:4, of first-class materials, carefully selected a graded to form a strong and dense mixture. The inve is laid in alternate lengths of 15 ft., connected by a co per expansion joint. The arch is built in alterna lengths of 45 ft. with expansion joints of the same kin The lengths of both invert and arch are built alternate and an entire length is poured in one operation. T inverts are first laid down for a considerable distan and then the arch is built upon them, the horizontal join between the invert and the sidewalls being provided wi an effective water stop. Steel forms are used in the co struction and the interior surface produced is very smoot while the concrete work in general is of high quality.

The Board of Engineers discuss separately the desi of the arch and the design of the invert. Backfilling o the arch is limited to 4 ft. in depth, even in deep cu Besides this, before backfilling begins, all standing wat loose materials, débris, etc., are removed and the ba fill for a depth of 4 ft. above the arch is required be of selected earth deposited in layers and solid rammed. Under these conditions the load on the ar is very small compared with the load carried by simil arches used in railway culverts, large sewers, etc. T board has examined many miles of the arch construct in 1915 and concludes that where cracks have occurr in the aqueduct arch, they are in no case due to a fault in the design of the arch.

Turning to the design of the invert, the board sa that the invert is built in a single monolith of good co crete and has a minimum thickness even in the small sizes of 6 in. at the center. The weight of the arch a its covering rests wholly upon the sides of the inve The board continues:

> If we disregard the considerable effect of such an inve in distributing the load, the outer ends only may be look upon as constituting the footings of the sidewalls. If the e fective area of the footings is not sufficient for the beari power of the soil, or if the trench bottom is carelessly or i properly prepared for the reception of the concrete, und settlement of the sidewalls relatively to the middle is likely take place, which will cause the invert to crack, usually alo the center line. The effective bearing area of the footin may be increased by extending the invert and increasing thickness by spreading the outside forms at the bottom of t

si walls of the arch, or the entire invert may be utilized to di ribute the load by sufficiently increasing its thickness ar reinforcing it with steel.

he trench excavation in which the aqueduct is being t is made in all sorts of materials, including clays arying degrees of compactness, quicksand, soft muck, muskeg. Clauses in the specifications provide for the ring of good foundations where soft material is en- tered.

he section on which the greatest number of cracks occurred at mile 23 is in a shallow cut, generally een 1½ to 4 ft. depth. This work is in a prairie ion and in a clay soil, the bearing power of which proved to be much less than was anticipated. The lting settlement has caused the cracking of the invert.

y way of experiment three arch lengths were under- ied with sand driven through holes in the invert close he sidewalls before sufficient settlement had taken e to form cracks. These inverts have since stood out cracking, but the practice has not been continued.

racks which have occurred on other sections of the duct can be traced generally to patches of soft ground nitting settlement of the structure.

Repairing the Damaged Sections

mong the series of questions propounded to the Board ngineers was the following:

> an the damaged work be repaired to be efficient or will ve to be removed? If it can be repaired, explain how.

he board replies that the damaged work can be re- ed to be as permanent and efficient as other por- s of the aqueduct, and that none of the work so far t will have to be removed.

he method of repair now being carried out is to cut the crack to a depth of 1½ to 2 in. and to a width bout 1 in. This groove as far as possible is made r at the bottom than at the top and never V-shaped. It carefully cleaned with water, then packed with neat nt slightly moistened, which is hammered solidly place using a special calking tool. This makes not an exceedingly tight joint but a very strong one. s of portions of the invert including these joints, shown that even after the cement filling has been lace only two or three days, it adheres so strongly he concrete that when broken the break has gener- been in the old concrete.

Testing the Aqueduct for Leakage

order to test the efficiency of this repair work, two ons of aqueduct, each about 270 ft. in length, and osely selected to include the most seriously damaged ion of the work done last year, were repaired in this in July, 1916. Water-tight bulkheads were built at end of the section and the aqueduct was filled with r to the level of the usual flow line. Daily records been kept since then of the loss of water as indi- d by the fall of level and are still being continued. he results so far are very satisfactory. The total at the present time is only about 250 gal. per day n each section, each of which has between 200 and lin.ft. of expansion joint below water level. This of water is equivalent to less than 5,000 gal. per of aqueduct per day, which is much less than the t usually specified in large concrete pipes under low l. Tests made in April, 1915, in Philadelphia on n. reinforced-concrete pipe under 5 lb. per sq.in. pressure gave a leakage varying from 8,000 to 16,000 gal. per mile per day. The entire cost for the repair work above described on the sections where the cracks are most serious amounts to about 93c. per lin.ft. of aqueduct.

Since no further cracking has taken place since April, it is believed that on the sections where the settlement has occurred the aqueduct has come to firm bearing and that no further defects need be anticipated.

Strengthening the Invert

At an early period in the work of the board it was requested to advise concerning the type of section to be adopted in the work carried on in 1916 to secure safety against future cracking. On May 5, 1916, the board recommended that in firm soil the base of the invert should be extended on both sides to a length of 8 in. beyond the sidewall; and that in compressible soils the inverts should be heavily reinforced. In all the work laid in 1916 these recommendations have been followed, and on about 15 mi. of aqueduct completed, the greater part of which has been backfilled, no settlement cracks have developed.

The results of further studies and tests made by the board, including examinations of twelve 200-ft. lengths of aqueduct at different points along the line, on different foundations, indicate that the inverts recommended in May are stronger than is necessary. The reinforced type of invert distributes the load over the entire width of the foundation and reduces the unit pressure to so low an amount that the 8-in. extensions are unnecessary.

Effect of Repairs and Changes on the Cost

The board is still continuing its experiments, and believes that further modifications may be made in the design which will reduce the cost. If the heavy inverts now in use were to be continued without any modifications in the design except the omission of the side extensions to the reinforced invert, the total increase in cost would be about half a million dollars. The design of the reinforced-concrete invert is based on unit stresses of 10,000 lb. per sq.in. of steel, and 500 lb. per sq.in. compression in the concrete, with liberal assumptions as to the distribution of the load. It is probable that by somewhat lightening the reinforcement where the nature of the foundation will permit it, the additional cost can be considerably reduced.

The original estimate of cost for the entire aqueduct was $7,097,640. The revised estimate at the present time, including the cost of building the inverts on the present expensive plan, amounts to $6,867,700. The aqueduct will be completed, therefore, under the modified design without exceeding the original estimate.

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Increasing Use of Vertical-Fiber Brick—Paving work in the towns and villages of Kansas, Oklahoma, Texas, Missouri and Nebraska has continued in increased amounts during the year. Over 1,500,000 sq.yd. of vertical-fiber paving brick have been contracted for by the brick plants in Western Paving Brick Manufacturers Association to towns and cities in the Central West during the season of 1916. Less than 10% of the product of these plants was in the form of repressed paving blocks. Vertical-fiber paving brick are wire-cut brick with bar lugs formed on the clay column by the die. They are laid with the wire-cut surface uppermost and in the majority of cases the joints are filled with asphalt. They are made in depths of 2½ to 4 in. but a large majority of this year's shipments have been brick of 3-in. depth, the recommended standard for towns.

Bridge Wrecked by Runaway Car Derailed at Curve

At 5:20 p.m. on Oct. 3, 1916, a southbound street car loaded with people returning home after the day's work ran away on the steep down grade of West Third St., Cleveland, Ohio, jumped the track at a sharp curve at the foot of the grade just at the entrance to a bridge over the B. & O. Ry. tracks, and demolished the bridge, as shown by the three photographs herewith. A northbound street car crossing the bridge was carried along in the fall (Fig. 1). Two people were killed and about 70 were injured. The motorman of the runaway car left the car before the wreck occurred; his conductor, trying to stop the car, was killed.

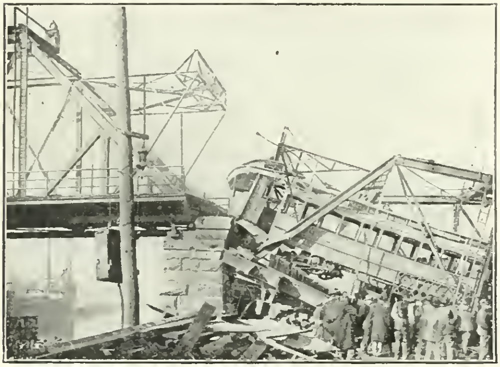

FIG. 1. SOUTH END OF WEST THIRD ST. BRIDGE

The grades on the hill approaching the bridge range from 3% to 9%, as follows: Champlain St. (top of hill) to Prospect Ave., 270 ft., 5.68% grade; across Prospect Ave., 49.5 ft., 3.33% grade; Prospect Ave. to north line of Canal Road, 347 ft., 8.93%; Canal Road to bridge, 139 ft., 7.19%. It is not known just at what point on this grade the motorman lost control of the car. The car had air brakes and hand brakes, and could also have been checked by the motors. At the foot of the grade the car tracks deflect about 30° to the right and enter on the north approach span of the first Cuyahoga River bridge,[1] a 105-ft. through truss span over the B. & O. tracks. This span was built in the spring of 1889, and was of iron. The truss depth was 20 ft., the panel length 15 ft., and the weight of the span 128 tons. The outline sketch shows its general proportions and the position of the two cars that were on the span, Car 369 being the runaway car. The speed of the runaway car when it struck the cur has been estimated as about 40 mi. per hour. The cur at the foot of the grade is short but its degree of curv ture could not be learned. There were about 100 passe gers on the car at the time of the accident.

At the curve the car left the track to the outside the curve, crossed over to the northbound track, a shortly after entering on the bridge struck the left-ha or east truss. According to F. D. Richards, bridge eng neer of the City of Cleveland, it struck Post 4 a glan ing blow, bent it badly, and knocked it out. Then struck squarely against Post 5 and broke it in two a point about 4 ft. above the bridge floor. The count were knocked out at the same time, and the floor l erals were broken. The car ran on to within 5 ft. Car 378, northbound, which had come to a full st Contrary to early reports, the cars did not collide.

The Baltimore & Ohio Ry. was completely blocked the fall of the span. Mayor Davis refused to allow t railway forces to start removing the wreck until ab

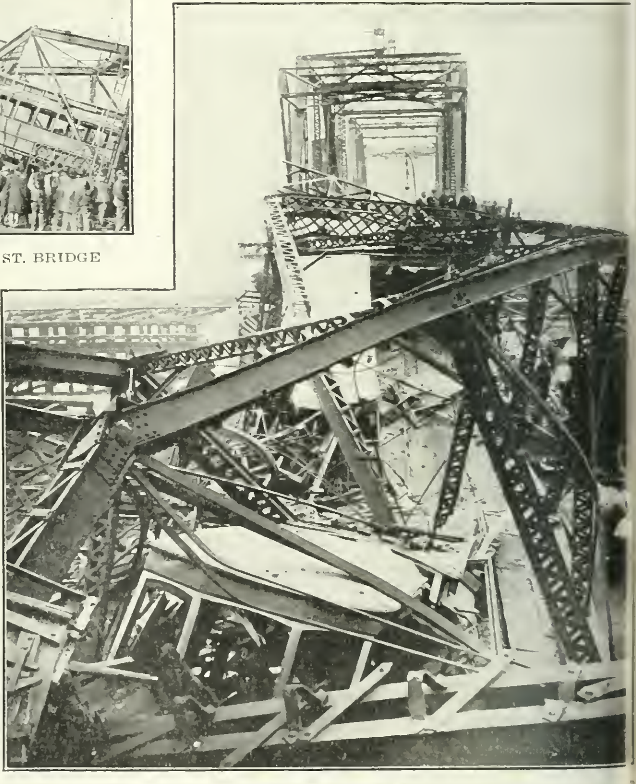

FIG. 2. WEST THIRD ST. BRIDGE, CLEVELAND; NEAR VIEW OF POINT FAILURE, FROM NORTH ABUTMENT; RUNAWAY CAR IN FOREGROUN

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[1] In the flood of 1912 the swing span of this bridge was carried away by a freight steamer that had torn adrift. It was replaced by a second-hand span bought in Detroit. As the views show, the present accident did not involve the swing span in any way.

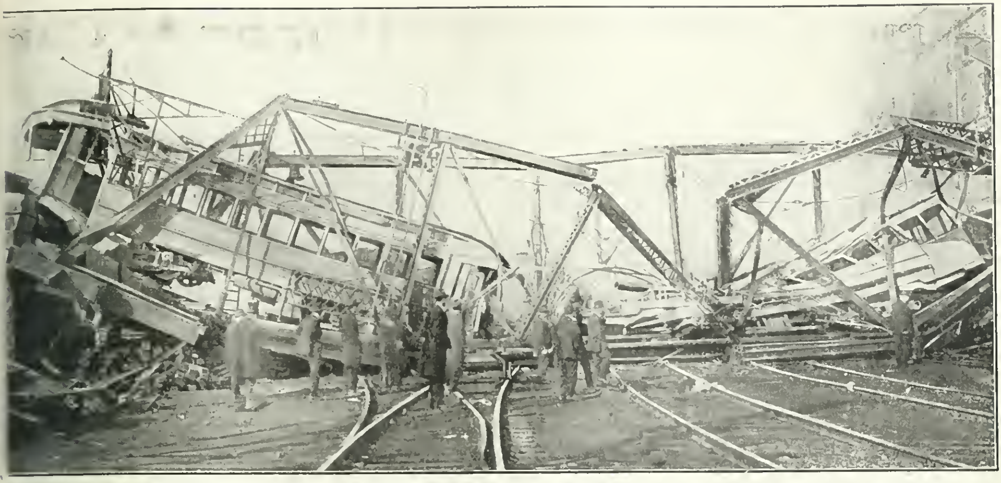
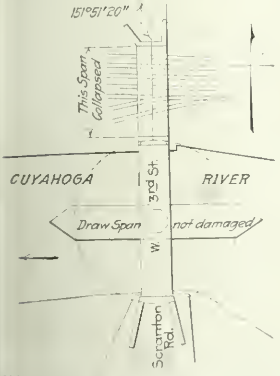


FIG. 3. VIEW OF WEST THIRD ST BRIDGE FROM EAST. AT RIGHT THE RUNAWAY CAR THAT WRECKED BRIDGE

ght o-clock the next morning. In the meantime in- stigations were made by A. J. Himes, engineer of grade imination of the Nickel Plate, and Henry E. Mertens, ief engineer of the Osborne Engineering Co., for the ty, and Wilbur J. Watson, and Wm. J. Carter, con- lting engineers, for the street railway company. Start- g work in the morning, the B. & O. got the tracks en by noon, or in about 4 hr. work. The truss members were cut through by oxyacetylene burners and wrecking cranes hoisted them out of the way. One of the pictures shows the hook of the wrecking crane attached to the end post. This track-clearing was a remarkably fast job. The grade and curve which are directly responsible for this accident have existed for many years, forming a combination at was likely to produce a bad wreck at some time r other. There is no knowledge of a prior accident f this kind at the same point however. Apparently e necessary element, a runaway car, has been lacking.



IG. 4. LOCATION PLAN OF BRIDGE

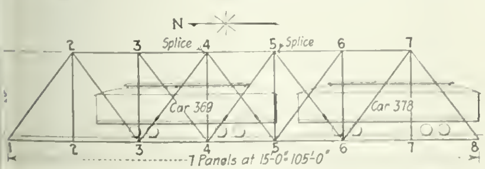


FIG. 5. TRUSS DIAGRAM OF WRECKED BRIDGE
orth end at left; position is the reverse of that represented by the view Fig. 3

On Thursday, Oct. 5, the City Council voted $50,000 for restoration of the bridge. On Oct. 6 contract was awarded to the King Bridge Co. for a new superstructure to cost $25,000 and other items of repair and reconstruction including work on the abutments to cost $5,000. It will be at least a month before the new bridge is in place and ready to be opened.

For most of the above figures and specific data *Engineering News* is indebted to F. D. Richards, Bridge Engineer for the city.

*

Cleveland Limits Loads and Speed of Motor Trucks

Ordinances providing for traffic regulation and the use of streets and sidewalks in Cleveland, Ohio, are specifically worded to guard against damage to pavements, such as that described elsewhere in this issue on West 42nd St., New York City. This is perhaps the only American city where such an ordinance is in effect. It has been in force since May 5, 1916. The following are the clauses in point:

Section 1343-b—(Speed of Motor Trucks)—A motor truck is a motor vehicle with solid tires and constructed to carry freight or merchandise. The speed of motor trucks upon the streets of the city shall not exceed 12 mi. per hr. in cases where the weight of the vehicle and the load is more than 3 tons and less than 8 tons, and shall not exceed 8 mi. per hr. in cases where the weight of the vehicle and the load is 8 tons or more.

Section 1343-e—No load in excess of 12 tons in weight, including the weight of the vehicle, shall be propelled or driven upon or over the streets of the city, provided, however, that the director of public service may issue permits in special cases for the carrying of heavier loads upon or over certain streets specially designated in the permit. Vehicles weighing more than 6 tons, inclusive of the weight of the vehicle, shall not be driven on or over the streets of the City of Cleveland unless there is conspicuously displayed on both sides of the outside of the vehicle in words and figures not less than 2 in. square the weight of the vehicle and the maximum carrying capacity thereof. Nothing herein contained shall be construed to prohibit the hauling of more than 12 tons in a train made up of a power vehicle and trailers, provided, however, that the number of vehicles in such train shall not be greater than is sufficient to haul three separate loads and that the weight of each load, including the vehicle, shall not exceed 12 tons. A train of such vehicles shall carry a brakeman on the rear vehicle.

News of the Engineering World

Additional Claims of Turner Patent Called Invalid

In the United States District Court, Fourth Division, of the Minnesota District, Judge Booth, on Oct. 4, 1916, handed down a decision against C. A. P. Turner, of Minneapolis, who was suing the Deere & Webber Co. for infringement of Turner's patent No. 985,119 in the construction of the flat-slab reinforced-concrete floors of the Deere & Webber building at Chicago. Claims 1, 4 and 6 of this patent were before the same court in the case of Turner vs. Moore & Scriver (*Engineering News*, Apr. 18, 1912, p. 750, Feb. 5, 1914, p. 329). In that case Judge Willard held that the elements in the claim were allowed but that the bringing of them together was not invention and further that the claims were void for lack of invention, in view of the prior art.

In the Deere & Webber case, Mr. Turner introduced Claims 2 and 8 in addition to Claims 1, 4 and 6. Judge Booth decided that there was nothing involved in the two new claims distinct from the original three and that all were subject to the same ruling as applied to the former suit.

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The National Research Council

For several months plans have been under discussion for coöperation between the engineering profession as represented by the national engineering societies and the scientific men of the country represented by the National Academy of Sciences. The National Academy was chartered by Congress during the Civil War, with the idea of enabling the Government to obtain the counsel of leaders in the world of science. By the terms of the Academy's charter, the Government has the right to call upon the Academy when it desires advice in scientific matters. Little use has been made of this privilege until recently, when President Wilson sought the aid of the Academy in organizing a commission to study the slides on the Panama Canal. More recently still the advice of the Academy has been sought in the selection of a process of nitrate manufacture to be adopted in the projected Government plant.

The membership of the Academy is confined to scientists who have to their credit some important piece of original work either in scientific investigation or in authorship. The members, therefore, are for the most part confined to the field of pure science, so called; and in both these cases where the aid of the Academy was sought by the Government it was necessary to add to the membership of the commission to be appointed, men selected from the engineering profession.

Realizing the need of coöperative action if the Academy is to fulfill its object of official adviser to the Government, the officers of the Academy have been working with a committee representing the principal national engineering societies, endeavoring to work out some plan by which those devoted to scientific theory and those dealing with applied science could coöperate for the public welfare. The plan decided upon is the organization of the National Research Council, made up of representative men connected with each of the national engineering societies, the heads of such governmental scientific bureaus as deal especially with scientific matters, and a number of other eminent scientists of national reputation.

While a definite charter and constitution for the Council are yet to be formulated, the general purpose is to foster coöperation among present research organizations in the Government departments, in educational institutions and in industrial plants. The chairman of the Council is Dr. George E. Hale, Director of the Mount Wilson Solar Observatory.

An arrangement has been concluded between the National Academy of Sciences and the Engineering Foundation under which the latter has placed its funds at the disposal of the National Research Council for one year and has given the services of its secretary, Dr. Cary T. Hutchinson, to the Council to serve as its secretary.

The Council is made up of 35 members. The American Society of Civil Engineers is represented on it by Clemens Herschel, president of the society; the American Society of Mechanical Engineers by Dr. John A. Brashear, Ambrose Swasey and W. F. M. Goss, past-presidents; the American Institute of Mining Engineers by Charles F. Rand, past-president; the American Institute of Electrical Engineers by John J. Carty and Gano Dunn, past-presidents, Elihu Thomson, C. E. Skinner and W. R. Whitney. It is announced that other members of the Council may be appointed from time to time.

In addition to and independent of this plan for organization already carried into effect, the National Academy of Sciences, in conference with leading engineers representing the different national societies, is canvassing a plan for an organization of larger scope and of larger membership than the National Research Council, still confined, however, to the leaders of the profession in any and all its branches. A committee is investigating plans for such an organization, but it is still undetermined to what extent the organization will be a merely honorary body, membership in which will be conferred as a mark of distinction, and to what extent it will be a working body with definite aims and purposes.

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Water Meters for Philadelphia

Meters for all water consumers in Philadelphia will be the practice in a few years, it is expected, as the result of an ordinance now before the City Councils. Large consumers are required and small consumers encouraged to use meters. It is expected that the ordinance will be enacted soon, as it is not only practically unopposed, but is believed to reflect public sentiment that meters will be the only salvation of the water-supply. The main features and effect of the ordinance have been summarized for *ngineering News* by Carleton E. Davis, chief of the ureau of Water, as follows:

> All large consumers of water, such as manufacturing esblishments, business houses, hotels, saloons, breweries, railads, etc., must be supplied through meters by Jan. 1, 1918. ne year is given for the change, as it is recognized that after e passage of the ordinance the time will be too short to ake the change effective on the first of January next.
>
> The present meter rate of 30c. per 1,000 cu.ft. will be ineased, the charge for water being 40c. per 1,000 cu.ft. Minums are fixed for each size of connection, and these miniums carry with them a certain allowance of water without ditional charge. In effect this will result in charging the dinary householder $1 per 1,000 cu.ft., while the largest conmer will receive his water as low as 43c. per 1,000 cu.ft. Beeen these extremes the charges will vary, depending upon e use of water.
>
> The minimums fixed include a proportional contribution for ch service-pipe connection to the interest and sinking-fund arges for outstanding water-works bonds. Such charges nount to about $2,000,000. The minimum charges for each ze of service-pipe connection were arrived at by adding to e interest and sinking-fund contribution a certain quantity water at 40c. per 1,000 cu.ft. The reasons for combining ese two factors in a minimum charge were manifold, but ere believed to apply with particular force to Philadelphia nditions. While all large users of water will be put on a mpulsory meter basis by the first of January, 1918, an incement is held out to all small users of water to change luntarily, in that there is a possible saving to the houselder by the introduction of a meter of from $1 to $8 or 0 a year.
>
> It is the expectation that in the course of 10 years pracally all domestic users will install meters. Some of these stallations will be voluntary; some will be compulsory, as e director is empowered to place meters on all premises ere waste is permitted.
>
> A proposition to compel all new connections to the mains ter Jan. 1, 1917, to be placed on meters was discussed, but nsidered inadvisable at this time, it being believed that it s better to have the consumer voluntarily place a meter cause of the inducement in the rates.
>
> The financial condition of the city made it necessary to ve meters placed at the expense of the consumer. While it uld be better for the city to own as well as control all ters, it is impossible at the present time. In two years it y be practicable to work out this situation.

ngineers Inspect Brick Paving

A demonstration of the new method of brick paving or streets and country roads), in which the brick is d directly upon the green concrete, was a feature of the th annual meeting of the National Paving Brick Manucturers' Association.

The meeting proper was held at the Deming Hotel, rre Haute, Ind., on Oct. 5, but was of a business or mmercial rather than a technical character. In the ening, however, there was a display of moving pictures owing the construction of brick and macadam roads, cluding the new automobile highway for the ascent Pikes Peak, Colorado. In all about 250 people were esent, including a large number of visitors (engineers, unicipal officers, highway superintendents, etc.) spelly invited to see the paving work in progress. The icers elected are as follows: President, C. C. Blair, eveland, Ohio; Vice-President, J. W. Robb, Clinton, d.; Secretary, W. P. Blair, Cleveland, Ohio.

On Aug. 6, the party was taken in automobiles over me of the notable brick-paved streets of Terre Haute. hese included a paving 25-yr. old, of brick on broken one base, with sand cushion and cement filler. Other ving included concrete with and without a bituminous p. Special interurban cars then took the party for a ip to Paris, Ill., where street cars were provided to rry them to the demonstration point, at which brick ving was in progress on a country highway. The inspection of this work was followed by lunch at the water-works park, after which automobiles took the visitors for a ride over several country roads having brick and gravel paving.

In the paving work under demonstration, the subgrade was rolled, with a tandem roller, and steel side forms were set (oiled to adhere to the concrete). The concrete was dumped upon it from a tilting bucket on the boom of a steam-operated mixer; it was tamped against the side forms and roughly leveled by a steel plate with chains drawn by men. Behind this came a steel templet carried by rollers traveling on steel forms. This consisted of two parallel transverse beams, braced together, and between these was filled a dry mixture of sand and cement, 2:3. The mixer hauled this templet forward by means of chains, and the wire-cut-lug brick were at once laid on the smooth surface of the dry mix.

After inspection and culling, the surface was rolled by a one-man hand roller, and then sprinkled. The first application of cement grout was quite wet, and was poured directly by a long spout on a grout mixer, being then broomed into place. For the second application, the grout was made thicker (of a soupy consistency), and delivered into wheelbarrows from which it was dumped upon the surface. This mixture was carefully spread and worked with squeegees for some time, thoroughly filling the joints and leaving quite a heavy coat of grout upon the surface. This completes the paving, which is then left for at least 15 days before being opened to traffic.

Flood Prevention at Olean

Joint appropriations of city and state and contributions of citizens provided the funds for the $500,000 flood prevention project now under way at Olean, N. Y., on the line of the Allegheny River and Olean Creek. Floods in the lowlands of the city have been destructive and dangerous for many years and in 1913 concerted action by a number of citizens resulted in the introduction into the State Legislature of a bill appropriating $150,000 by the state for flood prevention work provided the city raised a like sum. This bill became a law in 1915 and the local appropriation was carried at the next election by a vote of 6 to 1. In addition about $200,000 worth of land was donated by citizens.

Under the statute a Flood Abatement Commission came into existence and O'Connor & Chapman, of Albany, N. Y., were employed as executive engineers. They prepared plans, subject to the approval by the Superintendent of Public Works, and early in 1916 a contract was let to the James M. Hamilton Contracting Co. to do the work. Construction is now about one-third completed.

The plans comprise the straightening, widening and deepening of channels in river and creek and the building of an $8\frac{1}{2}$ mi. earth dike or levee along the widened channels. Electrically driven pumps will take care of sewage and lateral streams in flood time. Within the city limits Olean Creek is to be materially revised as to line. At present it meanders over a large area which it overflows at intervals. The new scheme replaces the many curves by one easy, long curve and widens the channel to a safe cross-section. In the land left by the straightening a number of city parks will be laid out.

Jacksonville Municipal Docks Are Open for Business

The new municipal docks at Jacksonville, Fla., have just been made ready for business. These docks have been under construction for about two years. They were built after the city voted to authorize the issue of bonds to the amount of $1,500,000 "for the purpose of acquiring site and constructing docks, belt line, cotton and merchandise warehouses, compresses," etc. The site is located about 3.7 mi. from the city hall on the St. John River, with full riparian rights to the 30-ft. channel now being dredged by the Federal Government, having now a minimum depth of 26 ft. One mile of water frontage was secured.

At the present time there is docking space for fourteen average-size freight steamers, with a three-quarters of a square mile 30-ft. depth anchorage in front of the dock. Two piers, each 1,000 ft. in length by 260 ft. in width have been built. One is an open pier for handling lumber, rosin, turpentine, tars, and other commodities not injured by the weather; the other has two immense steel warehouses 800 ft. long by 73 ft. wide. Both piers are timber extensions outside of fill, and are paved with vitrified brick set in cement. They are connected by railroad tracks to the municipal belt railroad.

There are in addition reinforced-concrete warehouses back from the pier but on the railroad, in which are installed two cotton compresses; one, the latest model "Standard" compress, which produces a rectangular bale with a density of 32 lb. per cu.ft. and contains about 16 cu.ft., somewhat smaller than the ordinary cotton bale. This reduced bulk saves in shipping rates. The piers and the warehouses are all protected against fire with fire-fighting appliances and fire pumps supplied with water from artesian wells and a reservoir on the property. Some of the details of the construction of the work were published in *Engineering News*, Dec. 2, 1915, page 1099.

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The International Correspondence Schools, of Scranton, Penn., celebrated their twenty-fifth anniversary on Monday, Oct. 2. Exercises were held in the afternoon at the Strand Theater in Scranton, and in the evening a banquet was given in the Educational Building of the schools, at which the guest of honor was Governor Brumbaugh of Pennsylvania.

A Transit Commissioner for Pittsburgh is proposed in an ordinance just passed by the Council of the city. The bill provides that the mayor appoint a transit commissioner at a salary of $8,000 a year, the appointment to be subject to the approval of the Council, and requests that the commissioner as soon as possible after appointment prepare a budget showing the number of engineers, draftsmen, etc., needed.

The Joseph A. Holmes Safety Association has been organized to establish a permanent memorial to the late Dr. Joseph A. Holmes, Director of the Bureau of Mines. Dr. Holmes' great achievement, in the work to which the later years of his life were devoted, was the safeguarding of those engaged in the mining industry. It is proposed therefore that the memorial to him shall take the form of an endowment fund, the income from which shall be devoted annually to the award of one or more medals with honorariums, to be known as the Holmes' award, for the encouragement of those originating, developing and installing the most efficient safety devices, appliances or methods in the mineral industry during the year. Twenty-three prominent scientific and technical organizations are represented in the association, including the American Societies of Mechanical, Mining and Electrical Engineers, the American Society for Testing Materials, the American Chemical Society and several important Government bureaus. The president of the association is Van H. Manning, Director of the Bureau of Mines, and the secretary is Dr. David T. Day, of Washington, D. C. Contributions to the endowment fund are invited from those who knew Dr. Holmes or are interested in the further development of the movement for safety in mining.

PERSONALS

Homer Neal, formerly with the Braden Copper Co., has recently been appointed Engineer in charge of the Central Chile Copper Co. mines in Tambillos, Chile.

H. E. Swuck, formerly with the American Steel and Wire Co., Donora, Penn., has been made Chief Draftsman of the Page-Hersey Iron Tube and Lead Co., Welland, Ont.

Thomas Stanley, formerly Engineer of the Georgia State Prison Commission, has been appointed States Highway Engineer, under the recent act creating a State Highway Department.

Joseph A. West, formerly Chief Engineer of the Ogden, Logan & Idaho Ry., has been appointed Chief Engineer of the Sumpter Valley Ry., of Oregon, with headquarters at Baker, Ore.

George Durham, recently Master Mechanic of the Delaware, Lackawanna & Western R.R., at Scranton, Penn., has been appointed Superintendent of Motive Power of the Wheeling & Lake Erie Ry., at Brewster, Ohio.

J. B. Lippincott, M. Am. Soc. C. E., of Los Angeles, Calif. has been made Consulting Engineer of the Automobile Club of Southern California. He is assisting the club in its campaign in favor of a new issue of state-road bonds.

C. F. Messinger, for several years Advertising Manager of the Chain Belt Co., Milwaukee, Wis., has been appointed Manager of the concrete mixer department of the company. He is a graduate of Sheffield Scientific School, Yale University.

Edward T. Bailey, formerly with the Emerson Building Co New York City, announces that he has become associated with Joseph O'Connor, of New York and Minneapolis, to conduct a general contracting business with offices at 103 Park Ave., New York City.

E. B. Taylor, M. Am. Soc. C. E., Second Vice-President o the Pennsylvania Lines, has been elected President of the Lorain, Ashland & Southern R.R., recently bought by the Pennsylvania. He succeeds the late Joseph Ramsey, builde and owner of the road.

E. P. Peck, Major, Corps of Engineers, U. S. A., in charge of the United States Engineer Office at Duluth, Minn., has been transferred to the office of the Chief of Engineers, Washington, D. C. He is succeeded by Lieutenant-Colonel E. L. Schulz now at New Orleans, La.

Prof. D. F. Thompson, for 45 years the head of the department of stereotomy and descriptive geometry at Rensselaer Polytechnic Institute, has resigned, and has been appointed Professor Emeritus. He is succeeded as head of the department by Prof. E. F. Chillman.

Edgar A. Van Deusen, for the past four years Chief Draftsman at the New York City office of the Southern Power Co has been transferred to the company's headquarters at Charlotte, N. C. **Austin H. Reeves,** of the New York office, has been promoted to succeed Mr. Van Deusen.

Harry S. Stanton, Assoc. M. Am. Soc. C. E., now engaged in the completion of the Elephant Butte dam, New Mexico, has resigned from the Reclamation Service and will be associated with E. W. Hess, Engineer, M. Am. Soc. C. E., at Du Bois Penn., in the general practice of engineering.

Charles Peter Weeks, Architect, and **W. P. Day,** Assoc. M Am. Soc. C. E., formerly of Leonard & Day, Consulting Engineers, San Francisco, Calif., announce the formation of the firm of Weeks & Day, Phelan Bldg., San Francisco, for the general practice of architecture and engineering.

H. V. Latham, for the past four years Designing Engineer of the Porto Rico Irrigation Service, has been appointed Engineer in charge of irrigation investigations in the districts of Ponce, Juana Diaz, Lajas and Isabela, Department of the Interior, Government of Porto Rico, with offices at Ponce, P. R

G. W. Stickney, formerly Designing Engineer of the paving department of the Syracuse, N. Y., Bureau of Engineering, has been appointed Chief Engineer of the Rivers and Lakes Commission of Illinois. He is a graduate of the University of Maine, class of 1900, and has had experience with the Metropolitan Water-Works of Boston, Mass., and the New York State Barge Canal.

Clark R. Mandigo, Assoc. M. Am. Soc. C. E., for the past six years Assistant City Engineer of Kansas City, Mo., has resigned to accept a position as Engineer with the Portland Cement Association. He will look after the interests of the Association in Kansas and western Missouri. Over 100 mi. of concrete pavements have been laid under his supervision on streets in Kansas City in the past six years.

, **A. Fellows,** a 1906 graduate of the University of Michi- s been appointed Instructor in the Civil Engineering -lma mater to succeed J. H. Bringhurst, Assoc. M. Am. E. Mr. Fellows was formerly Assistant Engineer of -al of Georgia Ry. and later General Superintendent Winsboro Granite Corporation of Savannah, Ga. He ved a master's degree in civil engineering in 1916.

R. P. Boyd, whose resignation as Assistant State Highway gineer of Alabama was noted in these columns of Sept. 28, becon associated with James W. Billingsley, Consulting gineer, New Orleans, La., and will have direct charge of a 0,000 road improvement contract in Ouachita Parish, in rthern Louisiana. He is a graduate of Alabama Polytech- Institute, and has been Principal Assistant State Highway gineer of Alabama since 1911.

Dr. Charles H. Fulton, M. Am. Inst. M. E., Professor of Min- and Metallurgy, Case School of Applied Science, Cleve- d, Ohio, who discovered a process of recovering zinc from by an electric process, has begun a commercial application the process at St. Louis, where a plant has been built. **s M. Hains,** Instructor in the department of mining eering, and **R. O. Jackson,** Instructor in the department mechanical engineering of Case School, will be associated h Dr. Fulton in the new undertaking.

Gen. George W. Goethals, M. Am. Soc. C. E., has been ap- nted Chairman of the Federal Commission which is to study l report on the effect of the eight-hour railway labor law, ently passed by Congress at the instigation of President lson. He has returned to this country from the Panama l, it is reported, will soon resign as Governor of the nal Zone. The other members of the commission are E. E. rk, a member of the Interstate Commerce Commission, and orge Rublee, a member of the Federal Trade Commission.

George F. Swain, Past-President, Am. Soc. C. E., has been pointed Consulting Engineer of the Canadian Railway ard of Inquiry, which is constituted under the Inquiries Act Canada to inquire into the railway situation of that intry. The members of the board are A. H. Smith, Presi- nt of the New York Central Lines, Sir Henry Drayton, Chair- n of the Dominion Railway Commission, and Sir George ish, Editor of "The Statist," of London, England. Profes- Swain is head of the department of civil engineering at rvard University and Chairman of the Boston Transit Com- ssion.

OBITUARY

James T. Golden, of the firm of Golden & Crick, general ntractors of Pittsburgh, Penn., died Sept. 27, at his home Wilkinsburg. He was born in 1863.

Jasper H. Sheadle, Vice-President of the Cleveland-Cliffs on Co., died Sept. 22, at Syracuse, N. Y. He was promi- ntly identified with the Great Lakes ore trade for the st 22 years.

L. E. Hall, Jr., Inspecting Engineer of the Southern Pacific ., died at the Southern Pacific Hospital in San Francisco pt. 26, as a result of an accident at the site of the rail- ay's new building at Market and Stewart St. He was struck the head by a piece of timber falling from the top of a le-driver. He was a nephew of William Hood, M. Am. Soc. E., Chief Engineer of the Southern Pacific.

E. M. Butz, of E. M. Butz & Co., Ltd., and widely known roughout the country as an architect and engineer, died on t. 4 at his home on the North Side of Pittsburgh. Mr. Butz as born in Allegheny in 1859. He was identified with the nstruction of some of the finest buildings in western Penn- lvania and had been a pioneer in the steel business and omoter and builder of the Columbia Iron and Steel Co.'s ant at Uniontown, of which for several years he was General anager. Mr. Butz retired from active business about six ars ago.

George M. Anderson, of the firm of Elzner and Anderson, chitects, died at his home in Cincinnati, Ohio, Oct. 3. He as a member of the American Institute of Architects and for e past two years president of the Cincinnati Chapter of the stitute. He was a member of the firm which designed the galls Building, at Fourth and Vine St., the construction of hich was completed in 1903. This structure has the distinc- on of being the first modern office building in the world con- ructed of reinforced concrete, 16 stories in height, or 210 ft. ove the street pavement.

Robert Cochran McKinney, M. Am. Soc. M. E., Chairman of e Board of Directors of the Niles-Bement-Pond Co., of New ork City, died at his home in Belle Haven, Conn., Oct. 3. He was born in Troy, N. Y., in 1851. Ten years later his parents moved to Cincinnati, where he was educated at the public schools. He took a partial course in mechanical engineering at Cornell University in the early seventies and became a draftsman with a company manufacturing steam pumping machinery at Hamilton, Ohio. In 1877 he became connected with the Niles Tool Works. From that time his talents and engineering ability were devoted to building up the great organization now known the world over as the Niles-Bement-Pond Co., organized 17 years ago. Colonel McKinney was a Past-President of the Machinery Club, New York City, and a member of the Engineers' Club and other organizations.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

IRRIGATION CONGRESS.
Oct. 14-24. 23rd International Irrigation Congress at El Paso, Tex. Secy., Arthur Hooker, El Paso.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

RAILWAY ELECTRIC SUPPLY MANUFACTURERS' ASSOCIATION.
Oct. 30-Nov. 3. Annual meeting at Chicago. Secy., J. Scribner, General Electric Co., Chicago.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Municipal Engineers of the City of New York will hold their annual dinner on Nov. 25.

The Richmond Railroad Club will hold its annual meeting in Richmond, Va., on Nov. 13. The secretary is F. O. Robinson.

The Vermont Society of Engineers held its 5th annual fall convention and excursion Oct. 11 and 12, at Rutland and Glens Falls.

The Southern and Southwestern Railway Club will hold its annual meeting on Nov. 16, in Atlanta. The secretary is A. J. Merrill, P. O. Box 1205, Atlanta, Ga.

The American Railway Association will meet on Wednesday, Nov. 15, in Denver, at the Brown Palace Hotel. The general secretary is J. E. Fairbanks, 75 Church St., New York City.

The Society of Naval Architects and Marine Engineers will hold its next annual meeting Nov. 16 and 17, in New York City. The secretary is D. H. Cox, 29 West 39th St., New York City.

The General Contractors Association will hold its annual meeting in New York City on Dec. 9; the election of officers, however, will not take place until January. The secretary is C. A. Crane.

At the American Association of Iron and Steel Electrical Engineers' convention in Chicago, F. D. Egan, of Midland, Penn., was elected president, and J. E. Kelly, of McKeesport, Penn., secretary.

The American Society of Refrigerating Engineers will hold its annual meeting at the Engineering Societies building, New York City, Dec. 4 to 6. The secretary is William H. Ross, 154 Nassau St., New York City.

The Texas Association of Members of the American Society of Civil Engineers, at the annual meeting in Dallas, Oct. 20 and 21, will listen to a report by a special committee on "Proposed Legislation Providing for the Licensing of all Engineers in Texas."

Ohio Society of Mechanical, Electric and Steam Engineers will hold its annual meeting on Thursday, Nov. 16, at Columbus, Ohio. It is planned to print the "Journal" of the meeting in advance, so that the papers need be given only in brief abstract.

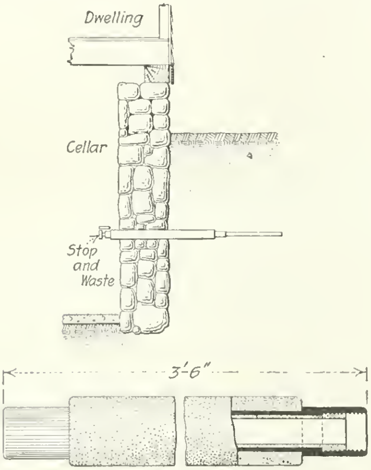
Water-Works Superintendents and Chief Engineers of municipally-owned plants and of electric-light and power plants of towns in Mississippi have formed an association. The organization meeting in Jackson, Miss., was called by Henry Converse, of Crystal Springs.

The Philadelphia Association of Members of the American Society of Civil Engineers, at the annual meeting on Oct. 2 elected the following officers: President, Samuel T. Wagner, vice-president, Edward Marburg, directors, Harrison Louder and Frederick E. Shall, secretary, C. W. Thorn. W. L. Stephenson was selected by the Board of Direction to fill the unexpired term of Colonel Zinn, resigned.

Appliances and Materials

Protected Water-Service Pipes

To meet the difficulties caused by excessive corrosion of water services at the place where they pass through the cellar walls of buildings, the Macbee Cement-Line Pipe Co., of Boston, Mass., has placed on the market a specially protected pipe for this part of the service connection. The device consists of a 3-ft. 6-in. section of cement-lined wrought-iron pipe, with a coupling at each end and with the exterior coated to a depth of about ½ in. with neat cement mortar. The accompanying illustration shows its use. A patent has been applied for. These sections are known by the trade name of "cellar wall services."

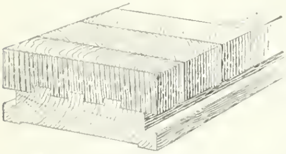


CEMENT-COATED SERVICE PIPE

* * *

New Wood-Block Factory Flooring

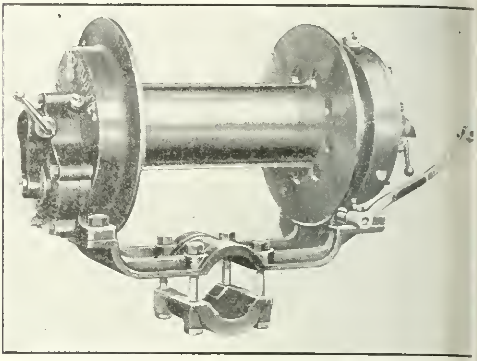
A new type of yellow-pine wood-block flooring, which is shipped and laid in plank lengths, has been patented (Mar. 28, 1916) and placed on the market by the C. J. Carter Lumber Co., Kansas City, Mo. This flooring is the invention of C. J. Carter and has the trade name "Bloxonend." The process of manufacture consists of dovetailing the ends of the blocks to a base board, then smoothing the block surface and dressing and grooving the edges. The base boards are about 8 ft. long. The relative thicknesses of the blocks and the base boards vary, $\frac{1}{2}$ and $\frac{2}{1}$ being the common sizes. The $\frac{2}{1}$ flooring has 2-in. blocks on a 1-in. base. On the surface the blocks are 1½x3½ in. The blocks are placed with the grain vertical and are glued to the base board as well as dovetailed.



NEW WOOD-BLOCK FACTORY FLOORING

New-Model Small Hoist

The Ingersoll-Rand Co., New York City, has placed on tl market a new model of its line of "Little Tugger" hoist known as No. 11. This has a hoisting drum 7 in. in diamet by 17 in. long with 5-in. flanges. The drum handles 300 f of ⅞-in. manila rope. The maximum capacity of the hoist rated at 600 lb. The hoist weighs only 358 lb. and is 21½x31 x23 in. over all. It can be operated by either compressed : or steam. The standard clamp fits a 4½-in. column or pi but by removing the clamp the hoist can be readily bolted any convenient support.



NEW MODEL "LITTLE TUGGER" HOIST

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ET
REQUIRED BY THE ACT OF CONGRESS OF
AUGUST 24, 1912,

of Engineering News, published weekly at New York, N. for October 1, 1916.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and Cour aforesaid, personally appeared Chester W. Dibble, who, havi been duly sworn according to law, deposes and says that he the Vice-President of Hill Publishing Co., Publishers Engineering News, and that the following is, to t best of his knowledge and belief, a true statement the ownership, management, etc., of the aforesaid pu lication for the date shown in the above caption, required the Act of August 24, 1912, embodied in section 443, Pos Laws and Regulations, printed on the reverse of this fo to wit:

1. That the names and addresses of the publisher, edit managing editor and business manager are:

Publisher, Hill Publishing Company, 10th Ave. at 36th New York, N. Y.
Editor, Charles Whiting Baker, 10th Ave. at 36th St., N York, N. Y.
Managing Editor, Frank C. Wight, 10th Ave. at 36th New York, N. Y.
Business Manager, William Buxman, 10th Ave. at 36th New York, N. Y.

2. That the owners are:

Hill Publishing Company, 10th Ave. at 36th St., New York, N

Owners of 1% or more of Stock Issued.

Estate of John A. Hill, 10th Ave. at 36th St., New Yo
Arthur J. Baldwin, 10th Ave. at 36th St., New Yo
Fred R. Low, 10th Ave. at 36th St., New York, N.
John McGhie, 10th Ave. at 36th St., New York, N
Fred S. Weatherby, 1600 Beacon St., Brookline, M
Frederick A. Halsey, 356 W. 120th St., New York, N.
G. Eugene Sly, 50 Union Sq., New York, N. Y.
Frederick W. Gross, 215 E. 11th St., Erie, Penn.
Emma B. Hill, 80 Munn Ave., East Orange, N. J.

The remaining stock is owned by 91 stockholders who o less than 1% each, 73 of whom are employees of the compa

3. That the known bondholders, mortgagees and ot security holders owning or holding 1 per cent. or more total amount of bonds, mortgages or other securities a Mortgage on building, Dime Savings Bank, Brooklyn, N.

4. That the two paragraphs next above, giving the na of the owners, stockholders and security holders contain only the list of stockholders and security holders as t appear upon the books of the company, but also, in ca where the stockholder or security holder appears upon books of the company as trustee or in any other fiduci relation, the name of the person or corporation for whom s trustee is acting, is given; also that the said two paragra contain statements embracing affiant's full knowledge belief as to the circumstances and conditions under wh stockholders and security holders who do not appear upon books of the company as trustees, hold stock and securi in a capacity other than that of a bona fide owner; and t affiant has no reason to believe that any other person, as ciation or corporation has any interest direct or indirect the said stock, bonds or other securities than as so stated him.

CHESTER W. DIBBLE,
Vice-President, Hill Publishing Co

Sworn to and subscribed before me, this 29th day September, 1916.

[Seal.]

RICHARD L. MURPHY.
(My commission expires March 30, 1917.)

Engineering News

LUME 76 OCTOBER 19, 1916 NUMBER 16

Chicago's Bubbly Creek Will Bubble No More

The notorious Bubbly Creek, which has had such an savory history in relation to the sewerage system of icago, will soon be a thing of the past. A conduit is ng constructed to carry the sewage and industrial stes that were discharged into it, and the creek is ng gradually filled with city refuse and earth.

This creek is the west arm of the end of the south k of the south branch of the Chicago River, as shown the map, Fig 2. The east arm is known locally as Stockyards Slip. The west arm was originally a all creek, almost dry for months at a time.

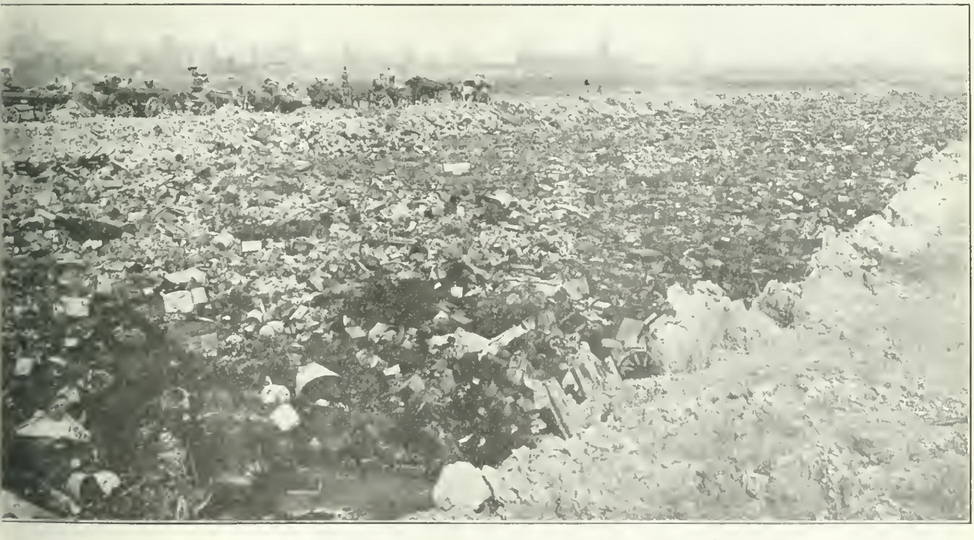


FIG. 1. THE WESTERN END OF BUBBLY CREEK, CHICAGO

The water (or sewage) here is about 18 ft. deep, but is almost entirely covered with a floating mass of débris and rubbish. The north bank (at the left) is a city dump and the creek is gradually being filled

Many years ago a channel or dock was excavated as an ension of this arm, about 1/8 mi. south of 39th St. d running westward half a mile from Ashland Ave. is street was carried over the channel by a swing-dge, which was used only for passing dredges and pile-iver scows, navigation having been abandoned years o. The channel was about 150 ft. wide. The clay avated was used in making brick, and near the west d there is still an old deep clay pit that necessitates cial construction in carrying a new sewer across it. Into this dead-end channel have poured the filth, refuse d wastes from half the packing-house and stockyards district, as well as from a main sewer afterward opened into it at Robey St. The sluggish flow from the creek was northward in the fork, many days being consumed in reaching the junction with the south branch of the river. In the dredged channel the water was practically stagnant, and this became in effect a huge open septic tank long before Cameron applied the name to a tank for sewage disposal purposes.

In 1910 the Western Ave. conduit was built, connecting the western end of the creek with the main drainage canal at Western Ave. This conduit is of concrete and passes under the old Illinois & Michigan canal by means of a siphon. The exceptional character and stale condition of the sewage in this conduit have been the cause of some disintegration of the concrete. This trouble was discussed in *Engineering News*, Sept. 14, 1916. The velocity in this conduit was low, and the flow was so small in proportion to the capacity of the creek that the latter continued to be practically an immense septic tank, its condition giving rise to its significant name.

At present Bubbly Creek is about 150 ft. wide, with 5 to 20 ft. of water. At times it is so covered with a heavy mass of septic-tank scum in some places and with

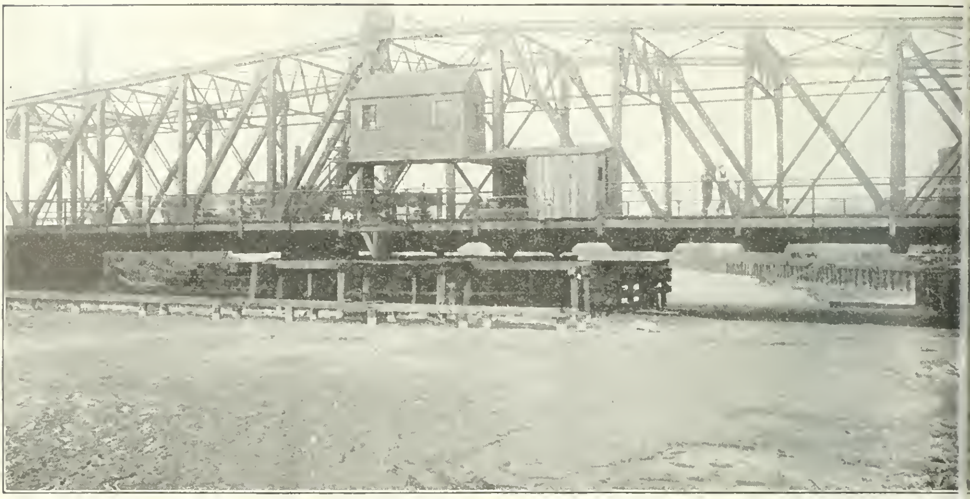


FIG. 3. BUBBLY CREEK; CHICAGO'S OPEN SEPTIC TANK (NOW BEING ABOLISHED)

This view is at the eastern end, at Ashland Ave. The water is almost entirely covered with a thick mass of septic-t k scum. Just beyond the bridge a bulkhead has now been built to close the channel

refuse and rubbish in other places that it has the appearance of a shallow and dried-up swamp. There is a legend that a drunken man who fell off the Ashland Ave. bridge walked ashore dry-shod on the covering of scum. However that may be, chickens and dogs have been seen to walk across.

The scum-covered condition of the creek at its eastern end, at the Ashland Ave. bridge, is shown in Fig. 3. At the right, just beyond the bridge abutment, is the temporary outlet of the Ashland Ave. sewer, with a raft from which men scoop up the floating grease. Fig. 1 is a view near the western end (looking east), showing the city dump on the opposite (north) bank. The water here is about 12 to 18 ft. deep, but is entirely covered with most offensive floating débris and refuse.

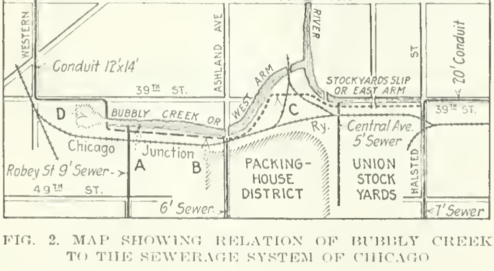


FIG. 2. MAP SHOWING RELATION OF BUBBLY CREEK TO THE SEWERAGE SYSTEM OF CHICAGO

A—Portion of Bubbly Creek now being filled. B—New sewer under construction. C—Possible future sewer for Stockyards Slip. D—Old clay pit crossed by new sewer

It is hardly credible that the city should have mitted such an unsanitary and disgusting place to for so long. Doubtless one reason is that it is i territory adjacent to the stockyards and packing h the residents of that territory not being apt to any powerful protest against disagreeable or dang conditions.

Now that this "septic tank" discharges into the drainage canal it comes under the jurisdiction o Sanitary District of Chicago, the authorities of have made strong protest against allowing the liqui semi-solid wastes to be disposed of in this way. protest is due not only to the unsanitary condition to the very large amount of water necessary for the tion of the material to the extent called for by th in relation to the drainage channel. Much experin work has been done, both by the packers and the tary District, and in August, 1916, after protracte ferences, a committee representing both interests appointed to endeavor to work out a practical so of the problem of treatment of the wastes. This mittee is composed of W. D. Richardson, chief ch of Swift & Co., and Langdon Pearse, division en of the Sanitary District of Chicago. This action result of a growing public opinion and a deter movement on the part of the trustees of the Sa District to require the packing houses to scree treat the wastes before discharging them into the nel. The activated-sludge process appears to o solution of the problem, as noted in *Engineering* Aug. 31.

In order to avoid the septic-tank conditions res from sluggish flow in the present channel, and to the west arm to be filled up, a sewer is being built the south bank of Bubbly Creek, as shown in F This will intercept the Ashland Ave. and Robe sewers and will connect with the Western Ave. c conduit mentioned above, giving a normal veloci flow to the drainage canal. Thus Bubbly Creek w eliminated from the sewerage system. The north s now a city dump, so that the channel is gradually being filled. The east end of the channel has been closed with a timber bulkhead, cutting off its connection with he south fork of the river; and when the fill at this end s completed, the Ashland Ave. bridge will be removed.

The history of Bubbly Creek from its sewerage aspect would not be complete without reference to the use of ts foul and sluggish companion—the east arm, known s the Stockyards Slip—as a source of water-supply. A ew years ago the stockyards interests, finding the supply from the city's mains inadequate and expensive, lecided to utilize the slip for a private supply.

A mechanical filter was installed, and in addition hypochlorite of lime in large amounts was used to disinfect he water—a pioneer chlorination plant. Although the ffluent was claimed to be pure, the City of Chicago prohibited its use for drinking purposes or for watering animals. The installation was then converted into a water-softening plant for the use of the Chicago Junction Ry. and is now operated largely to provide water for lushing the cattle pens.

The raw water was very heavily polluted with sewage, s the slip received the discharge of the flushing tunnel rom the 39th St. sewage pumping station, this discharge arying from straight domestic sewage to a sewage diluted with 10 to 15 parts of lake water. The slip also received large amount of stockyards refuse and waste. Probbly no other filter plant in the world has ever handled uch a strongly polluted water. The large amount of ypochlorite used necessarily left a decided taste and odor n the water, which stock shippers claimed was distasteful to cattle.

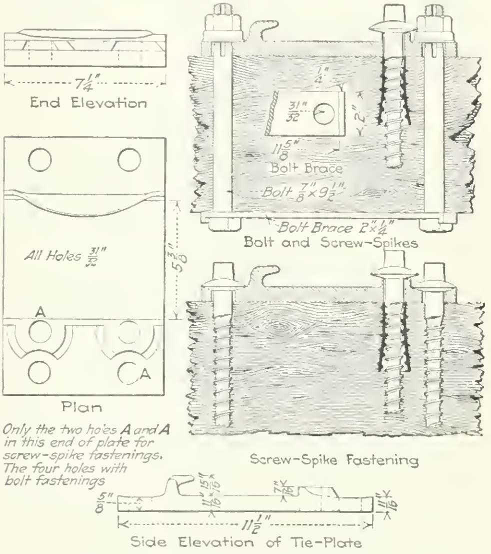
A plan is under discussion to fill in the Stockyards lip and to build a sewer connecting with the present Ialsted St. outfall and leading to the sewer now under onstruction along Bubbly Creek. This would give a ontinuous closed channel from the intercepting-sewer ystem to the main drainage canal. It is doubtful if he slip will be filled up for a good many years to come, ut the sewer beside it may be built first as a means of ollecting the sewage for treatment of the industrial vastes.

* * *

Experimental Rail Fastenings

The use of hooked tie-plates with screw-spike and hrough-bolt fastenings is being tried on the Delaware, Lackawanna & Western R.R. as a development in track or heavy traffic. The two types of construction are laid on certain test pieces of track, and are shown in the accompanying drawing.

The tie-plate has a shoulder on each side of the rail seat, and one of these shoulders is formed as a hook or p to engage the edge of the rail base. The plate is laid with this hook on the inner or gage side of the rail. With ... fastenings, each plate is held to the tie by screw spikes, and the rail is held by one drive spike $\frac{5}{8}$x6 in. on the outer side. With bolt fastenings, each plate is secured to the tie by two $\frac{7}{8}$-in. through bolts (at diagonally pposite corners), the heads being beneath the tie and prevented from turning by means of a channel-shaped washer or brace which engages both bolts. The rail is held on the inner side by the hook of the tie-plate and on the outer side by the head of a screw spike. This screw spike is held in the tie by means of a Tenax split sleeve. Bolt fastenings for rails and rail-chairs have been used for many years in Europe, and this present design of through-bolt fastenings for tie-plates has been developed by A. J. Neafie, Principal Assistant Engineer of the railway, who has great hopes for its use in permanent construction. He believes that as railways are now using treated ties and expensive tie-plates under heavy traffic, especially on curves, they can well afford to go into the question of bolted fastenings. This should be an ideal construction also for subways and tunnels, where it is difficult to apply new material in maintenance work. The modern construction consists of treated materials, heavy tie-plates, screw spikes, etc., which material should have a minimum life of at least 14 years, according to Mr. Neafie's estimate. He considers therefore that the question of applying bolts is not a serious one, and they need be applied only in new work and renewals.



EXPERIMENTAL TRACK WITH HOOKED TIE-PLATES AND BOLT AND SCREW-SPIKE FASTENINGS

One serious condition in track is that of corrosion of rails and metal fastenings, and prior to the design of this bolted construction the engineering department had gone into the matter carefully, spraying the fittings with oil once or more per year if necessary, in order to prevent any trouble from corrosion. On the test location of the new fastenings, all bolts have been greased and the bolt holes filled with grease. The bolts are fitted with special nutlocks, each of which represents a compression of 2,000 lb., making a total compression of 8,000 lb. on the tie-plate, and thereby reducing the mechanical wear that takes place when tie-plates are loose on the ties. It is believed that fastenings of this type will be adopted on heavy permanent track construction.

The hook-shoulder tie-plate applied with screw-spike rail fastenings has not developed any great amount of noise due to contact between the rail and hook. The tie-plates fit the rail base very tightly, but there is no wedging of the rail under the hook. Even where there is a loose fit between the tie-plate and base of rail there is no apparent rattling or noise.

Device To Prevent Blowouts in Shield Tunneling

By Frank D. Leffingwell*

All subaqueous tunnels thus far built in porous ground have been subject to extraordinary hazard, expense and delay. This has been due to excessive escape of compressed air and disastrous blowouts, which continue to occur in spite of the best attempts at control.

The sole reliance of the builder has thus far been the clay blanket—a device costly, uncertain and highly unsatisfactory. The blanket has features that are clearly unsafe and the method of deposit invites its ultimate destruction through forces which it aims to control.

In the light of modern knowledge, however, it is feasible to modify the ordinary blanket and develop a construction that will insure safety.

How Blowouts Occur

The sketch, Fig. 1, represents a tunnel being excavated in porous ground, but at such depth that the excess head of escaping air is largely balanced by the friction encountered. It is evident that if either depth of cover or its unit resistance be lessened a clay blanket must be added.

Fig. 2 shows a case in which the porous cover is not adequate to limit the air escape. A clay blanket, theoretically solid and homogeneous, has been placed on the river bed. The weight and tenacity of the blanket oppose vertical loss of air; the width of the blanket controls lateral escape.

The real clay blanket, as against the theoretically solid one, is of the kind sketched in Fig. 3. Deposited in separate scow loads, the clay never becomes a solid mass. The air leaking up from the tunnel face tends to seep along the joint surfaces of the clay. The result is a common experience: Sooner or later the blanket is punctured at some point of incipient flow, torn open and tossed aside (Fig. 4).

An attempt was made in April, 1905, to cure the weakness of the clay blanket in a radical way. This was on the Brooklyn side of the Battery tunnel under the East River, at the foot of Joralemon St. Walton I. Aims, Chief Engineer of the New York Tunnel Co., planned to seal the porous ground by first spreading sailcloth and then plac the blanket (F 5). This was a s cess in so far vertical escape air was prevent but it failed control lateral longitudinal flow the air along t smooth under s face of the canv When, to cont this lateral esca weight was added to the blanket, more "blow" contin at the lateral edges, and a hole formed under the can cover until finally, under the influence of the weight fr above and agitation from below, the canvas sagged was caught by the hood of the shield in passing.

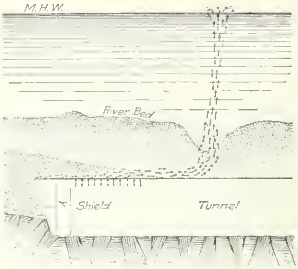


FIG. 6. BLOW ON BATTERY TUNNEL

Further illustration of how direct a relation horizon flow of air bears to this question was furnished later the same year (1905) on the Battery tunnels. An cipient blow occurred about 200 ft. back of the headi as sketched in Fig. 6. While it did not get beyond point of being a rather lively local leakage, it pointed the possible cumulative effect of leakage from the tun in combination with longitudinal flow of the air along a smooth horizontal surface, and its tendency to cause trouble. Evidently any method of preventing upward blowouts will be a disappointment if it does not also control the tendency to lateral flow. The method of Fig. 7 has been developed by the writer as a full solution of the problem. It consists of the use, with a blanket, of a river-bottom diaphragm or seal provided with baffles on its lower surface to prevent flow of air along its under side. This river-bottom diaphragm, which the writer is enting, contains the elements necessary for dealing all the separate factors promoting blowouts. Its promises to afford economy in amount of blanketing terial, and—the important thing—by eliminating the of blowouts take away the one feature of greatest ha in subaqueous tunneling.

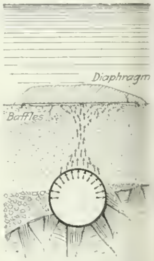


FIG. 7. LEFFINGWI METHOD

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*460 Bloomfield Ave., Montclair, N. J.; formerly Resident Engineer, Rapid Transit Subway Construction Co., Battery Tunnels under East River, New York.

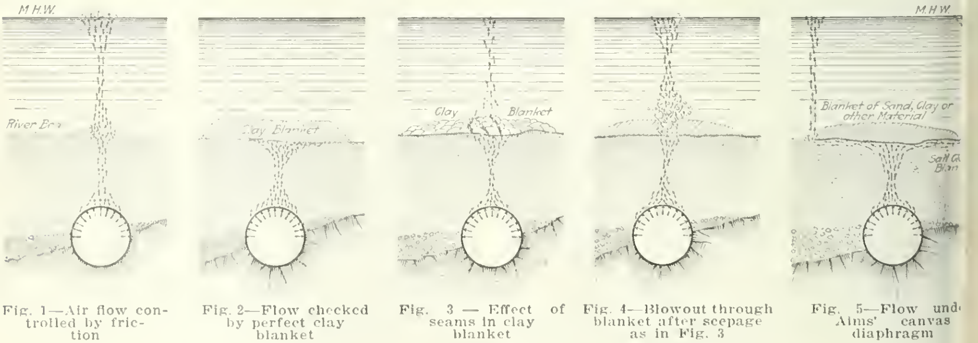

Fig. 1—Air flow controlled by friction

Fig. 2—Flow checked by perfect clay blanket

Fig. 3 — Effect of seams in clay blanket

Fig. 4—Blowout through blanket after seepage as in Fig. 3

Fig. 5—Flow und Aims' canvas diaphragm

FIGS. 1 TO 5. TYPICAL CASES OF TUNNEL BLOWS AND METHODS OF CONTROL

Tearing Down an Old Concrete Ice Factory

By Arthur G. Hoadley*

SYNOPSIS—Details of methods employed in wrecking a one-story reinforced-concrete building, part of which was used in the layout of a new building.

A baking plant for the Great Atlantic and Pacific ea Co. has been built during the last year at First and arren St., Jersey City, N. J., on the site of a one-story inforced-concrete ice-manufacturing plant. The partial recking and removal of this one-story building and the corporation of certain portions of the old into the new ructure furnished several interesting additions to the ethods previously used in wrecking a reinforced-concrete ilding.

The plans showing the detailed construction of the xisting one-story building were found after a very ligent search, the building department having destroyed copy. There was not enough information shown on e plans, however, to be of much assistance to the design- g engineer in incorporating any of the old work into e new building, without first subjecting the old struc- re to tests that would prove the carrying capacity of the piles and show the reinforcement used in the walls, floors, footings, etc.

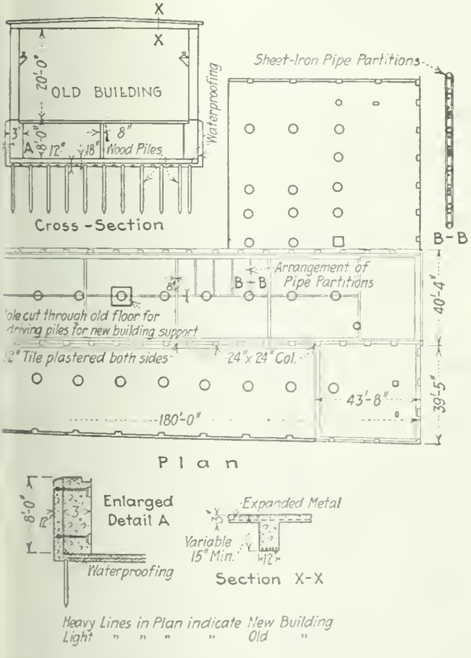

FIG. 1. PLAN AND DETAILS OF OLD REINFORCED-CONCRETE BUILDING TORN DOWN

The building to be wrecked (Fig. 1) was approximately 180x40 ft. with an east wing 40x40 ft. A mat which proved to have a varying thickness had been poured on top of the pile heads and heavily waterproofed with a membrane waterproofing. From this level the exterior foundation walls and interior cross-walls had been constructed. These cross-walls were 8 in. thick, reinforced on both faces with vertical ½-in. round bars 4 in. c. to c.; ¼-in. round bars 12 in. c. to c. were placed horizontally.

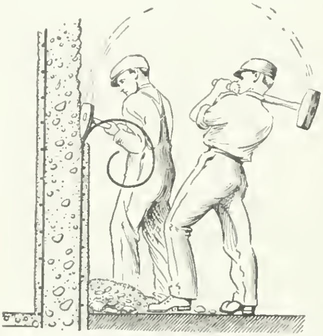

FIG. 2. METHOD OF CUTTING OUT REINFORCEMENT IN WALLS

The exterior foundation walls were not reinforced except at the column points, but heavy reinforcement was placed in an additional 12-in. wall poured on the outside of the main wall to act as a protection for additional waterproofing that it was found necessary to apply. The wall columns were 24 in. square and were reinforced with four 1-in. round bars with ¼-in. hoops 12 in. c. to c. The roof slab was reinforced with expanded metal; the roof beams by a unit system of reinforcement employing four double-bent bars.

All of the superstructure, including the refrigerating equipment, had to be removed, certain walls partly removed to permit new footings and a new building, as shown in Fig. 1, built.

The removal of the refrigerating equipment was accomplished within a month; in the majority of cases the salvage contractor used the oxygen flame for cutting through the pipe partitions which made up the individual freezing tanks. These partitions were constructed of ⅛-in. sheet iron, incasing double extra-heavy wrought-iron pipe. Through one series of these pipes the brine was circulated, while through another series was run the hot water used in freeing the ice from the side of the pipe partition. The manufacturing process was to fill the individual freezing tanks with fresh water, freeze, release by using the hot water, lift with an overhead crane and convey to one end of the building where a tilting table received the large cake of ice in a vertical position, and then revolving itself into a horizontal position fed the

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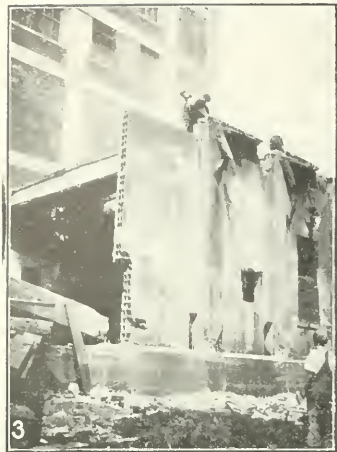
*Superintendent, Turner Construction Co., 11 Broadway, w York City.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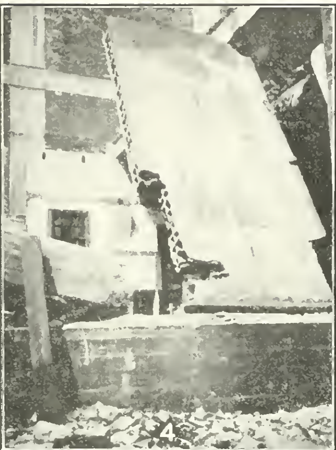
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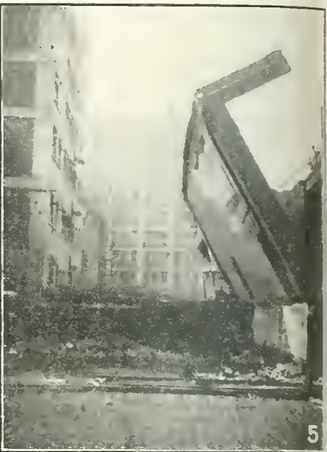
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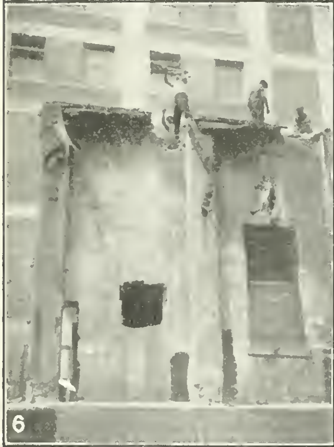
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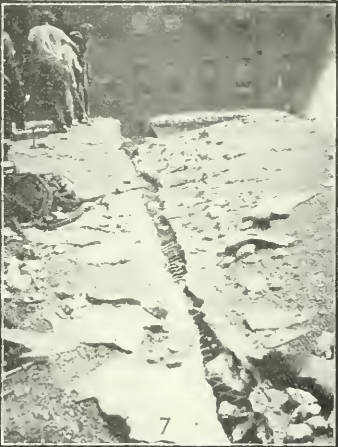
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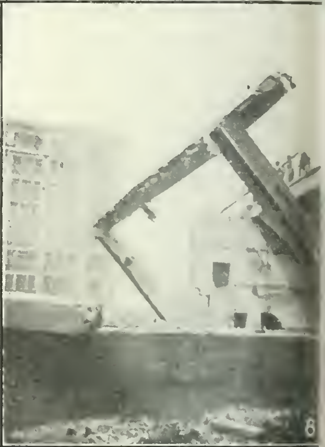
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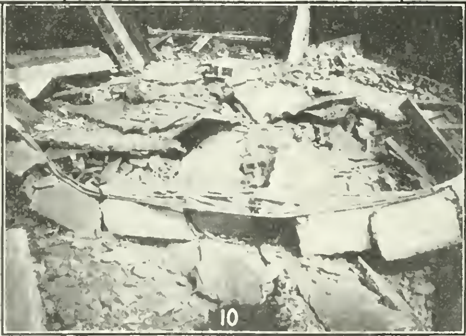
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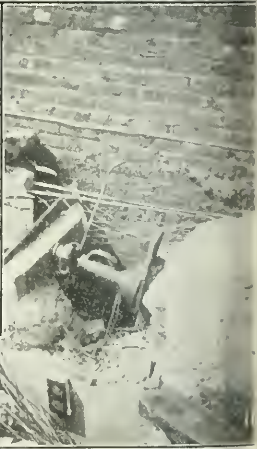


FIGS. 3 TO 11. VIEWS IN TEARING DOWN CONCRETE ICE FACTORY IN JERSEY CITY

Fig. 3—Prying off side wall. Fig. 4—Side wall failing. Fig. 5—End wall falling. Fig. 6—Cutting floor reinforcement. Fig. 7—Floor reinforcement being cut just before columns and floor are let go as shown in Fig. 8. Fig. 8—One of the floor sections falling. Fig. 9—Drill holes in foundation wall and break caused by shooting. Fig. 10—Effect of fall on roof beam. Fig. 11—Jack used in pushing down column

rge cake to a series of saws which cut it up into the ommercial size.

The wrecking of the structure proper was started in ıe basement with the cross-walls. These walls were 8 in. ıick and about 9 ft. high, and reinforced as previously scribed. There was sufficient room between two of the oss-walls to swing a 16-ft. piece of 3-in. shafting suprted at the roof, and to use it as a battering ram. his method worked very efficiently from the top of the all down to within 2 ft. of the bottom where the reinrcement was near its floor anchorage. For the rest of ıe wall it was necessary to strip the steel from both ces before using the ram.

In wrecking the central basement wall, it was necessary strip all steel from the wall and then use a short ram; ere was not sufficient room in which to swing the long m, and a shorter ram did not prove effective. In stripng the steel from these walls two men worked with ıll point and sledge. The point was driven down in ck of each bar and as it progressed the bar was bent out a spiral form, thus being entirely out of the way of e workmen, but at the same time destroying the bar r any other use (Fig. 2). In trying out the short ram fore stripping the steel from this central wall there was sign of fill lines, with the exception of one indicating e addition of 6 in. of unreinforced wall on top of the ain reinforced section. After stripping the steel, hower, there were several fill lines that were clearly defined, dicating the flow line of the concrete and showing the esence of laitance between each fill. No attempt had en made to mix the two fills, which were probably ured on the same day.

It was decided that in wrecking the superstructure a ll of 30 ft. into the basement would be of great help breaking the concrete into pieces small enough for ading into trucks. This proved true as the photographs ow. The wall beams were first cut through to provide om for inserting a screw jack. The four vertical column rs were exposed and cut at the bottom; then the roof ıb was cut on three sides leaving the expanded metal inct until everything was in readiness for dropping the ıb. The expanded metal was cut on the two ends of the ab and then adjacent to the roof beam. An interesting fact garding this operation was the cantilever action that veloped in the strands of the expanded metal; these ld the entire slab in a horizontal position until the last rand had been cut. The slab usually fell with sufficient rce to tear away from the opposite beam, but in some ses the fall was gradual, and the reinforcement though bent at right angles held the slab in a hanging sition. Fig. 7 shows the slab just as it has started to ll; the large man in the picture has just cut the last rand of the expanded metal.

The next operation was to push over two columns, gether with their respective wall beams and their conting roof beam. This was accomplished as in Fig. 11, hich shows the jack in position ready for forcing the ction past its center of gravity. Two jacks were used, e in each wall beam, and were worked simultaneously. ig. 8 shows one of the sections in the act of falling.

The exterior walls were 8-in. hollow tile plastered th sides, but not anchored in any way to the columns; t even a wall recess was provided in the columns. This ade it particularly easy to force these walls into the asement after the section of superstructure immediately in front of them had been disposed of. Fig. 3 shows the wall being started with a 2x4-in. pry, Fig. 4, the same wall in the act of falling. Needless to say these walls were entirely demolished in falling into the basement. Fig. 5 shows the end section of the wing falling intact. The last section to be dropped was the north end of the main building and the wing combined; these were pulled over by lines placed on the ends and in the center and operated by six men on each line. Fig. 10 shows the effect of the fall on one of the main roof beams.

There were two areas cut in the south section of the old building basement wall and through these openings it was possible to drive the teams into the basement and load the débris, which amounted to 608 two-yard loads for the entire job. The columns usually fell on top of the foundation walls and so were not broken in falling. Two of the entire lot were shot with powder, but it was found to be cheaper to release the steel at each corner and then break up with a heavy sledge hammer. The steel from the columns was used in the new footings as was also any of the beam steel that could be salvaged.

The holes cut in the basement floor for driving additional piles were blasted, but under very unfavorable circumstances because of the varying thickness of the floor slab. It was impossible to drill to a uniform depth for shooting. A fabric waterproofing was incorporated in this floor, as well as a very great number of reinforcing bars, which made it very difficult to remove the concrete after it had been shattered by the blast. The blast did not break the steel in the great majority of cases.

The east exterior wall was used as a bearing wall for supporting the first floor and was cut off and recessed for the beams and girders. The north wall was used as a bearing wall also, but additional piles were driven on each side and a new footing poured on top of the old and new piles, thus in reality underpinning the old wall. Much difficulty was experienced in drilling this old wall on account of the heavy layer of waterproofing that clogged the drills. The main wall in this case was not reinforced, but the 12-in. waterproofing protection was heavily reinforced with square bars. Fig. 9 shows the arrangement of blasting holes and the effect of the first shot.

The unusually thick foundation walls in the main portion of the old building were in no way damaged by the vibration due to blasting off the top or shooting the opening for the underpinning. The wing walls, which were but 24 in. thick, were found to be in excellent condition before any additional piles had been driven in this section, but the vibration of the pile-driving together with the blasting so shattered these walls as to make it necessary entirely to demolish the two exterior sections and replace with a new wall. No reinforcement of any kind was found in the wing walls.

The new building was erected mostly during the more severe months of the winter season, but with the aid of heavy canvas curtains and coke fires the speed schedule starting from the completion of the first floor was maintained.

The wrecking of this ice plant and the construction of the new four-story bakery for the Great Atlantic and Pacific Tea Co. were both handled by the Turner Construction Co., of New York City. Ballinger & Perrot, of Philadelphia, were the architects for the new bakery.

Cleveland Water-Supply To Be Purified and Softened

SYNOPSIS—Bacteria and turbidity will be removed and incidentally a not very hard water softened by lime treatment, coagulation with sulphate of iron, and mechanical filtration.

A water-purification plant with a daily capacity of 150,000,000 gal. is nearing completion by the City of Cleveland. The primary object of the plant is bacterial reduction and the removal of turbidity when necessary. At the same time the water will be softened. The plant is located at the Division Ave. pumping station, which is being rebuilt and provided with low-lift pumps to supply the filters and with high-lift pumps to deliver the filtered water to the city. The purification plant and accessories include a coagulant house, mixing chambers, coagulating basins, mechanical filters and a clear-water basin. Some clear-water storage is provided under the filters in addition to that afforded by the clear-water basin. A general view of the plant is shown by Fig. 1, and Fig. 2 gives a plan of the coagulant mixing chambers, coagulating basin and filters and some sections of the chambers.

The plant is notable because it will soften a relatively soft water (total hardness of 110 and temporary hardness of 90 to 55); because with a chemical-handling system otherwise similar to that used at St. Louis the chemicals will be handled only once, instead of twice; and also because of the provision for a thorough mixing of the lime with the water to be softened. The latter will permit a relatively short reaction period of 3½ hr. in the mixing chambers.

The engineers in immediate charge of the design and construction of the plant have been R. Winthrop Pratt, consulting engineer; Frank H. Stephenson, engineer, and Milton F. Stein, assistant engineer of design: and R. S. Jones, engineer, and A. V. Ruggles, assistant engineer of construction. Charles F. Schulz was commissioner
water during the greater part of the construction peri
and was succeeded by Charles P. Jaeger.

A switch from the Erie R.R. comes up to one side
the coagulant house. At each end of this house the che
icals may be dumped from covered gondola cars ont
short run of conveyor that discharges onto an eleva
leading to a hopper, or they may be unloaded from b
cars by power shovels. In either case the chemicals
deposited in hoppers. For the present, box-cars will
used. The chemical agents are taken from the hopp
crushed if necessary, elevated and distributed to 10 st
age bins (Fig. 3), of which eight are for lime and two
sulphate of iron. These storage bins are approximat
16 ft. square inside and 33 ft. high, including the de
of the hopper bottom. The bins are arranged to
charge into a smaller, or daily, hopper. One such h
per is provided for each four lime bins, and there
two others, of metal, for the sulphate of iron.

From the daily hoppers the lime and iron are fed
automatic scales similar to those in use at Colum
Ohio, except that the scales are so connected to a
turi meter as to trip the discharge of the chemicals
the proper intervals to maintain the required pro
tions, depending upon the volume of water flow. Th
scales are supplied by the Richardson Scale Co., of
saic, N. J.

The lime goes from the scales to slaking tanks (
5), where hot water is introduced, the lime slaked, pas
over a weir and dropped through a perforated hop
into a solution tank. A new feature of the solution t
is the use of a Pelton wheel to drive the stirring
paratus and centrifugal pumps that will raise the l
solution for discharge into the raw water. The wa
that drives the Pelton wheel goes to the solution ta
so it is not wasted but does double service.

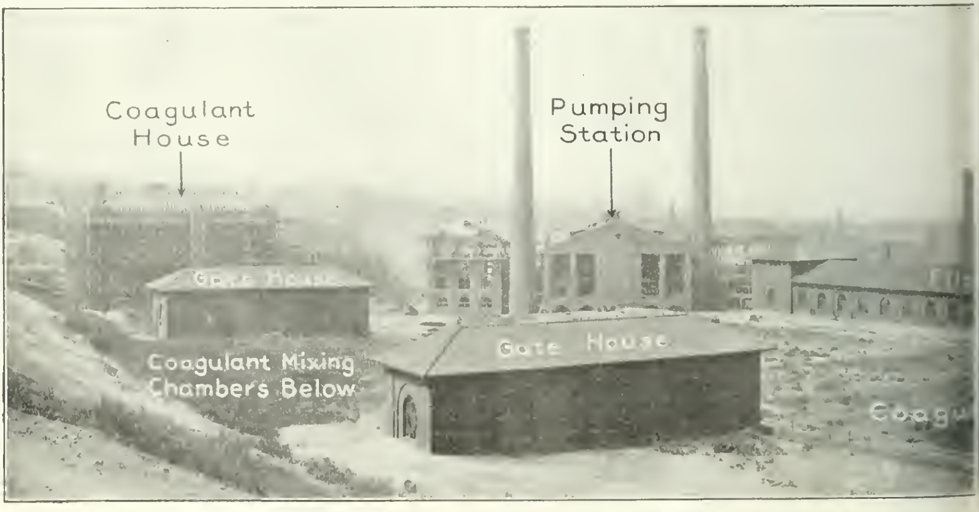


FIG. 1. GENERAL VIEW OF DIVISION AVE. PUMPING STATION,

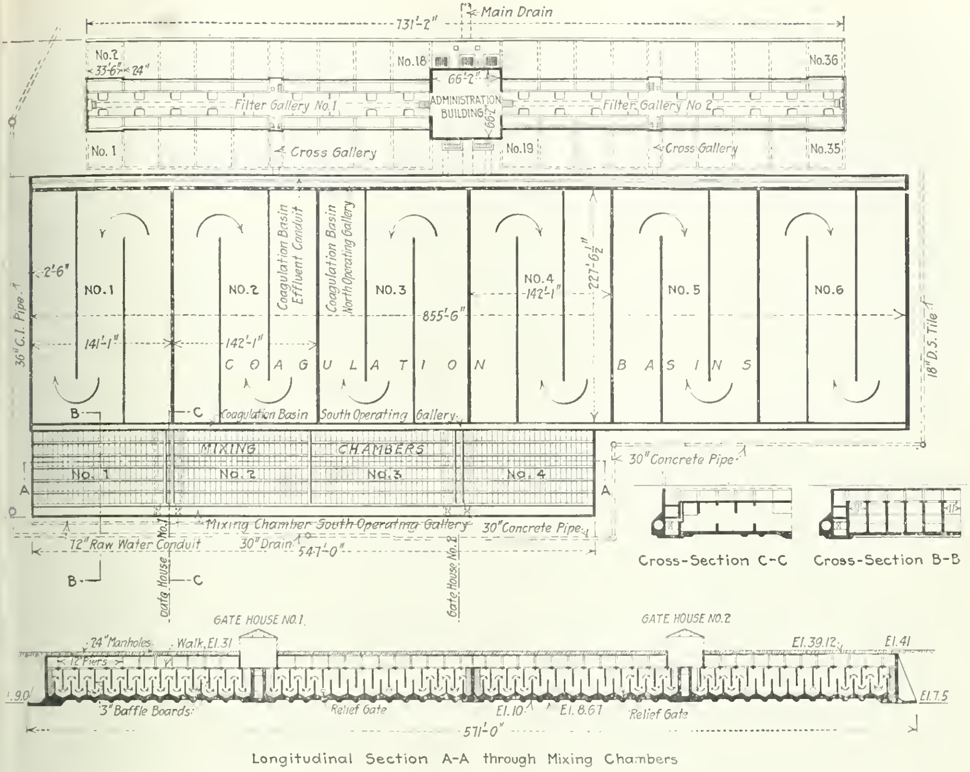


FIG. 2. PLAN OF CLEVELAND WATER-TREATMENT PLANT AND SECTIONS OF MIXING CHAMBERS

The lime solution is fed into the raw water just after passes through a venturi meter on the 72-in. supply in. There are 12 lime-feeding nozzles, inserted ver- ally in the top of the raw-water pipe. These nozzles can be flushed with water under pressure. If this does not prevent stoppage, as indicated by a pet-cock on the feed pipes, the solution can be shut off by slide valves. Then the nozzle may be removed for cleaning.

ATING AND FILTRATION PLANT FOR THE WATER-WORKS OF CLEVELAND, OHIO

The sulphate of iron from either of the two storage bins drops to a screen in a hopper and meets an upward current of water. The solution thus formed passes over a weir into a storage tank, from which it is pumped to orifice boxes, which are in duplicate. Ten of the 12 orifices connect one each to four mixing chambers and to the six coagulating basins. The other two orifices will be large enough to carry the whole dose to the desired point of discharge into the raw water. The solution from these two orifices will go into the raw water shortly after it leaves the low-lift pumps, or just before it enters the mixing chambers, so that iron can be introduced at any one of four points. In case the iron is admitted to the coagulating basin the point of introduction will be just after the water has spent two-thirds of its time in the basin, so there will be an opportunity to correct any excess of alkalinity. Even then there will be an hour's time for the coagulant to take effect. The iron solution will be passed through lead pipes.

There are four mixing chambers, each about 83 ft. wide and 135 ft. long, divided longitudinally by reinforced-concrete walls into six channels, baffled up and down with planks placed 5¼ ft. c. to c. The baffles are adjustable. This arrangement gives a water travel of about 2,100 ft., which it is expected will take about 35 min. (1 ft. per sec.). Two mixing chambers can be operated in series if extra mixing is desired.

The water from the mixing chamber is discharged into a channel that runs the whole length of the end of the six coagulating basins. From this channel the water can be introduced to any one of the basins. Each coagulating basin is about 142 ft. wide by 250 ft. long, with two baffle walls dividing it into three compartments longitudinally. It is expected that it will take about 3½ hr. at maximum capacity for the water to pass through a basin, on the basis of all six basins being in operation. This will give a working rate of about 25,000,000 gal. per basin.

The basins are of ordinary groined-arch roof and floor construction. Facilities for draining and cleaning the basins by water under pressure are provided.

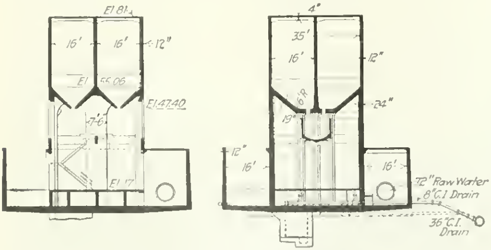


FIG. 3. SECTIONS OF STORAGE BINS, CLEVELAND COAGULANT HOUSE

From the coagulating basin the water is taken into a channel from which four outlets lead to an influent line. From the influent pipe the water flows to any one of 36 rectangular filters, 33½x19 ft. in plan (see Figs. 2 and 4). The net filtering area is therefore 1,460 sq.ft. per filter. The filters are disposed in two rows of nine each, or 18 in all, on either side of a central administration building that is 70 ft. square. There is a pipe and operating gallery 24 ft. wide between each row of nine filters. The filtering material consists of 27 in. of sand on 22 in. of gravel. There is a manifold strainer system. Th central manifold is of cast iron, elliptical in section, an the laterals are of 2½-in. cast-iron pipe provided witl two rows of ¼-in. holes on the under side, bored at a angle of 45° with the vertical. The holes are designe to give an area of 0.33% of the sand area.

The water collected by the laterals and manifolds i discharged into a system of collector pipes under th filters. These connect into a single 24-in. pipe leadin from each filter. The water then passes through a co trolling device into the space beneath the filters. Fro there the water passes through a conduit to a 25,000,00 gal. clear-water basin about 1,000 ft. distant.

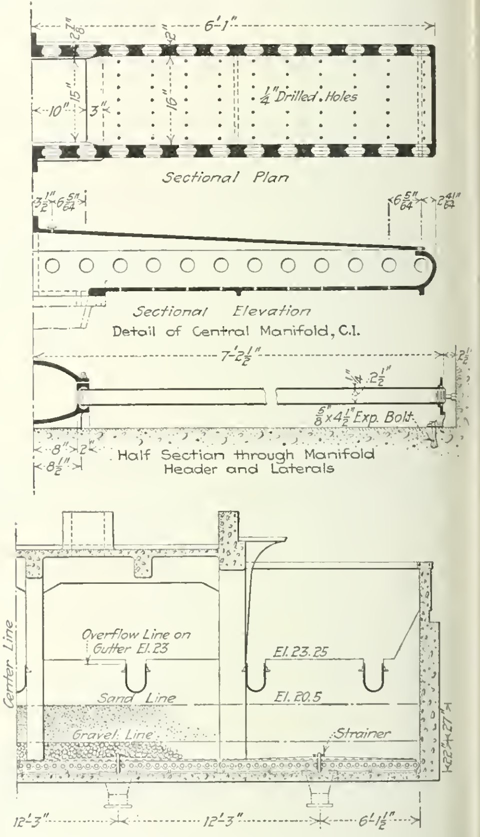


FIG. 4. DETAILS OF CLEVELAND FILTER UNIT AND STRAINER SYSTEM

There is a covered wash-water reservoir of reinforc concrete holding about 450,000 gal., located on a hi about 50 ft. above the floor of the filter. Wash wat is conducted to the filters through a line of 48-in. cas iron pipe on which there is a Simplex meter for measu ing the flow. This water will be introduced at the ra of 15 gal. per min. per sq.ft. of filter area, but no a will be used at present.

Dirty water will be taken from the filters over a justable weirs on the wash-water troughs to and throug

30-in. pipe to a main filter drain. It will eventually each the old river bed, now an arm of the lake.

Provision is made in the administration building for sand-storage bin, with room left for the installation of sand washer in case it is found necessary for any cause o supplement the regular washing.

All sluice gates and the 10 large valves in the mixing hambers and coagulation basins will be electrically operted. All the filter valves (five for each filter) will be ydraulically operated. There will be heat in the filter uilding, but not in the mixing chamber. The pressure or hydraulic operation, controllers, etc., will be the reglar city-water pressure.

The filter house is 733 ft. long, extending over the lter and operating gallery. It is a one-story structure, uilt of special wire-cut brick of varying shades, laid in lark mortar with joints raked out to a depth of ½ in. he other buildings are of the same kind of brick, giving pleasing effect. The building over the filter gallery, bout 50 ft. wide and one story high, has steel roof trusses overed with sheathing and red Spanish tile. The administration building in the center, about 70 ft. square and wo stories high, has offices on the first floor and three iboratories and an office on the second floor. The chemal-storage bins and machinery for the preparation and ntroduction of solution of lime and coagulant are in a rick building of similar style of architecture. Over each air of mixing chambers there is a small gatehouse in armony with the other buildings. F. B. Meade, of leveland, acted as consulting architect. All parts of he plant not taken up with buildings will be covered with arth and grassed.

The filter equipment, except operating tables, was suplied by the M. L. Bayard Co., of Philadelphia. The perating tables were furnished by the Pittsburgh Filter lanufacturing Co. The filter controllers were made by he Builders Iron Foundry, of Providence, R. I.

A summary of the water-testing operations preliminary o the design of the plant appeared in *Engineering News* f Sept. 3, 1914. The purification and softening works ere virtually completed in the summer of 1916, but annot be put in full operation until the completion of he pumping station and the new intake tunnel. Meanhile the plant is being "tuned up" under the direction f J. W. Ellms, of Cincinnati, who is dividing his time etween the Cincinnati and Cleveland plants. It is not probable that the new purification works will go into full operation until some time in 1917, but possibly some 20,000,000 gal. or so may be supplied for treatment from the Kirtland pumping station, on the east side of the city. The city is now being supplied with chlorinated lake water from that station. It is expected that within a few years a filtration plant will be built at Kirtland.

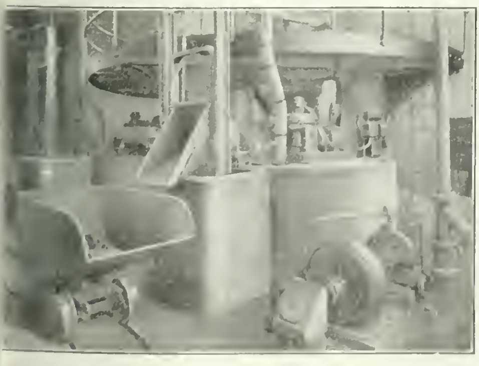
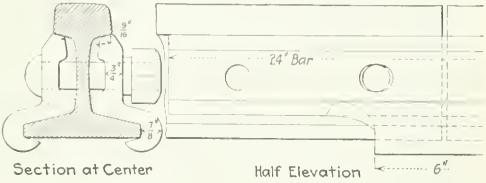


FIG. 5. CLEVELAND LIME-SLAKING TANK

The Pelton wheel drives the pump and stirrer. The perforated bucket is shown in position to dump unslaked material

New Rail Joint of Grip Type

A rail joint now in experimental use is so designed that the splice bars transmit the pressure or load upon the rail head directly to the junction of the web and base of the rail. The bars have a vise-like grip on the rails at this point, instead of a wedging fit between the head and base of the rails. In this way they prevent relative movement of the two rail ends, both laterally and vertically. The object is to hold the rail ends in exact line and level, and thus to prevent battering and wear of the top and side of the rail heads, as well as to prevent wear of the contact surfaces of the splice bars and rail heads. At the same time the joint is flexible enough to conform to the wave motion of the track.



NEW GRIP RAIL JOINT
Used on the Chicago & Northwestern Ry.

The splice bars are 24 in. long, with four bolts, the alternate bolts having their heads on opposite sides of the rail. The end portions are of fishplate section, with the lower edge fitted to the fillet of the rail. The middle portion of the bar has a wide flange that fits closely upon the rail base, and a special feature of the design is that this flange has a rib that hooks under the edge of the rail base. Thus the bars cannot oscillate or rock upon their bearings at the rail fillet. Wear upon the top surface of the bar and the bottom of its flange can be taken up by tightening the bolts. This rotates the bars on their bearings, drawing the upper end inward and the flange upward, so as to maintain the two rails in proper level and line.

One of these joints is in use on 100-lb. rails near the end of a subway, where there is considerable wave motion in the track and where the traffic amounts to about 100 trains daily, with heavy equipment. During six months' service the bolts have not required tightening and the joint did not become low, so that no tamping or raising was necessary. The joint is the invention of A. L. Clapp, of Chicago, Roadmaster of the Chicago & Northwestern Ry.

* * *

The Standard Code of Boiler Construction formulated by the American Society of Mechanical Engineers will probably be adopted by the State of Louisiana. At the recent session of the legislature a bill was enacted authorizing the appointment by the governor of a commission of five experts to examine the code and report to the next legislature whether it should be enacted as a law. Recent specifications for boiler work for the Panama Canal have specified that the construction should be in accordance with the Mechanical Engineers' Code, with alternate bids on boilers not so constructed.

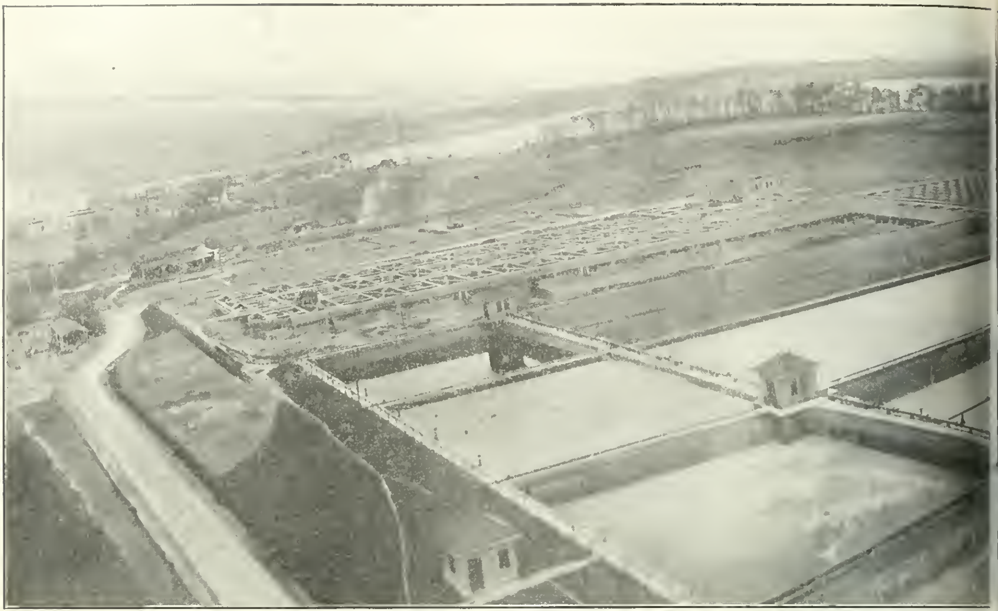


FIG. 1. GENERAL VIEW OF BACK RIVER SEWAGE-TREATMENT WORKS, CONSISTING OF HYDROLYTIC, IMHOFF

Completion of the Sewerage System of Baltimore

By G. J. Requardt*

This month sees the practical completion of the building of Baltimore's new sewerage system. From a condition where the city's wastes were poorly handled by means of cesspools and a few scattered private drains, and stormwater was allowed to flow down the street and alley gutters for great distances before entering inlets, the work of the Baltimore Sewerage Commission has wrought wonderful changes. Formerly, sewage was allowed to flow into the harbor, and the result was the harbor turned into an immense septic tank which gave off terrible odors whenever the backwater from the sidewheel excursion steamers stirred up the sludge on the bottom. At present, civic pride in the conditions surrounding the waterfront has been aroused to such an extent that the Harbor Engineer maintains a police system, and anyone detected throwing a watermelon rind or other unsightly floating object into the harbor is liable to arrest and a fine!

Baltimore began thinking of a comprehensive sewerage system for itself about forty years ago, but it was not till 1892 that serious study was given the subject. In that year a commission was appointed, headed by the late Mendes Cohen, Past President Am. Soc. C. E. The first report given out by this commission (1897) recommended that the city sewage be collected and disposed of by dilu-

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*With Norton Bird & Whitman, Munsey Building, Baltimore, Md.

FIGS. 2 AND 3. THE ORIGINAL JONES FALLS CHANNEL AND THE FALLSWAY BUILT ABOVE IT AS PART OF BALTIMORE SEWERAGE PROJECT

Mayor Preston and Chief Engineer Hendrick are standing by the automobile in the view showing the completed Fallsway

ATE SLUDGE-DIGESTING TANKS, SPRINKLING FILTERS, FINAL SETTLING BASINS AND SLUDGE-DRYING BEDS

on with the waters of Chesapeake Bay. This scheme as strongly opposed as it was felt that the large shellfish yings in the bay would be liable to contamination. An-her report, brought out in 1899, gave as an alternate heme the disposal of sewage by irrigation. Kenneth llen was principal assistant engineer of this commission.

In 1904 a new commission was created, a sewerage loan iade, and Calvin W. Hendrick was appointed chief igineer to begin work on the design and construction of ie system. The work started in 1906 and has been con-nuously carried on to date.

The system comprises about 800 mi. of sewers, storm-ater drains, interceptors, force mains, outfalls, etc., inging from 8 in. to 29 ft. in diameter; a pumping ation that houses three 27,500,000-gal. pumps for raising ie level of about one-third of the city's sewage flow; the nmense disposal plant at Back River which consists of ough and fine screens, hydrolytic, Imhoff and separate udge-digesting tanks, 30 acres of sprinkling filters, final ttling basins, sludge beds and a power house.

A spectacular feature of the work of the commission onsisted of covering over and building a beautiful boule-ard on the top of Jones Falls, a stream 60 ft. wide flow-ig through the heart of the city and which for the last wenty years had been assuming the rôle of an open sewer.

The work has been completed in a little over ten years t a cost of about $23,000,000.

Some of the engineers connected with the work are: alvin W. Hendrick, Chief Engineer, 1905-1916; Thomas . Pitts, Division Engineer and Assistant Chief, 1906-916; A. M. Brosius, Assistant Chief, 1906-1912; O. W. onnet, Division Engineer, 1906-1916; Alfred H. Hart-nan, Division Engineer, 1906-1916; Ezra B. Whitman, ivision Engineer, 1906-1911; Herbert M. Knight, Divi-ion Engineer, 1906-1910; Kenneth Allen, Division En-ineer, 1906-1908.

Are Bleeding Wood Blocks Really Bleeding Joints?

By Ellis R. Dutton*

An experimental strip of creosoted wood-block paving in Minneapolis, on 15th Ave., S. E., was laid on June 23 and 24, 1915, using blocks that were treated by the Kettle River Co. about 10 days before. There was laid under this special test about 250 sq.yd. of blocks. These blocks were laid in the regular way, except that instead of a pitch filler a sand filler was used. The object in doing this was to determine how many of the difficulties attributed to the bleeding of blocks are due to the blocks themselves.

Upon examination of this pavement at various times since it was laid, but very little bleeding has been noticed. Probably not 5% of the blocks have shown any exudation, and then only slight. On the remainder of the street, where the joints were filled with pitch in the ordinary way (by flooding and squeegee) and the pavement was covered with sand, the blocks became quite sticky, and it was necessary to cover them a second time with sand.

In the treatment of these blocks an oil of a specific gravity of about 1.11 was used, and the treatment was continued for 9 or 10 hr.

This contrast of results with the same blocks in the same pavement shows that almost all the trouble attributed to the bleeding of creosoted wood blocks is actually not in the bleeding of the blocks themselves, but in the pitch filler used in the joints; and it also shows further that if the blocks are treated with a tar creosote oil, using more than 16 lb. per cu.ft., there is very little bleeding on account of the oil. If the treatment has been properly done so that the blocks are subjected to the proper penetration, the bleeding is reduced to almost nothing.

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*Assistant City Engineer, Minneapolis, Minn.

Building Albany Sewage Pump House and Grit Chamber

By Stephen B. Vernon*

The design of the grit chamber, Imhoff tanks and sewage-pumping station for Albany, N. Y., was very adequately treated in articles by John H. Gregory, in *Engineering News* of Oct. 7, 1915, p. 692, and June 22 and 29, 1916, pp. 1164 and 1224. The writer has a word to say here about the construction of the pumping station and the grit chamber.

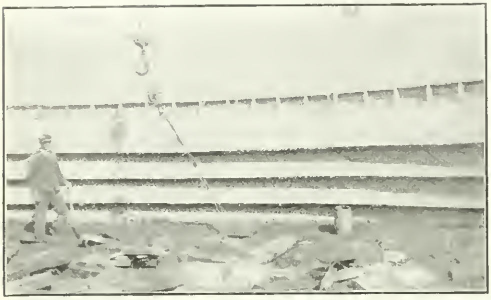
FIG. 1. INSIDE OF CUTTING-EDGE SECTION, SHOWING REBATES AND KEY FOR FLOOR

The contract for construction was awarded to the Foundation Co., of New York, on Sept. 13, 1915. It seemed a late day in the season to commence such work; but plant was soon assembled, and about a month later a real start had been made.

The surface of Westerlo Island lies from 10 to 12 ft. below the highest recorded high water in the Hudson River. For periods of a few days during the early spring months the island is often inundated—usually to a depth not in excess of 4 or 5 ft. There is a considerable deposit of silt on the island, and the top soil has a depth of from 5 to 7 ft. Under this is a sand, so fine in grain that it bears a close relation to quicksand, to a depth of some 35 ft. below the surface, and then gravel, running from fine to coarse, to rock.

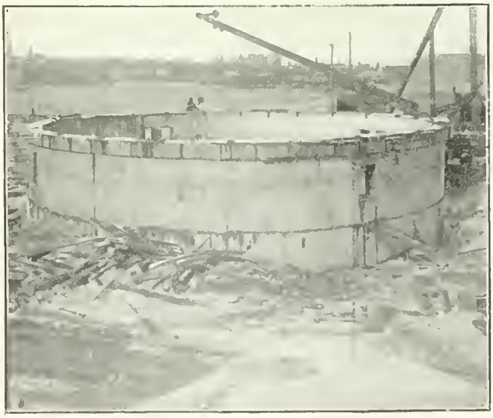
FIG. 2. EXTERIOR OF WESTERLO CAISSON

The pumping station has a cylindrical substructur 62 ft. in inside diameter, with an inner cylindrical dr well for the pumps, 38 ft. in diameter, and an oute annular suction well 10 ft. in width. The main floor o the station, dividing the superstructure from the substru ture, is 2 ft. above the highest known high water o the river, 23 ft. above mean low tide, and stands 13 f above the former ground surface. The top of the founda tion floor is 44 ft. below the main floor—that is, 31 f below the former ground surface, with a hydrostatic hea against it of 23 ft. of groundwater.

Neither the plans nor the specifications for the wor provided a method for building the substructure. Th was understood to be optional with the contractor, th scheme to be approved by the engineer. Discarding th usual method of sheetpiling the excavation, the Founda tion Co. proposed to sink the outer concrete wall a caisson, to excavate under water with clam-she buckets as the weight of the caisson carried it down, t deposit the concrete bottom as a seal under water an lastly to build up the inner parts of the substructur The contractor was reluctant, as he expressed it, t undertake to pump the Hudson dry by a system o under-drainage—for one sees, from what has been sai that the foundation of the station lies in the grav stratum far above rock. Other contractors, however, ha the more usual scheme in mind, and the very design o the building indicates that this had been contemplate

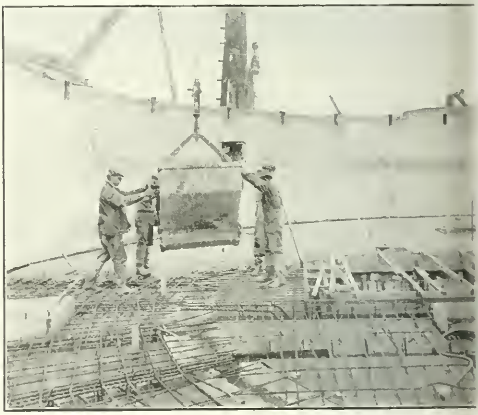
FIG. 3. CONCRETING THE BASEMENT FLOOR

This method of construction necessitated certain de partures from the design—as described by Mr. Gregor The outer wall, instead of having a maximum thickne of 3 ft. and a thickness of $2\frac{1}{3}$ ft. at the ground surfac was built with a uniform thickness of 4 ft. for abo half its depth, and was then offset to the original dime sions. It was heavily reinforced, moreover, by horizonta circumferential rods and vertical rods 1 in. in diamete which were introduced to resist the torsional stresses ar ticipated in sinking the caisson, whereas the design co templated no steel reinforcement for the outer cylinde The steel used in the design, however, was necessaril omitted from the foundation floor, and the concrete thick ness was increased at the center of the station from $4\frac{1}{4}$ t 10 ft., so as to make of the bottom a large plano-conve disk. It was obviously impossible to provide an outsid

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*Engineer, Intercepting Sewer Design and Construction, City Hall, Albany, N. Y.

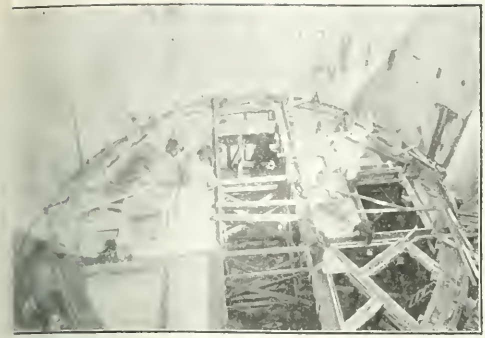


FIG. 4. FORMS FOR ONE OF INTERIOR FLOORS OF PUMPING STATION

oting, and the foundation floor was keyed into the caisn by a series of offsets.

The details and photographs which accompany these otes show the essential features of the work, with little eed of further description. And since no layout of the lant has appeared with former articles, the general yout is here reproduced. The construction-plant layout ndicated on the latter will also, perhaps, add to the ader's interest.

Caisson Easily Sunk

Very little difficulty was found in sinking the caisson. oward the end of the operation it was at one time ecessary to add an extra load of sand bags to the weight the concrete, but otherwise the caisson sank evenly of s own weight. As to the method of procedure, the rface excavation was carried to a depth of 5 ft. before e shoe was placed, and the wall was built up in sections out 12 ft. in height, each section being sunk and the rms removed before the next concrete section was built on it. The time required for changing the forms and acing the steel was such as to allow the concrete to t sufficiently between the periods of sinking. The antity of concrete placed in any one day ranged between and 100 cu.yd. The section, of course, was not truly cylindrical upon completion, but the warp was so small as to limit the variation in diameter to about 3 in. over or under the plan dimensions, and the footing came to a rest within a fraction of an inch of the position intended for it.

Nor was difficulty encountered in placing the seal. The concrete was deposited by deep-sea buckets and was allowed to set for a period of three weeks before the water was pumped out. The leaks discovered were minute, but nevertheless, in order to give a perfectly dry pump well, the inner well floor and the side walls also between the two lowest floors were later waterproofed by The Waterproofing Co.'s method of applying a compound coating about 1 in. thick.

Questions have been asked so many times about the thickness of laitance on the concrete seals that it may be well to say it was necessary to clean off about 6 in. of the deposit before reaching a sound concrete. Wherever these seals were used, allowance was made for a surface finish coat about 6 in. thick.

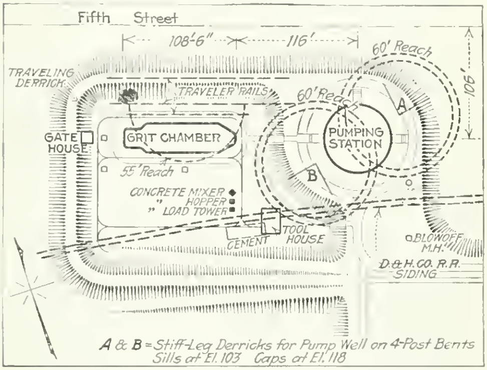


FIG. 5. CONSTRUCTION PLANT LAYOUT OF ALBANY SEWAGE WORKS ON WESTERLO ISLAND

The seal once completed, the construction of the inner wall and the columns and floors was merely a matter of routine. This work was all heavily reinforced with

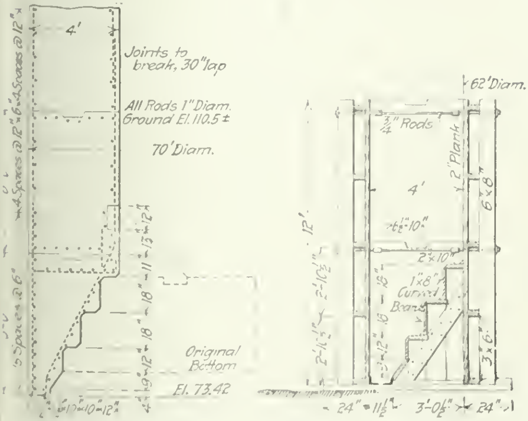


FIG. 6. PUMPING STATION FOUNDATION, LOWER SECTION OF WALL AND FORM

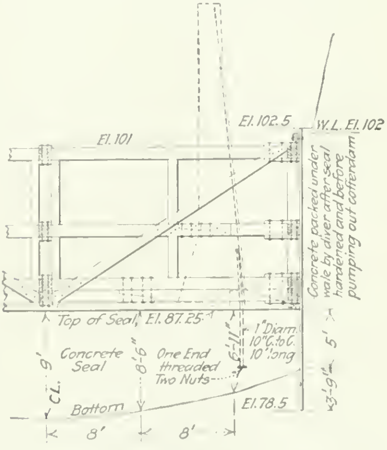

El. 102.5
W. L. El. 102
El. 101
Concrete packed under wale by diver after seal hardened and before pumping out cofferdam
Top of Seal, El. 87.25
1" Diam. 10" C. to C. 10' long
Concrete Seal
9'
8'-6"
6'-11"
One End threaded Two Nuts
5'
3'-9 1/2"
CL.
Bottom
El. 78.5
8'
8'

FIG. 7. SHEETPILE COFFER-DAM FOR GRIT CHAMBER

steel, and the concrete itself, as well as that in the outer wall and seal, was a 1 : 2 : 4 mixture.

At the present writing the superstructure is well toward completion. It follows in plan the size and shape of the substructure, of course, with a circular monitor about the diameter of the inner dry well. The face brick are Hytex tapestry effect, and the inner face of the walls will be plastered, the lower 6 ft. being tile covered. On the conical roof there is a cinder concrete slab, covered with a Nalecode coat and finished with red tile.

How the Grit Chamber Was Built

The excavation for the grit chamber was sheeted with steel sheetpiling; the timber framing and steel piling were carried down as the excavation progressed, and a concrete seal was then laid under water. The walls, finished floor and other parts were constructed thereafter. The excavations for the deep conduits connecting the gate house, grit chamber and pumping station were similarl sheeted and sealed. The grit-chamber walls were bui as cantilevered retaining walls, and the concrete, as we as practically all other concrete on the work except tha in the conduits, where a $1:2\frac{1}{2}:5$ mixture was used, wa a 1 : 2 : 4 mixture.

As to the contract costs of the work, all excavatio below groundwater level was priced at \$3.50 and th above this level at 60c. per cu.yd. Concrete rang between \$9 and \$15 per cu.yd. The cast-iron pipe, tl iron castings, steel reinforcement and other metal i corporated in the work of course brought higher pric than would be expected in normal times.

The superstructures were sublet by the contractor the Peter Keeler Building Co., of Albany. The writ has been in charge of the work for the city, und Frank R. Lanagan, city engineer, and Wallace Greenal commissioner of public works.

* * *

Building Six Hundred Miles of Drainage Ditches

SYNOPSIS—All the work is done by about 26 dipper dredges of various sizes. A notable feature is that the dredges are required to make cuts with slopes of 1 : 1. The method of attaining this is described. The engineers and contractors use motor boats to get over some of the work. Supplies are taken in on motor scows and on sternwheel barges.

The Little River Drainage District, in southeastern Missouri, will have about 625 mi. of drainage ditches in its area of 500,000 acres. These ditches will drain the low lands and provide for carrying off the normal rainfall over the district, which averages 39.8 in. annually. The flood waters formerly discharged into the district by rivers at its north end will be excluded entirely, being cared for by extensive river diversion works, with flood detention basins and a channel extending eastward to the Mississippi River, as described in *Engineering News*.

Fig. 1 is a map of the district showing the ditch layout. The ditch system involves about 31,250,000 cu.yd. of excavation, at an estimated cost of \$2,706,000. The work is divided between a number of contractors, and it is expected that it will be completed by 1918. The character of the work is indicated by the views in Fig. 2.

Size and Layout of Ditches

Some of the ditches are of notable size. They range from 4 ft. bottom width and 8 ft. depth at the upper ends of laterals, to 123 ft. bottom width and 8 to 12 ft. depth at the lower ends of the main ditches. While 4 ft. is a specified width, it has been exceeded as a rule, the bottom width being determined by the minimum top width practicable for a dredge. This is usually 20 to 24 ft., depending upon the distance from ground surface to water level. The minimum width of dredge hull is about 14 ft., and this with 1 ft. draft and water level 1 ft. below the ground would give a top width of 21 ft.

The district is long and narrow, with a length of abo 90 mi. (north and south) and a width of 10 mi. serve this area the ditches are divided into three grou as shown in Fig. 1. The group in the upper porti of the district is served by a main ditch extending near the full length of the middle of the district, being ov 90 mi. long. This has a bottom width of 4 ft. (no inal) at its upper end and 123 ft. at the lower en The two other groups are in the lower portion of t district, and each is served by a main ditch parallel wi the central ditch. These three parallel ditches are abo $\frac{1}{4}$ mi. out to out. They leave two strips of unavaila land, but in planning the work it was thought that t width might not be more than sufficient for disposi of the soft soil and keeping it back from the channe

The width of cleared right-of-way ranges from 1 ft. on the laterals to 350 ft. on the main ditches. this work a small amount of timber in the form saw-logs has been salvaged by landowners and tim leasers ahead of the clearing, and by subcontractors connection with the clearing. The use of the ditches floating timber is prohibited. At some points an stable soft black soil is encountered, which churns i slush under the action of the bucket so that the bott cannot be finished to grade line. It has been suggest that a small hydraulic dredge may be used later to move this soft slush from the bottom.

On the laterals, the spoil banks have openings 500 apart (alternating on opposite sides) for the escape surface water to the ditches. On the main ditches spoil banks are placed on both sides to provide for t ditches running more than bank full. The minim top width on the laterals is about 20 ft., or just w enough for a dredge boat. The maximum top wi is 140 ft., with a 10-ft. berm on each side, or 160 between spoil banks.

All work is done by floating dipper dredges, with ha spuds for the smaller, and bank or bottom spuds for larger machines. The laterals are cut mainly by dred with 1-yd. buckets. For the main ditches, a 1-yd. dre

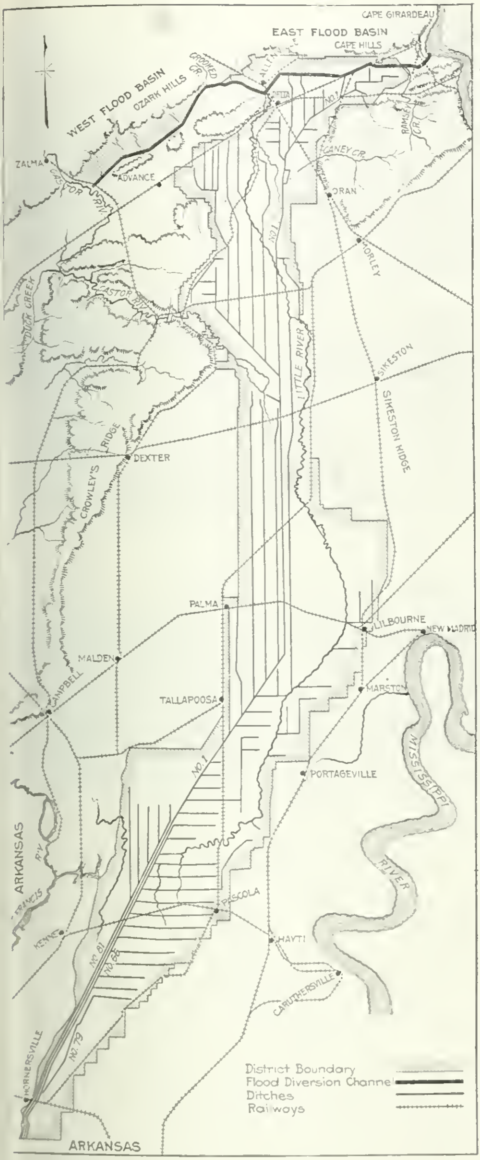


FIG. 1 PLAN OF 600 MI. OF DITCHES FOR THE LITTLE RIVER DRAINAGE DISTRICT, MISSOURI

akes two pilot cuts 6 ft. deep, one on each side. These re about 22 ft. wide on top and 12 ft. on the bottom, ith the 1:1 ditch slope on the outer side. A larger edge first extends each pilot cut to the full depth and en takes out the center. In this way five cuts are made the complete section. On the big ditch (No. 1) with 23-ft. bottom width a dredge with 4-yd. dipper has ade a record of 83,278 cu.yd. in 26 working days.

On one residency there are no less than twelve dredges th dippers ranging from 1 yd. to 1½ yd. capacity. he other two residencies have eight and six dredges each. The larger ones are mostly Marion machines, though some are built from designs of the contractors and have combinations of parts by different makers. Others are by the Fairbanks, Monighan, American Steel Dredge, and other makers. Most of them are operated by steam.

The dredge men work mainly in two 12-hr. shifts. The day shift is from 6 a.m. to 6 p.m., with an hour (or less) at noon for lunch and oiling. The men live in double-deck quarter-boats, built on the work. For getting over the work the engineers and contractors use fast motor boats and slower motor launches with single-cylinder engines. For taking in material and supplies there are motor scows and home-made stern-wheel barges. These latter have gasoline engines mounted either longitudinally or transversely and driving a shaft with chain drive to a sprocket on the stern-wheel shaft. One of the larger barges has an 8-hp. engine. The quarter-boats and stern-wheel barges are shown in Fig. 2.

DREDGING DITCHES WITH 1:1 SLOPES

A specially interesting feature of the work is that by the specifications the dredges are required to finish the cuts with 1:1 slopes. On ditches of this kind the usual practice is to excavate them to practically a U-shape, and let the sides cave in. This results in rough cuts and obstructed bottom. Mr. O'Brien considered that the ditches should be and could be excavated with proper slopes, as stated in a paper by him in *Engineering News*, March 23, 1916.

Some trouble was experienced at first in getting the dredge men to do the work as required, but after a little explanation and requiring them to go back and dress the work not properly finished, they soon came to understand how to get the desired results. This is accomplished by taking a succession of light cuts on each side in such a way as to approximate the 1:1 slope, and then to excavate the center or core.

The diagram issued for instruction as to this slope cutting is shown in Fig. 4. The prism is cut by digging the corners first and working to the center, and it is especially insisted that light cuts must be taken in digging the corners, as indicated on the cross-section. The roll from the berm is cleaned on completion of the fifth round.

FEATURES OF THE WORK

The contract sets forth that completion of the work within the time provided is of special importance. With this in view it is specified that any contractor, before beginning the erection of a dredge, must obtain the engineer's approval of its size and capacity. This is in order to prevent the use of dredges of insufficient capacity to make the required progress. It is for the same purpose that the monthly record is made of the estimated and actual progress on each contract, as noted later.

The specifications provide that the work is to be staked out in advance by the engineer to show the exact location and width of right-of-way, the ditch, the berm and the levees. The depth of cut for a ditch and height of fill for a levee are to be marked on the stakes. In dredging, many of these stakes are displaced or pulled out, and careful contractors mark the location and replace them or get the engineer to reset them so as to avoid excess cutting and to approximate their work to the required cross-section.

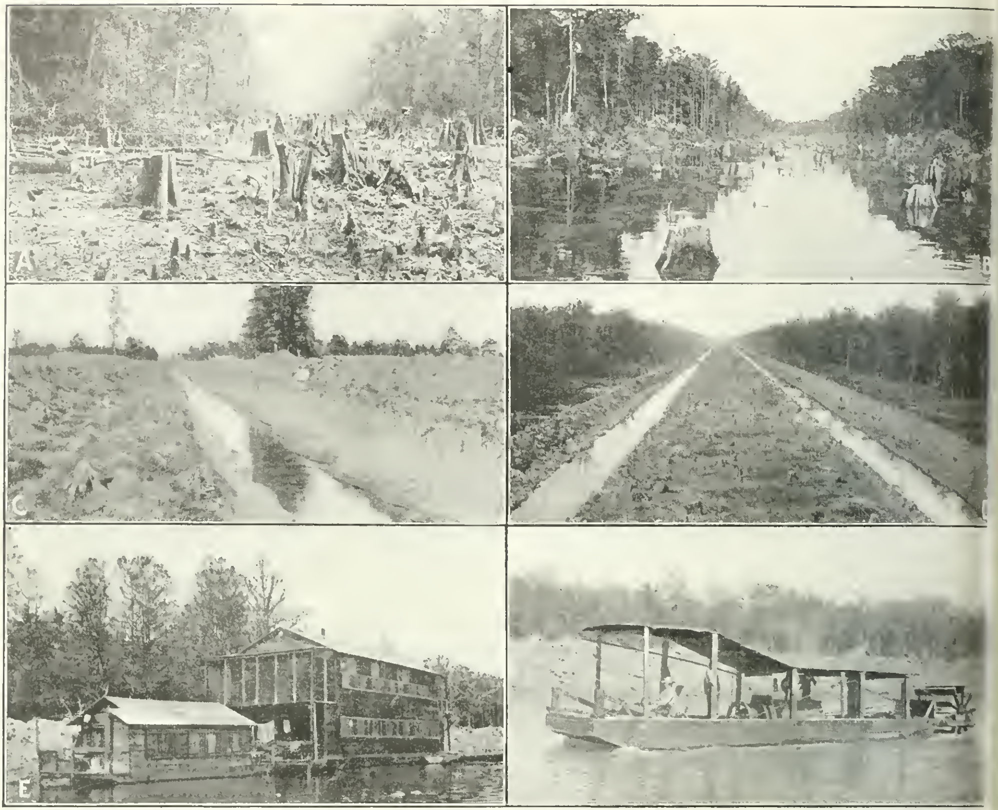


FIG. 2. DITCH WORK ON LITTLE RIVER DRAINAGE DISTRICT, MISSOURI

A—Clearing right-of-way for ditch. B—Cleared right-of-way overflowed. C—Typical small ditch. D—Excavation fo main ditch No. 1. The two small channels are the pioneer cuts at the sides; the large dredge takes out the material betwee them. E—Quarter-boat for crew of dredge. F—Home-made gasoline stern-wheel scow for contractors' use

The cutting of small ditches to greater widths than those specified (in order to admit floating dredges) has been mentioned. The specifications provide that when the prism is not of sufficient width to accommodate the dredge installed, the necessary width shall be obtained when possible by flattening the side slopes. Increasing the prism of ditches is permitted, subject to the approval of the engineer, but the increased prism must conform to the specified section (except in area), and payment is made only for material within this section.

In moving dredges from one piece of work to another it may be necessary for one contractor to pass over work which has been let to another contractor but has not been constructed. In such cases the former makes a cut sufficient for the passage of his dredge and is paid for this on the basis of volume actually removed at a price ½c. per cu.yd. below that of the contract price of the other contractor. The ½c. deduction is paid as compensation to the latter.

In some places where ditches are in bog land it is anticipated that it will be necessary for the contractor to make several cuts before the ditches assume their final set or section. It is provided that in such case the contractor shall go over the work again and make such additional cuts as may be directed by the engineer, payment for the additional work being on the basis of actu cost plus 15%.

The entire right-of-way is to be cleared, stumps l on the berm being not more than 2 ft. high. The ar

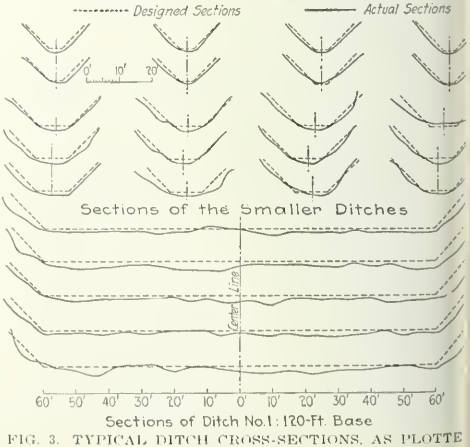


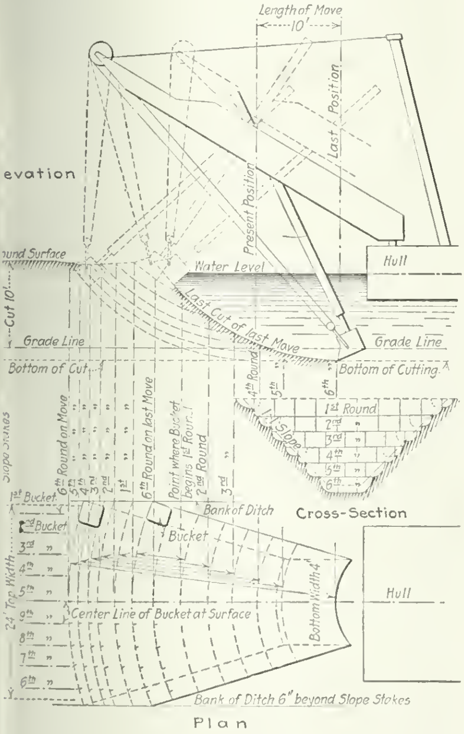
FIG. 3. TYPICAL DITCH CROSS-SECTIONS, AS PLOTTE IN THE FIELD

r base of levees is stripped and grubbed, and all stumps it to within 6 in. of the ground.

Where the levee or embankment is to hold back a head water the surface at the base is to be plowed or broken as to bond with the material of the fill. Embankents of dry material must be made in layers of full idth and over 12 in. thick, each layer being compacted rolling, tamping or driving animals over it. Where e fill is of plastic material deposited by dipper dredges, must be made in layers averaging 24 in. thick, and e material must be dropped at least 8 ft. in order to ake a compact fill.

Cross-Sectioning and Progress Records

The cross-sectioning of the ditches is done by soundg, taking measurements at the top, middle and bottom each slope, and at 5-ft. intervals on the bottom for rge ditches and 3 ft. for the small laterals. Instead entering the figures in a book to be plotted later, t diagrams are plotted directly upon sheets of thin sect n paper, 17x10 in., clamped to a stiff board, the vertical l horizontal scales being 1 in. to 10 ft. This elimites much of the office work, and blueprints from the grams are very useful and effective in showing the tractors just what results they are getting and how t se may be improved.



G. 4. DIAGRAM SHOWING HOW TO DREDGE DITCHES WITH SLOPES OF 1:1

Typical diagrams from these plotted cross-section sheets shown in Fig. 3, for both the large and small canals. ese indicate the character of the actual excavation and the closeness with which the channels can be excavated to the theoretical section. In the smaller ditches the bottom is invariably concave instead of flat, but soon fills up practically to the grade line.

At the main office estimates are made of the amount of monthly excavation required for proper progress, and contractors not meeting requirements are notified as to the amount (and percentage) by which they are below the estimates. This assists materially in the progress of the work.

The Chief Engineer of the Little River Drainage District is William A. O'Brien, of Cape Girardeau, Mo. On the ditch system, William Mulholland is locating engineer and Blair Boyle, E. S. Blaine and Howard Henderson are resident engineers. The party on each residency consists of an instrument man, a rodman and from one to three chainmen. Each residency has its headquarters in a town from which there is the best railway service to points convenient to the location of the dredges. The parties make use of trains, hand-cars, motor boats, push boats, automobiles and teams (besides walking and wading) in getting over the work.

A Defective Bascule Bridge

A recently constructed bascule bridge of modern type, which has been in operation less than half a dozen years, exhibits defects so serious as to threaten its safety and stability, according to an examination recently made by an engineer representing the designers of the bridge. It is charged that the pile foundations of the bascule pier have allowed the pier to move laterally an inch or more and that the span and machinery are now sufficiently out of adjustment so that both the steelwork and parts of the machinery have suffered damage. The designers charge that this is due to lack of proper adjustment before the bridge was put into operation. The essential points reported are the following:

> The bascule span is completely out of balance, the counterweight being heavy. It takes 25 amperes to start the lift; but after starting, the amperage drops to zero, and as the bridge raises the brake is necessary to control its momentum. In closing the bascule the amperage averages 190.
>
> The main rack pinions on opposite sides of the bridge are not timed with each other. The result is that the downstream motor does all the work of opening and the upstream motor all the work of closing the bridge. This causes vibration, and also must produce a serious twist in the structure.
>
> On the upstream side the bearing of the pinion engaging the main pinion gear is held by four anchor bolts to the flanges of a girder. These flanges are torn almost through at the rear, owing to the unbalanced condition of the bridge and to the fact that the one motor closes the bridge.
>
> The outer end of the bascule span is about 2¼ in. off center, and the spans back of the trunnion end of the bascule show such relative movements as prove that there has been a movement of the bascule pier upstream.
>
> All the accessible anchor bolts on the bascule span are loose and can be readily lifted out by hand. There is no evidence that wedges were ever placed in the ends of these bolts or that any of these bolts were grouted. The top anchor bolts on the inside main trunnion bearing upstream have been sheared off.

As a result of the examination it was reported that the bridge was in imminent danger of accident and that steps should be taken at once to correct the trouble. The city officials have not followed this recommendation up to the present, although the report was made some two months ago.

It is believed that the conditions at the time of building the bridge were such that the construction work did not secure proper supervision.

Engineering Literature

Earth Pressure, Retaining Walls and Bins

Sir—My attention has just been called to a review of my book on "Earth Pressure, Retaining Walls and Bins" in *Engineering News* of Aug. 17, 1916, by Edward Godfrey.

Leaving out any controversial matter, it seems proper to correct some errors of statement of Mr. Godfrey relative to the text. Thus, the nomenclature used in connection with the tables, pages 116-120, is not simply scattered throughout the volume, as Mr. Godfrey seems to think, but is all to be found on pages 107-110. Most of the symbols used are to be found on page 107, including K and K_1, since these are defined by the equations $E = Kwh^2$, $K_1 = K \cos \lambda$. The remaining symbols are a, θ and A, which are defined on pages 109-110.

In connection with the counterfort, the text, pages 163-164, makes it plain that the horizontal rods of the counterfort are supposed to be "continuous U-rods" passed around or through vertical steel angles placed near the exposed face of the vertical slab. The angles were not shown on Fig. 54, as the addition would have confused the figure.

Mr. Godfrey states that the vertical slab, Fig. 54, "is reinforced all the way from top to bottom with continuous rods near both front and back face, with equal area of steel." Neither the drawing nor the text warrants this statement, the drawing showing ⅝-in. rods near the front face and ⅜-in. rods near the back face—the latter being a part of the temperature reinforcement, as explained on page 164. Next, Mr. Godfrey states that "the base slab is reinforced near both top and bottom all the way." The text calls for no reinforcement near the top, and no bars, with their spacing, are indicated on the drawing, Fig. 54. Near the bottom, usual practice is followed in extending one-third of the bars to the toe reinforcement to the rear.

Appendix I contains two approximate solutions of toe and heel beams (with or without fillets) and cantilever beams. The solutions of toes and heels, with the reinforcing rods in one plane, are very simple. For the heel with a fillet, with the usual rods inclined to each other, the more general solution is required. Contrary to Mr. Godfrey's opinion, it certainly seemed appropriate to apply this general theory to the cantilever beam, as is done, pages 251-252, "for the purpose of gaining an idea of the actual stresses involved," though a rough approximation is recommended in practice and used in the design.

Mr. Godfrey again states: "On page 127 a section of a retaining wall cut from point A downward to the right does not touch any steel, though this section is under heavy bending stress. The same is true of the figure on page 140." Both of these statements are absolutely wrong. The reinforcement for the toe, Fig. 46, page 127, is computed on page 131 and that for the toe, Fig. 48 (a), page 140, on page 142.

From the foregoing notes, it will be seen that ther are so many misstatements in this review that the writer feels impelled to correct them, particularly as the chapter criticized was an earnest attempt to analyze more carefully than usual the stresses in reinforced-concrete retaining walls.

WILLIAM CAIN.

Chapel Hill, N. C., Sept. 25, 1916.

Sir—I have before me Prof. William Cain's letter commenting on my review of his book and beg to reply briefl

Professor Cain finds the symbols used in pages 116-120 mentioned in the text and used in equations within te pages of the tables. The use of a symbol in an equation does not define it, and a search through the text to fin others is the very thing that I criticized as being exasperating.

Concerning the anchoring angles in the retaining wall, his text does not state that they are to be used, but merel that they are "one simple way." The figure certai does not indicate that they are used.

Concerning Fig. 54, my review is in error in stating that the same area of steel is used near front and back the vertical slab. The same number of rods are used, bu they are of different diameter. These questions st remain unanswered: Why all of these rods to reinforce a slab in bending in only one direction? Why the doubl reinforcement of the horizontal slab? Why any reinforcement under the vertical slab, where no bending whatever can exist? Why reinforce the lower face of the left-hand portion, where the load is upward?

Concerning the walls on pages 127 and 140: Cut a section at 45° from A downward to the right in the former and from C in the same direction in the latter. No steel whatever is cut. These are sections of heav bending. The rods should run farther to the right to reinforce these sections. Breaks are not always accommodating enough to occur on vertical planes calculated the text. Professor Cain makes the strong assertion th my statements are absolutely wrong and cites the portion of the text that seems to prove it. This is an unfortunate citation, for the text makes it worse than Fig. 46. T reinforcing rods, by the text, are required to extend on 2½ ft. to the right of A, whereas if they extended 4 ft they would still not be cut by a section at 45°. Professor Cain merely extends the rods for anchorage, but he overlooks the fact that beyond the point where this anchorage is satisfied there is still need of reinforcement. This is a very common error of designers.

EDWARD GODFREY.

Pittsburgh, Penn., Oct. 1, 1916.

⁂

Indexing Technical Literature

Sir—Your review of the "Industrial Arts Index," p 313, issue of Aug. 17, 1916, would seem to imply that we index by title rather than by subject matter.

In citing the example of the Imhoff tank it is true as you say, that there is a good deal of material on Imhoff tanks under the general heading of Sewage Disposal

Under every broad subject heading is to be found material on particular divisions or phases of the subject. Our plan is to *read* the article, place it under the subject heading which best covers its contents and to bring out also, under proper subject headings, parts of the article that are of sufficient importance to be indexed. If an article covers Imhoff tanks only, it would be put under that subject heading. If it is an article on the general subject of sewage disposal, in which there is enough about Imhoff tanks to warrant an added entry, the article is indexed both under Sewage Disposal and Imhoff Tanks. A large amount of this analytic work is done.

As to there being no reference from Imhoff Tanks, it is not the practice of many professional indexers to make references from specific headings to those of a general nature. We find, however, that they are often useful, and the omission of a reference from Imhoff Tanks to Sewage Disposal was an oversight—due to the fact that the first entries under Imhoff Tanks were duplicated under Sewage Disposal. You will notice, too, that in five of the entries under Imhoff Tanks the titles do not contain the words of the heading.

H. W. Wilson,
President, H. W. Wilson Co., Publisher.
White Plains, N. Y., Sept. 6, 1916.

REVIEWS AND NOTES

Recent Highway Literature

ELEMENTS OF HIGHWAY ENGINEERING—By Arthur H. Blanchard, M. Am. Soc. C. E., Professor in charge of the Graduate Course in Highway Engineering in Columbia University. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xii + 514; 202 illustrations. $2.50 net.

HANDBOOK FOR HIGHWAY ENGINEERS: Containing Information Ordinarily Used in the Design and Construction of Roads Warranting an Expenditure of $5,000 to $30,000 per Mile. Part I, Principles of Design. Part II, Practice of Design and Construction—By Wilson G. Harger, C. E., First Assistant Engineer, New York State Department of Highways, and Edmund A. Bonney, Supervising Engineer, New York State Department of Highways. Second edition, entirely revised and enlarged. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C. Leather; 4x7 in.; pp. 609; illustrated. $3 net.

THE AMERICAN ROAD: A Nonengineering Manual for Practical Road Builders—By James I. Tucker, Professor of Civil Engineering, University of Oklahoma, and Consulting State Engineer, Oklahoma Department of Highways. Norman, Okla.: Publishers, "The American Road." Cloth; x8 in.; pp. x + 235; illustrated. $1.08 by mail. Sold by booksellers and publishers.

THE CONSTRUCTION OF ROADS AND PAVEMENTS—By T. R. Agg, C. E., Professor of Highway Engineering, Iowa State College. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. vii + 432; 116 illustrations. $3 net.

Professor Blanchard is well known to the highway-engineering fraternity as co-author with Henry B. Drowne of the "Textbook on Highway Engineering," which was reviewed in *Engineering News*, Nov. 13, 1913. The book before us is of much the same character as regards make-up and illustrations. It has been written especially to meet the needs of engineering students. Nevertheless, it is a book of 150 pages and 202 illustrations, as compared with 750 pages of the "Textbook."

Some of the material is identical with that in the larger book, which was highly commended by Samuel Whinery in the review referred to above, but except for the first chapter, the history of road building, and extracts here and there, the text appears to be entirely rewritten. The practice of taking copious verbatim quotations from the proceedings of road conventions and engineering societies has been followed, as in the "Textbook on Highway Engineering." While the smaller book has been in a large measure made by condensing or "boiling down" the larger, chapter by chapter, there is much new and later material added, and the chapter arrangement has been changed a trifle.

A page by page comparison of the two books leads to the conclusion that excellent judgment has been used in selecting the material "with a view to emphasizing the fundamental principles" and omitting such material as "is not considered essential to a broad knowledge of the science of highway engineering"—the expressed intention of the author. This has been done without limiting the scope of the larger book, which includes besides pavement construction much material on street cleaning, curb and gutter construction, etc. Practically all the illustrations are new. The new "Elements" should prove an excellent college textbook.

The first edition of the "Highway Engineers' Handbook," reviewed in *Engineering News*, Jan. 16, 1913, by A. W. Dean, Chief Engineer of the Massachusetts State Highway Commission, has become pretty well known to the profession. The preface of the second edition, recently off the press, states that the book has been revised "by bringing the material on top courses up to date and by adding considerable data on tests, designs, costs, maintenance and specifications." About 100 pages of new material have been added.

The character of the book has not been changed, and the criticism of Mr. Dean—that the data cited were largely local—still holds. But perhaps this is in a large measure unavoidable. The tables and data are of unquestioned value, but the expediency of combining these with general information and expert opinions based on local experience may well be questioned. It is quite impossible to keep such opinions up to date.

For the prime purpose for which "The American Road" is written, "to assist in forming an enlightened public opinion by presenting simple facts which underlie and are essential to sound practice in roadwork, and to promote an understanding of and coöperation with the movement for economic road building," the book seems to answer very well. It deals largely with the improvement of plain dirt roads, emphasizes the necessity for the best engineering talent available and gives sound advice on financing road improvement.

There are chapters on road administration, convicts and roadwork, earth-road construction, cost accounting and earthwork, earth-road maintenance, waterways, bridges, road finance, stone roads, gravel roads, sand-clay roads, road building with oils, and needed legislation. The author has constantly before him the problems of his own state of Oklahoma, which are similar to those of the other prairie agricultural states, and his book is well worth the attention of all highway engineers who have to meet these problems. It contains many homely truths that cannot have too wide a circulation or make too deep an impression.

Professor Agg's book is the most recent contribution to college textbooks on road construction, and it will be found a useful one. The successful experience of the Iowa State Highway Department in the construction and maintenance of earth and gravel roads and experience with an efficient system of state, county and township highway administration have furnished the author with splendid material and inspiration for these phases of road building.

On pavements he has drawn largely from practice as expounded at the various road and engineering conventions, city specifications, etc. The value of this material, as of any other data similarly compiled, depends on the extent of the compiler's acquaintance with current literature and on the judgment and skill used in selecting, abstracting and digesting the material available. Professor Agg's citations and examples leave one open to some doubt on these points.

The contents, cited in order, are: The development of highway systems, surveys and plans, design of rural highways, construction and maintenance of earth roads, testing nonbituminous materials, sand-clay roads, gravel roads, waterbound macadam pavements, concrete, vitrified brick, wood-block, stone-block, bituminous pavements, dust layers and bituminous carpets, penetration and mixed macadam pavements, sheet asphalt and asphaltic concrete, selection of class of pavement, design of pavements and tests of bituminous materials.

The book gives a concise treatment of the subjects mentioned, but its value to practicing engineers is limited for lack of more complete bibliographical data and the apparent limited sources from which the material is drawn. This is a real defect in a textbook on this particular engineering practice, which perhaps more than any other is based on individual experience, judgment and opinion.

In conclusion, in view of the rapidly increasing amount of road-building literature, the memory of highway engineers may be recalled to the very excellent book called "American Highways," written by the late N. S. Shaler, Dean of Lawrence Scientific School, Harvard University, in 1896. While written for popular consumption at a time before modern road building had commenced, it contains the soundest exposition of the principles underlying all road-improvement work that has yet appeared, and it is written in language that is a pleasure to read.

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Some New Hydraulic Formulas and Tables

REVIEWED BY ROBERT E. HORTON*

HYDRAULIC FLOW REVIEWED: A Book of Reference of Standard Experiments on Pipes, Channels, Notches, Weirs and Circular Orifices, Together with New Formulas relating Thereto—By Alfred A. Barnes, A. C. G. I. New York: Spon & Chamberlain. Cloth; 6x10 in.; pp. 158; illustrated with frontispiece and 2 folding plates. $4.50.

The author admits that several existing formulas for flow of water in pipes and channels are reasonably correct for some portion of the range covered by experiments. The purpose of his book is to show that a general formula of the type

$$v = CR^mS^n$$

or, in the author's notation,

$$v = Km^{\alpha}i^{\beta}$$

applies to the full range of experimental data for each class of conduit surface. The author goes farther and attempts to show that the same form of expression applies to weirs, both of the V-notch form and with level crest, both contracted and suppressed, and to orifices.

As a foundation for his deductions the author presents a table of results of 3,162 experiments on flow in pipes, flumes, canals and natural river channels, which he claims "form the most complete lists that have so far been compiled." The author hints that this table may be the most valuable part of the book. A short list of authorities consulted and cited is given. Neither in this nor in th table of experimental data does there appear any mentio of American experiments reported during the past eigh or ten years. This omission detracts materially from th value of the table, since many recent data on flow i brass and wrought-iron pipes, flumes, wood-stave an concrete pipes, and over weirs, are thereby ignored There is no evidence that the author is familiar wit other researches very similar to his review, or re-review— for example, those of Louis Schmeer and William H Echols.

A most interesting feature of the book is the metho of logarithmic plotting of experimental data develope for determining the constants K, α and β. By th system it is claimed that the experimental data whe plotted depart from straight lines only to the extent the accidental errors of observation. Furthermore, i this system the constants K, α and β for the full rang of values of hydraulic radius and slope can be determine from four, or even three, sets of experimental determin tions of v, R and S.

Since the same data have been repeatedly used deducing other flow formulas, the merit of the author formulas rests mainly on the superiority of this meth of analysis of the experimental data. Those having occ sion to make or analyze flow experiments will do well become familiar with this method. The author finds th for a given class of friction surface the coefficient K a exponents α and β are constant. Others have reach the same conclusion. The fact is that the present-d tendency in hydraulics and hydrology is to abandon t older and simpler rules and methods in favor of mo elaborate methods made necessary to meet mode requirements as to accuracy.

The author's formulas differ from other so-call exponential formulas, however, owing to the fact th instead of having constant exponents for R and S for classes of friction surfaces, but with different coefficien for each class, the coefficient and exponents in his f mulas, while constant for a given class, are different f each class of friction surface. The author presents flow formulas for as many schedules of friction surfac varying from glass pipes to natural and artificial cha nels and canals in earth. He has computed by formulas the calculated value of v for each of the 3,1 experiments listed, and the agreement with obser values on the whole is exceedingly good.

His method of plotting experimental data throws light on certain existing formulas. He shows graphica that, granting that an expression of the form v CR^mS^n can fit the experiments correctly, then the Ba formula is very nearly correct within the common ran of experiments, but gives too small values of v outsi the experimental range.

The author answers in a very satisfactory manner question raised by Kutter himself, and on which cr cisms of the Kutter formula are often based, as to w C is independent of the slope for $R = 1$ meter. Furth more, he shows the Humphreys and Abbot experime to be consistent with the so-called exponential form The use of these experiments in the derivation of Kutter formula has often been subject to criticism. author very properly hints that it is a misnomer to an expression of the form $v = CR^mS^n$ an exponent formula, since the exponents are not the independ variables in the ordinary sense. It is not claimed that he coefficients in the author's formulas are absolutely inal or that the formulas apply below the critical velocity.

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*Consulting Hydraulic Engineer, Albany, N. Y.

The author specially tests his formula for velocities nd slopes much above the ordinary range and claims hat they hold true for all possible slopes and velocities bove a minimum of about 1 ft. per sec. The author akes the position that the common theoretical forms of xpression for flow in pipes and orifices or over weirs hould be disregarded until their adaptability is conirmed by experiment. It seems, however, like straining oo far to use the form of expression $Q = KM^{a}H^{3}$ for ircular orifices, since it is known that the discharge oefficient varies with the diameter of the orifice; and if ′ is replaced by $C = 0.60\ D^{-0.015}$, the author's forula reduces to identity with the ordinary theoretical orm of expression. Thus the theoretical expression fits s well as the author's empirical formula, and instead f the discharge varying with the wetted perimeter as main independent variable, as the author contends, the oefficient varies with the perimeter and with it the ischarge, but in a very minor degree. A similar critiism might be made of the author's deduction with egard to weirs.

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An American Huette

ECHANICAL ENGINEERS' HANDBOOK: Based on the Hütte and Prepared by a Staff of Specialists—Lionel S. Marks, Editor-in-Chief, Professor of Mechanical Engineering, Harvard University and Massachusetts Institute of Technology. New York: McGraw-Hill Book Co. Flexible leather; 4x7 in.; pp. xxiii + 1,779; illustrated. $5 net.

The few engineers around the country who have known hat 50 contributors, and some 30 other specialists aiding by criticism and suggestion, were working on an merican handbook to be a counterpart of the famous ütte, will be interested in the volume which has finally peared. The list of contributors makes an impressive ray of names well known in teaching or commercial ractice. The handbook is based only on the mechanal engineering section of the Akademischer Verein ütte and only the sections on "Friction" and "Hydraulic urbines" follow the original at all closely. The chaprs on "Heat" and the "Mechanics of Materials" follow e German book in a general way, and the rest of the olume seems to have depended on the original only for e benefit of the German publishers' experience in rerd to scope and handling of topics. Comparatively few erman data are used. All things considered, this book ay be regarded as the fullest development of the coerative handbook. The impression made by the book a whole is very pleasing, to which effect the neatness illustration materially contributes.

There is little need of dwelling at length on the matheatical section, but the insertion of hyperbolic functions d log tables perhaps should be noted. The mathematal text is unusually extended for a handbook, there being rticularly handy matter on applications of geometry, determinants, complex quantities, useful curves (antical geometry), differential equations, and graphical presentation of equations involving two to four variables. The theoretical elements of mechanics, while consed, might be called extended for a mechanical engiers' pocketbook, judging by old standards—especially regards kinematics of rigid bodies and stresses in ructures. The treatment of friction, especially of mae elements, is ample.

The hydraulics chapter contents itself with a brief review of the theory of hydrostatics and hydrokinetics—plus data on flow through orifices, nozzles, pipes and channels and over dams and weirs—and with descriptions of pressure, velocity and level gages. Here are introduced condensed conversion tables, consisting of two parallel scales separated by a single reference axis. There is not given as wide a range of Kutter's coefficients for flow as is available—as illustrated by the tables collected by Horton.

A considerable part of the section on heat is devoted to theory—general thermodynamics and transmission phenomena, flow of gases, fuel combustion, etc.—but there is an immense compilation of data on specific expansions, densities, heats, melting and freezing points, conductivities, radiation constants, properties of steam, gases and vapor mixtures.

About a third of the book is devoted to what might be called the raw materials of engineering, although this part is split up into sections and chapters bearing various titles. Herein are included the summaries of textbook matter on the production, handling and strength of materials and of structure and machine elements—in contrast with the parts presenting the performance of complete plants, plant units or structures (or the physical characteristics of the output from plants or plant units), which may be regarded as forming another distinct part of this book, although also broken up into sections and chapters. Under "Strength of Materials" are given the specific constants of various materials, the definitions and theory of stresses and deformations and the familiar properties of beams, sections, springs, columns, etc. The theory of reinforced-concrete design is found here (and there is a complementary section on reinforced-concrete construction later, under "Building Construction and Equipment"). Another section, entitled "Materials of Engineering," opens with a tabulation of chemical elements and weights of most common substances. The different iron and steel processes and products are described and accepted specifications and test figures given for the latter. The whole nonferrous-metal world is similarly covered. One chapter reviews present knowledge on corrosion of metals, particularly iron; closely related is a following chapter on protective coatings—in which various kinds of paints, varnishes, etc., are described, with notes on their proper application. A chapter on cement, mortar and concrete tells what these things are, what they are used for and how they are affected. Similar is the makeup of the chapters on wood, abrasives, adhesives and all the nonmetallic materials, including fuels. What has so far been noted fills 800 of the 1,780 odd pages of text.

In that part which may be said to deal more or less completely with power generation or utilization there comes first a section on "Machine Elements," with descriptions of fundamental mechanisms and data on such machine or plant elements as screws, riveted joints, keys, shafts, couplings, commercial bearings, gears, belts, engine parts, pipes and fittings, valves, hose, rope and nails. Then the book switches to a section on "Power Generation," which opens with notes on animal and wind power and gives data on design, on construction and operation costs, on best performances, etc., of boilers, gas producers, chimneys, engines, steam and hydraulic turbines. Much the same sort of treatment is given to hoisting and conveying apparatus—including therein excavating machinery—and to transport equipment—automobile, railway, marine and aërial.

Some readers might expect that the section on "Machine-Shop Practice" would immediately follow—since it describes foundry and forging machines, machine tools, welding equipment, gives data on best metal-cutting speeds and power requirements, reviews modern shop management and accounting, and covers pumps, compressors and fans in the same way as noted for power-plant equipment. But there is an interjected section on "Building Construction and Equipment," the first part of which is complementary to some of the chapters on materials—in so far as it gives proper foundation loads, proper use of masonry, timber and reinforced concrete, roof loads, design of frames, etc. This building section gives more than half of its space to planning industrial buildings, defining good heating, ventilation, illumination, accident prevention and fire protection.

Electrical engineering comes in with a section in which are found a brief dissertation on the theory of magnetic and electric circuits, data on electrical properties of certain materials, descriptions of distribution systems, instruments, batteries, dynamo-electric machinery, transformers, and notes on the uses and costs of such apparatus.

The final section of this notable compendium, entitled "Engineering Measurements," first covers laboratory work in temperature, pressure, speed, weight, area, power, fluid-flow and gas-composition determinations. It has the briefest possible review of field surveying and leveling. There are placed here also some miscellaneous topics not closely related to the other parts already reviewed—refrigeration, patent law, first aid, optics, and the American Society of Mechanical Engineers' various test codes.

In what has been thus ably presented by the many authors of this handbook it would seem as though the needs of mechanical engineers had been met in about every possible way one could forecast. The real test of every such handbook lies in its daily use by the thousands of practitioners who will buy it. Only when such results are compiled can a critique—a real review—be written or definite comparison made with the older handbooks which have apparently a greater accumulation of time-honored performance records.

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Panama Mosquito Engineering

MOSQUITO CONTROL IN PANAMA: The Eradication of Malaria and Yellow Fever in Cuba and Panama—By Joseph A. LePrince, C.E., A.M., Chief Sanitary Inspector, Isthmian Canal Commission, 1904-1914, and A. J. Orenstein, M.D., Assistant Chief Sanitary Inspector, Isthmian Canal Commission. With an Introduction by L. O. Howard, LL.D., Entomologist and Chief, Bureau of Entomology, United States Department of Agriculture. New York: G. P. Putnam's Sons. Cloth; 6x9 in.; pp. xvii + 335; 100 illustrations. $2.50 net.

The extent to which mosquito control on a large scale is a series of engineering problems is well illustrated by this book, the senior author of which is an engineer with long experience under General Gorgas in mosquito-reduction work at Havana and on the Isthmus of Panama.

Part I, which fills two-thirds of the volume, deals with the campaign against malaria. After briefly sketching anti-malarial knowledge prior to 1904 and also the Havana campaign, the book takes up meteorological and topographical conditions on the Isthmus. Attention is called to the effect of topographical changes on the *Anopheles*, or malaria-spreading mosquito—a matter of prime importance to engineers engaged in construction work affecting surface water conditions in any part of the world where mosquitoes abound. Next come discussion of *Anopheles* as regards species, propagation and har boring areas, food, flight and attraction to human being and their habitations, followed by descriptions of method of attack on propagation areas by filling, drainage, oilin larvacides, natural enemies, cleaning bodies of water vegetation and débris, and cleaning jungles. Protectio of inmates of houses by screening mosquitoes out an destroying those within is given a chapter. Part I close with a summing up of anti-malaria results.

Part II, on the campaign against yellow fever by con trolling the species of mosquitoes known as *Aides calopu* follows the same general lines as Part I, but with muc less detail.

Points of the book that have great interest for all rea ers and at the same time demand close attention by eng neers and others working in mosquito-infested areas a the vagaries of mosquitoes as regards breeding places an other habits bearing on their control, and the great ca that must be given to a variety of engineering and alli matters, large and small.

An attractive feature of the volume is its halftone e gravings. Equally attractive and very useful to ma engineers will be the line drawings showing such deta as concrete linings for various kinds of ditches splas walls at ditch junctions to prevent water from breaki over and forming small pools; eave-troughs, door scree mosquito traps and various devices for studying the flig of mosquitoes.

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Railway Sociology

PRINCIPLES OF RAILROAD TRANSPORTATION—I Emory R. Johnson, Ph.D., Sc.D., Professor of Transpo tation and Commerce, University of Pennsylvania; a thor of "Ocean and Inland Water Transportation," "E ments of Transportation," etc., and Thurman W. V Metre, A.M., Ph.D., Instructor in Transportation, Sch of Business of Columbia Universtiy. New York. Appleton & Co. [Appleton's Railway Series.] Clot 6x9 in.; pp. xix + 619; illustrated. $2.50 net.

The last edition of Professor Johnson's treatise "American Railway Transportation" was published 1908. With the assistance of Professor Van Metre Columbia University, he has rewritten and enlarged former work and it now appears under the title ab quoted. The present volume contains probably twice much matter as the old one, and the increase of price fr $1.50 to $5 is rather a significant illustration of economic changes that have taken place in the eight yea

The present volume is divided into four parts. T first takes up the history of the American railroad syst and gives an elementary description of its physical c struction, track, rolling stock, etc., with chapters on financial and legal side of railway operations. Part deals with the railroad service, classified under freig service, passenger service, express and mail service. chapter on railway accounts and statistics is also includ Part III is entitled "The Railroads and the Public," a there is included under this head the relation of railwa to each other, railway competition and monopoly, a railway freight rates and passenger fares. Part IV ta up the relation between the railways and the Governme and covers not only the United States, but Great Brita Germany, Italy and France. Other chapters in t section give the history of state and Federal regulation this country, and the final chapter discusses the gene problem of Government ownership and Government reg lation in the United States.

A useful feature of the book is a brief bibliography ppended to each chapter. As will be gathered from the oregoing brief review of the contents of the volume, the ook is chiefly devoted to the social, political and economic elations of the railway rather than to the physical eatures of its construction and operation. It is on these ublic relations of the railways, however, that attention s concentrated at the present day. Thinking men who esire to ascertain fundamental facts in order to form ntelligent opinions on questions relating to the railway ll find safe guidance in this excellent treatise.

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Model Engineering Report on Sacramento Water-Supply

Reviewed by Caleb Mills Saville*

REPORT UPON POSSIBLE SOURCES OF WATER-SUPPLY FOR THE CITY OF SACRAMENTO, CALIFORNIA—By Charles Gilman Hyde, George H. Wilhelm, Consulting Engineers; Frank C. Miller, City Engineer. Sacramento, Calif.: City Commission. Paper 6x9 in.; pp. 660; illustrated.

Not since the illuminating and instructive reports of ohn R. Freeman on the water-supplies of New York d San Francisco has there appeared such a voluminous d well-presented water-supply report as the one sub-itted last April to the City of Sacramento and just ade public in printed form. The mass of detail ap-licable to both local and general water-supply conditions so considerable that it would be impracticable to at-mpt a detailed review. The general character and ethods of handling the subject, therefore, can only be uched upon at this time. The report is carefully and gically assembled, maps well drawn and excellently osen to illustrate the text, and tables and diagrams so repared and placed as to set forth clearly the ideas of e authors.

Preceding the text is a very complete table of contents lling 30 pages. In the back of the book are two ap-ndices, one of 11 pages giving an "interpretation of emical and biological analysis of water," the other a able of particular references" applicable to the subjects eated in the body of the report. The index in the ck of the volume occupies 34 pages and bears evidence very careful compilation.

The text is divided into five principal parts: I. Funda-ental Considerations Relating to the Water-Supply roblem in Sacramento. II. A Filtered and Disinfected ater-Supply from the Sacramento River. III. A Sup-y from the Ground in the Vicinity of Sacramento. V. A Supply from the Sierra Nevada Mountains. V. omparison of Sources and Projects and Recommen-tions.

The table of contents in itself is of considerable edu-tional importance as a guide for comprehensive investi-tions and reports of this character. The subheads are ll chosen, each principal part is closed with a sum-ary and conclusions, and the report is completed with comparison of the sources and projects.

The letter of transmittal of $1\frac{1}{2}$ pages states very con-y the results of the investigation and closes in a nified manner without any of the fulsome balderdash ften met with in public reports. The writers of this port are undoubtedly men of decision, and Sacramento to be congratulated in having intrusted her investi-tion to men who not only were capable of making exhaustive inquiry into the problems of public water-supply, but having arrived at a definite conclusion, had the courage of their convictions to state in no uncertain terms:

> If the works are built in accordance with the general project outlined and described in our report, and if the works are properly operated, the writers do not hesitate to guarantee that the water-supply furnished from this source will be brilliantly clear, colorless, satisfactorily soft and hygienically most gratifying and safe.

Part V, which is a statement of "Comparison of Sources and Projects," is equally concise and to the point. Containing only 17 pages of text and tables, it reviews the entire subject fully and completely, apparently omitting no important point, but giving a brief comparison of the principal features of all the sources investigated. The citizen who has only ordinary interest in this matter will find in the letter of transmittal and in the comparison of sources and projects all that he needs for forming an opinion. The 568 pages contained between these two statements are crammed full of water-supply data—results and conclusions—necessary for a proper study of the subject, but oftentimes entirely omitted from a report. Like the other portions of the book, this matter is so clearly and compactly stated that it not only forms a most valuable record for the Sacramento Water Department, but gives to that citizen who is sufficiently interested to read it through a comprehensive knowledge of the most important of the city's utilities.

The purpose of the report is excellently carried out. That is, to place clearly and concisely before the public of Sacramento the whole matter of the additional public water-supply—stripped of technicalities, but complete in reasoning and deductions.

Such reports as those of New York, San Francisco and Sacramento, if interpreted by competent teachers, are the best textbooks that can be used in engineering schools. They embody the latest thought of engineering specialists, while the contents of the stereotyped textbook, except for fundamentals, are often antiquated before their appearance in print.

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Safety Engineering

PRACTICAL SAFETY METHODS AND DEVICES: Manufacturing and Engineering—By George Alvin Cowee, E. M., S. B., Manager, Bureau of Safety, Utica Mutual Compensation Insurance Corporation. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. ix + 434, 128 illustrations. $3 net.

In the introductory chapter to this book the author remarks that safety engineering has become a well-established profession, although it is a comparatively new field of endeavor. He declares that industrial accidents in the United States cause annually the loss of 35,000 lives and about 350,000 serious injuries, while 2,000,000 persons suffer minor accidents sufficient to cause loss of time. These figures challenge attention and fully justify the nation-wide movement toward accident prevention which has had such great development during the last 15 years.

That the work of accident prevention is justified not alone from humanitarian motives, but as a matter of business economy, is proved by the experience of the United States Steel Corporation. Its subsidiary companies have spent in the neighborhood of $5,000,000 during the last eight years in the installation of safety devices and accident-prevention methods. The results of this work have been to reduce the accident rate about

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*Chief Engineer, Hartford Water-Works, Hartford, Conn

40% during the past five years. In the past three years, after adding to the expenses due to accidents all the amounts expended on safety work, the total still shows a reduction of over 35% compared with the accident expenses of earlier years. This reduction has taken place notwithstanding the fact that in recent years the rate of compensation to injured workmen has been materially increased.

Within the limits of a single volume the size of the one under consideration it is of course impossible to cover more than a small part of the safety methods and appliances in use in special industries. The author devotes, for example, one chapter of about 25 pages to the matter of safety on steam and electric railroads; but to cover completely all the features of safety work in the different departments of railway service, such as signaling, braking, crossing-guards, rules for trainmen, rules for shippers, etc., would take a whole book or several books of the size of this one.

What the author has aimed to do in this book is to cover the most important features and principles of safety-engineering work as carried on in different industries.

Beginning with such general matters as safety instruction to employees through the organization of safety committees, use of danger signs, guarding moving machinery, education and discipline for safety, the author proceeds with a chapter on "Buildings and Fire Hazard." He makes no mention here of the admirable system of safeguarding the occupants of multi-story factory and loft buildings, hospitals, etc., by carrying a fireproof division wall through the building from foundation to roof, with an escape doorway on each floor, so that in case a fire occurs at any point the occupants can quickly escape through the fire-door to the other side of the fire wall.

The chapter on "Boilers" is one of the longest in the book, but we find no mention in it of the American Society of Mechanical Engineers' standard code for boiler construction.

In the chapter on "Explosives" a long quotation is made from the Pennsylvania R.R. rules for handling explosives. These rules went into effect on the Pennsylvania R.R. in 1899. There is no mention, however, of the work of the Federal bureau that has for many years had supervision of all handling of explosives in interstate traffic. In addition to the chapters on safety work proper there are other chapters on sanitation; heating, lighting and ventilating; welfare work; occupational diseases; first aid to the injured; etc.

The book is printed in large type on a heavy coated paper with wide margins and a profuse use of halftone illustrations. The same matter could easily have been presented in a book of less than half the weight, a saving that would have been appreciated by engineers who have to carry their libraries with them in moving from place to place.

Worthy Official Description of Los Angeles Aqueduct

FINAL REPORT ON THE CONSTRUCTION OF THE LOS ANGELES AQUEDUCT, with Introductory Historical Sketch. Los Angeles, Calif.: Department of Public Service. Cloth; 8x11 in.; pp. 319; illustrated with maps, drawings and photographs. $1.95.

The unique plan, for an American city, of putting on sale the report on the construction of the Los Angeles Aqueduct, announced in these columns some weeks ago, resulted in such an unexpected and continuing deman that it was decided to print an edition sufficient to fill a probable orders received after the expiration of the orig nal time limit on July 15. The report is now available all who desire to pay a small sum for a concisely writt and handsomely illustrated account of this great enginee ing enterprise. Very appropriately, the report has as frontispiece a portrait of William Mulholland, chi engineer of the Los Angeles Aqueduct and for many yea prior to that in charge of the Los Angeles water-worl under early private and later municipal ownership.

After some 40 pages on the history of the project, i cluding an account of investigations of other sources supply, the report takes up the Owens River draina area, the quality of the water and the Federal aid e tended to the city in securing the necessary water righ on the public domain. There follows a general descripti of the aqueduct. Then comes an account of the metho of transportation that played so important a part in co struction. The municipally owned cement mill and tu plant are very properly featured in the report.

These subjects disposed of, there follow in order descri tions of the various dams, tunnels, conduits and sipho with particular reference to their construction. The lar power development is considered next.

The organization scheme that made possible the succe ful carrying out of this great work is described, and th is also a brief outline of the cost-keeping and accounti methods employed, a few pages on finances and two three pages of very interesting figures comparing t estimated and final cost of the work. Appendices ta up in some detail the water resources of Owens Val and also the sanitary quality of the aqueduct water. T second of the appendices just named recounts what it to be hoped will be the last attack made by the enem of the aqueduct project. The outcome of this attack the quality of the water, as any sensible person mig expect, was the utter discomfiture of the assailants.

Besides the many handsome halftone plates and a f drawings in the body of the book, a pocket at the ba contains some two dozen maps, profiles and ot drawings.

The report is notable for containing so little that is merely local interest—if indeed it contains anything the sort. It will undoubtedly be given a place in ev library, public or private, that welcomes important c tributions to the literature of hydraulic and water-wo engineering and interesting and suggestive records of v municipal undertakings. That the Los Angeles Aq duct, 250 mi. long, with an unprecedented number a variety of tunnels, siphons, open and covered stretches canals, and with its dams, reservoirs, hydro-electric pl and vast irrigation system, falls in both categories no will deny.

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Some phenomena of the plastic flow of moist clay w studied at the United States Bureau of Standa recently, and are discussed by E. C. Bingham in pamphlet just issued as Scientific Papers, No. 278, " Investigation of the Laws of Plastic Flow." Measu ments of flow through capillary tubes under various pr sures were made, using different percentages of wat The quantity of material flowing through in a given ti was found to be proportional to the pressure less a va that the author calls the friction. Pressures less than the friction did not produce flow, except that with some mixtures there was a slight flow attributed to seepage of water through the pore space. The pamphlet should be read by all who have to deal with plastic flow of clays.

* * *

Statistics of the amount and value of sand and gravel roduced for various purposes in the United States in 915 and a short discussion of the differences in weight f a cubic yard of gravel, as reported in various states, ill a 12-page reprint of "Mineral Resources of the United tates, 1915." (Washington: United States Geological urvey.) The text is by R. W. Stone.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or amphlets listed in these columns is given in each entry. If ne book or pamphlet is for sale and the price is known by he editor, the price is stated in each entry. Where no price given it does not necessarily follow that the book or pamhlet can be obtained without cost. Many, but not all, of the amphlets, however, can be secured without cost, at least by iclosing postage. Persons who are in doubt as to the means be pursued to obtain copies of the publications listed in hese columns should apply for information to the stated pubsher, or in case of books or papers privately printed, then the author or other person indicated in the notice.]

NNUAL REPORT OF THE BOARD OF PUBLIC UTILITY COMMISSIONERS FOR THE STATE OF NEW JERSEY FOR 1915—Trenton, N. J.: The Board. Cloth; 6x9 in.; pp. 405.

PPLIED ELECTRICITY FOR PRACTICAL MEN—By Arthur J. Rowland, Professor of Electrical Engineering at Drexel Institute. New York: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. xiv + 375; 323 illustrations. $2.

ENTRIFUGAL PUMPS AND SUCTION DREDGERS—By E. W. Sargeant. Philadelphia: J. B. Lippincott Co. Cloth; 6x9 in.; pp. viii + 188; 160 illustrations, including 14 folding plates. $3.25.

HE CHEMISTRY AND TECHNOLOGY OF PAINTS—By Maximilan Toch, author of "Materials for Permanent Painting." New York: D. Van Nostrand Co. Second revised edition. Cloth; 6x9 in.; pp. 366; 83 photomicrographic plates and other illustrations. $4 net.

NCRETE LININGS FOR IRRIGATION CANALS—Published by the Portland Cement Association, 111 West Washington St., Chicago, Ill. Paper; 6x9 in.; pp. 15. Free on request.

The advantages of concrete lining are discussed and various examples are presented.

LECTRICAL ENGINEERING, ADVANCED COURSE—By Ernst Julius Berg, Sc. D., Professor of Electrical Engineering, Union College; author of "Electrical Engineering, First Course." New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 332; 163 illustrations. $3.50 net.

LECTRIC UNITS AND STANDARDS—Washington, D. C.: United States Bureau of Standards. Circular No. 60. Paper; 7x10 in.; pp. 68. 15c. a copy, from Superintendent of Documents, Government Printing Office, Washington, D. C

NGINEERING FEATURES OF THE WAIAHOLE WATER PROJECT OF THE WAIAHOLE WATER CO. (Island of Oahu, Territory of Hawaii) By Charles H. Kluegel, M. Am. Soc. C. E. Honolulu, T. H.: Hawaiian Engineering Association. Press Bulletin No. 55. Paper; 6x9 in.; pp. 24, illustrated.

XAMPLES IN ALTERNATING CURRENTS, VOL. I—By F. E. Austin, B. S., E. E., author of "How To Make a Transformer for Low Pressures," etc. Second edition, with additions for students and engineers. Hanover, N. H.: The Author. Leather; 5x8 in.; pp. 223; 70 illustrations. $1.10 postpaid.

HE FLOTATION PROCESS—By Herbert A. Megraw, M. Am. Inst. M. E., Member of the Editorial Staff of the "Engineering and Mining Journal," author of "Practical Data for the Cyanide Plant" and "Details of Cyanide Practice." New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. ix + 249; 18 illustrations. $2.50 net

VERNMENT OF THE CITY OF ROCHESTER, N. Y.: General Survey, Critical Appraisal and Constructive Suggestions—Prepared for the Rochester Bureau of Municipal Research by the New York Bureau of Municipal Research (261 Broadway, New York City). Paper; 6x9 in.; pp. 546; illustrated.

GRAPHICAL METHOD FOR THE CORRECTION OF STEEL TAPES—By Walter Scott Weeks. Berkeley, Calif.: University of California. Engineering Publication No. 9. Paper; 7x10 in.; pp. 261-268

NDBOOK OF MACHINE-SHOP ELECTRICITY—By C. E Clewell, Assistant Professor of Electrical Engineering, University of Pennsylvania. Leather; 4x7 in.; pp. xi + 461; 61 illustrations. $3.

HEALTH CONSERVATION AT STEEL MILLS—By J. A. Watkins, Passed Assistant Surgeon, United States Public Health Service. Washington, D. C.: United States Bureau of Mines. Technical Paper 102. Paper; 6x9 in.; pp. 36. 5c. a copy from the Superintendent of Documents, Washington, D. C.

HOW TO MAKE LOW-PRESSURE TRANSFORMERS—By F. E. Austin. Third edition, with additions. Hanover, N. H.: The Author. Linen; 5x7 in.; pp. 22; 16 illustrations. 40c.

The size of this booklet has been doubled in the present edition.

A HYPOTHESIS REGARDING THE USE OF THE DIVINING-ROD IN LOCATING UNDERGROUND WATER—By Carl B. Andrews. Honolulu, T. H.: Hawaiian Engineering Association. Press Bulletin No. 56. Paper; 6x9 in.; pp. 16; illustrated.

A compilation from the "writings of M. Henri Mager, the Encyclopedia Britannica and other books." The author concludes that a "sensitive mechanical device" is essential to satisfactory water finding, which he believes "is now to be considered as a process explainable by physics, in regard to which we should not despair of eventually obtaining a complete knowledge."

INDEX OF TRANSACTIONS, 1883 TO 1885, AND JOURNAL, VOLS. I TO XXIX, NEW ENGLAND WATER-WORKS ASSOCIATION (1882 to 1915 inclusive)—Boston, Mass. (Tremont Temple): The Secretary of the Association. Paper; 6x9 in.; pp. 123. $1.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE, Vol. XCIII—Edited by George C. Lloyd, Secretary. London: Offices of the Institute, 28 Victoria St., S. W. New York: Spon & Chamberlain. Cloth; 6x9 in.; pp. 440; illustrated.

LAWS AND REGULATIONS RELATING TO THE RECLAMATION OF ARID LANDS BY THE UNITED STATES—Washington, D. C.: United States Reclamation Service. Paper; 6x9 in.; pp. 72.

MINERAL RESOURCES OF ALASKA: Report on Progress of Investigations in 1915—By Alfred H. Brooks and Others. Washington, D. C.: United States Geological Survey. Bulletin 642. Paper; 6x9 in.; pp. 279; illustrated.

NEW JERSEY BOARD OF PUBLIC UTILITY COMMISSIONERS: Financial and Miscellaneous Statistics Compiled from the Annual Reports Made by Public Utilities for 1914. Trenton, N. J.: The Board. Cloth; 6x9 in.; pp. 352.

THE PANAMA CANAL AND COMMERCE—By Emory R. Johnson, Ph.D., Sc. D., Professor of Transportation and Commerce, University of Pennsylvania; Member Isthmian Canal Commission, 1899-1904; Special Commissioner of Panama Canal Traffic and Tolls, 1911-1913. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. 296; illustrated. $2 net.

PRINCIPLES OF ALTERNATING-CURRENT MACHINERY—By Ralph R. Lawrence, M. Am. Inst. E. E., Associate Professor of Electrical Engineering of the Massachusetts Institute of Technology and Harvard University. New York: McGraw-Hill Book Co. [Electrical Engineering Texts.] Cloth; 6x9 in.; pp. xvii + 614; 273 illustrations. $4.50 net.

PROCEEDINGS OF THE BROOKLYN ENGINEERS' CLUB FOR 1915: Constitution and By-Laws and Annual Report of the Board of Directors—Brooklyn, N. Y.: Office of the Secretary, 117 Remsen St. Cloth; 6x9 in.; pp. 274; illustrated. $2.

PROCEEDINGS OF THE VERMONT SOCIETY OF ENGINEERS, 1916—Barre, Vt.: Secretary, George A. Reed. Paper; 6x9 in.; pp. 80.

PROGRESS REPORT OF THE MANITOBA HYDROMETRIC SURVEY FOR 1912-13-14—Ottawa, Canada: Dominion Water-Power Branch. Water Resources Paper No. 4. Paper; 7x10 in.; pp. 287; illustrated.

PUBLICATIONS OF THE UNITED STATES RECLAMATION SERVICE: List No. 3—Washington, D. C.: United States Reclamation Service. Paper; 6x9 in.; pp. 46.

REPORTS OF THE ALASKAN ENGINEERING COMMISSION FOR THE PERIOD FROM MAR. 12, 1914, TO DEC. 31, 1915—Washington, D. C.: House of Representatives. Document 610, Part 2. Paper; 6x9 in.; pp. 210; illustrated and 18 maps in portfolio.

REPORT ON PIPE-LINE TRANSPORTATION OF PETROLEUM—Washington, D. C.: Federal Trade Commission. Paper; 6x9 in.; pp. 467; illustrated.

THE SANITARY PRIVY—St. Paul, Minn.: Minnesota State Board of Health. Paper; 6x9 in.; pp. 15; illustrated.

STRESSES IN STRUCTURES—By A. H. Heller, C. E., late Professor of Structural Engineering, Ohio State University. Revised by Clyde T. Morris, M. Am. Soc. C. E., Professor of Structural Engineering, Ohio State University. Third edition. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. xviii + 374; 230 illustrations. $2.75 net.

SUMMARY OF COMMONWEALTH STATISTICS OF TRANSPORTATION FROM 1905 TO 1915—Melbourne, Australia: Commonwealth Bureau of Census and Statistics. Transport and Communication Bulletin No. 9. Paper; 8x13 in.; pp. 52.

WATER-SUPPLY PAPERS, UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in. Copies may be procured from the Superintendent of Documents, Washington, D. C., for the prices stated below.

- No. 360, Surface Water-Supply of the United States, 1913; Part X, The Great Basin. Pp. 293. 30c.
- No. 384, Surface Water-Supply of the United States, 1911; Part IV, St. Lawrence River Basin. Pp. 128. 10c.
- No. 387, Surface Water-Supply of the United States, 1911; Part VII, Lower Mississippi River Basin. Pp. 60. 5c.
- No. 393, Surface Water-Supply of the United States 1911 Part XII, North Pacific Drainage Basins. B. Snake River Basin. Pp. 218. 15c.

Notes from Field and Office

Sand-clay surfacing 15c. per lin. ft.—How one contractor erects transmission towers—Spanish influence in Tex surveying—Vicissitudes of a bridge built from a "picture"—Drills rough 113,000 sq. ft. of concrete floor—Breaking rock not attractive to the unemployed

Sand-Clay Street Surfacing from Sewer Trenches

By M'Kean Maffitt*

An excellent sand-clay surfacing for residence streets is being obtained at minimum cost in Florence, S. C. Trenching for sewers always opens up strata of clay. There is usually a covering of loamy clay or sand to a depth of 18 in. or 2 ft., under which is a stratum of good stiff clay of varying thickness.

Our method is as follows: We take a two-horse turn plow and go over the entire surface of the street, plowing up all the top soil. Then with drag scrapers all of the top soil is removed from one side of the street and piled on the opposite side.

FIGS. 1 TO 3. BUILDING SAND-CLAY PAVEMENTS IN FLORENCE, S. C., WITH CLAY FROM SEWER TRENCH

In trenching, a negro with a mule and a rooter plow breaks up the clay in the ditch (see Fig. 1) so that the other laborers can shovel it out on the side of the street from which the top soil has been removed. The top soil is on the left and the clay on the right in Fig. 1.

After the pipe has been laid and bedded in clay, the top soil and spoil bank on the left (Fig. 1) are thrown into the ditch and puddled, leaving, where available, enough sand to go with the clay for surfacing the stree Where there is insufficient sand to go with the clay, is hauled in from streets where there is an excess.

The sand is dumped to the outside of the clay p and then shoveled over and mixed thoroughly with t clay as it is spread over the street (see Fig. 2). In th way we get about the proper amount of sand with t clay and get it thoroughly mixed. Fig. 3 shows the stre after being surfaced, only a small amount of traffic ha ing gone over it.

After a couple of rains and when the street has be dragged with a split-log drag several times, it will be lev smooth, practically waterproof and so hard that a go sharp pick will hardly make an impression on it.

On the last two blocks of street surfaced by the abo method the cost of surfacing a 30-ft. width was abo 15c. per lin.ft. of street. The exact cost has not be determined, as all the labor and cartage were charg to the sewer work and the final cost sheets have not been made out.

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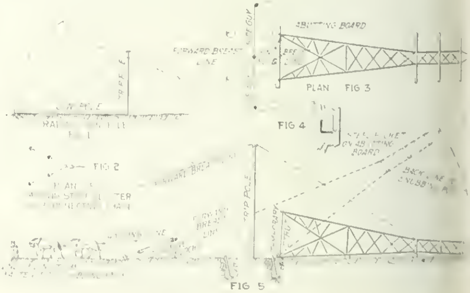
Erecting Steel Transmission Towers with Ginpole

By L. R. Allison*

Steel transmission towers of standard design and co struction usually are assembled on the ground adjac to the site and drawn up as a unit on the provided fou dations. The use of a ginpole for the erection of buil up steel structures of this type affords particular adva tages, not only facilitating installation operations in t field, but introducing an economy factor, under prop working conditions, of no mean importance.

To obtain the greatest efficiency in the erection pha of their extensive transmission-tower work, Millike Brothers, Inc., New York, iron and steel contractor have arranged a simple and effective plan of operatio using a ginpole for rapid and easy installation. Th accompanying diagrams explain the method.



FIGS. 1 TO 5. ERECTING TRANSMISSION TOWERS

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*Superintendent of Water and Sewers, Florence, S. C.

*170 Roseville Ave., Newark, N. J.

Fig. 1 shows the manner of raising the ginpole by means of a trip-pole. Fig. 2 is a diagram of ground-stake arrangement, showing a cluster of four stakes with connecting chain. Fig. 3 is a plan of an assembled tower ready for erection on four constructed footings; as will be noted, the breast line extending to the ginpole is attached to the tower at a level with the first crossarm. The detail drawing, Fig. 4, explains the steel pocket on the abutting board used in erecting the tower; this pocket is formed of steel angles with connecting clip bolted to the board, and forms a brace support for the lower legs of the transmission towers as it is drawn up into position.

Fig. 5 is a side elevation of the tower, and comprehensively illustrates the practical use of the ginpole for erection. A temporary strut is placed between the legs of the bottom section of the tower to brace it thoroughly during erection. As will be noted, a second position of the tower as it assumes the foundation and the corresponding ginpole movement are indicated; during the operation, the ginpole is sustained in an upright position by the guy wires.

This plan of transmission-tower erection has proved so efficient that representatives of the company are furnished with instructions similar to the diagrams here reproduced, in order to become familiar with the practical principles involved.

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Land Surveying in Texas

By J. M. Howe*

Surveyors accustomed to sectionized lands will find themselves confronted by absolutely new problems when they attempt work in Texas. When the Republic of Texas was admitted to the Union as a state it retained its lands; therefore the United States system of sections and quarter-sections does not prevail. In order to do work in the state, some knowledge of the history of the land laws is essential.

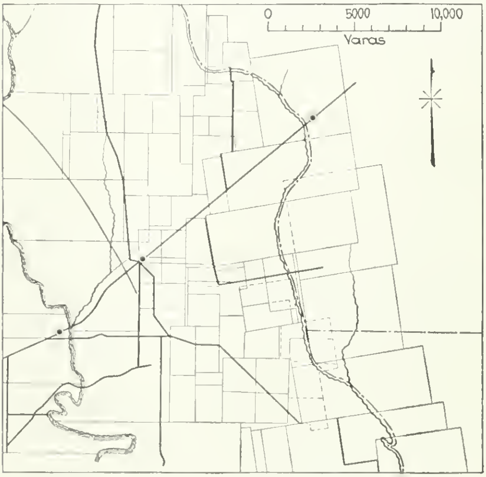
In the early settled portions of Texas there are large tracts of land granted by Spain to her colonists, and over a much greater area there are Mexican Republic grants. These Spanish and Mexican grants were usually made as *labors* and *sitios* or leagues and multiples or fractions thereof. A *labor* contains about 177 acres and a *sitio* 4,428 acres.

These units of area were derived from the basis of linear measurement, which was the *vara*, a square *labor* being 1,000 *varas* on a side and a square *sitio* 5,000 *varas*. The exact length of the *vara* seems to have been a little uncertain, but it has been fixed by statute in Texas at 33⅓ in. The usual method of conversion used by surveyors is to divide distances in *varas* by 0.36, there being 36 *varas* in 100 ft. Spanish and Mexican measures were continued by the Republic of Texas, though Texas as a state, while continuing the use of the *vara*, changed the basis of grants from the *labor* and *sitio* to the section of 640 acres.

Grants made under Spanish, Mexican and Texas Republic titles were located wherever vacant land was found, and with some restrictions as to frontage on streams, in whatever shape the grantee desired. The location work was done by surveyors sometimes using 10- or 20-*vara* chains, but frequently, especially during the colonization period just before and during the days of the Texas Republic, using Gunter's chains. The surveyors coming from the older states of the Union had Gunter's chains, which they cut down to a 20-*vara* length. Land at the time was worth from 10 to 25c. per acre, so it can readily be appreciated that the pioneer surveyors did not trouble themselves much about accuracy.

As the country settled up, it became necessary to fill in between the early large grants with section and quarter-section surveys. These had to abut and tie in to the older tracts. As the early work was often poorly done, with original corners obliterated or nowhere near their called-for places, there has resulted a mass of overlaps and vacancies that make much trouble.

The later filling-in surveys located by surveyors working from such recorded data as were available are frequently found, on making a more thorough investigation, to be based on erroneous conclusions as to the correct location of the older surveys. When the early survey can be established, even though it be excessive in area, and they frequently are, conflicting junior surveys must give way to the senior ones. In consequence, when making surveys at the present time, it is necessary to investigate the date of the original surveys to establish priority.



TYPICAL CONDITIONS OF TEXAS LAND SURVEYS

A majority of the earliest surveyors seem to have been of a liberal disposition, for it is seldom that old league lines are short on distance; excesses are the rule. Now, with the passing of time and the consequent obliteration of original corners, efforts are sometimes made to hold early surveys to their net call for distance. When this is done and can be sustained in court, it leaves vacant land which is subject to grant by the state just as any other part of the public domain.

Another fruitful source of trouble is course. Where is North is a question that is continually coming up, and it has a different answer on nearly every line run. No effort was apparently made by the early surveyors to locate true north, each one using the declination that suited his fancy. The result is that in counties where the true declination is, say, 8° E., lines will be found running on declination from 6½° to 10° and all recorded

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Of Howe & Wise, Consulting Engineers, Houston, Tex.

as North. Frequently a survey is fitted in between two earlier surveys, one of which was run with a declination of 7° and the other with 9°. The fitting-in survey will have its lines recorded as North and South in spite of the fact that the lines are not parallel by 2°. The only way to determine North in any particular case is to get out on the ground and retrace a line or two. Some of the experienced surveyors profess to be able to tell, with reasonable closeness, what the course and distance of certain surveys will be when they know the name of the original surveyor.

Owing to the many difficulties of establishing lines, only really hinted at above, a certain facetious judge, prominent for his knowledge of Texas land law, is said to have demanded as a qualification to testify as an expert surveyor in his court the ability to solve the Texas rectangle. He defined this as a rectangular parallelogram, no two sides of which are the same length and no angle of which is a right angle. Fortunately for the present generation of landowners, occupation and inclosing of the properties are settling most of these uncertainties.

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County-Bridge Curiosities

In the county surveyor's office of a prosperous county in a mid-western state, search was being made for plans of a concrete bridge built some years previously. The assistant, whose memory ran back through several political generations in the office, said that if it had been a design prepared in the office they would have had copies of the plans, all right; but when, as in this case, the county commissioners let the contract on a bidders' "picture" plan for lump sum, the office had nothing to go by but the picture. And that would not tell much, if found, as to how the bridge was built.

No field notes would be found, he was sure, because as the grade at a bridge is already established by the existing road, the man giving levels would simply assume a bench and lay out the work. There would not be any correspondence either, or records in the files, because in those days they never wrote any letters or had any correspondence. The new county engineer had different ideas, and now they had a stenographer and the files were filling up.

The search did not turn up any data, beyond what the assistant carried in a memory as accurate as a wax record, but did bring out some pictures and stories of happenings to the county's bridges.

The first narrative was of an automobile that was being driven back to the city from a lake resort late at night—the owner was on his vacation, and the chauff had picked up four pals.

"They steered straight for the center of the end p of this little three-panel truss span, on a piece of straig away road. That end post consisted of two 5-in. chan and a 14x1¼-in. plate, but the two channels were crac sharply in two and the machine ploughed through u it reached the vertical post. We found a little blood the railroad trestle across the creek where one man and the tracks where another had crawled out of creek, but none of them were badly hurt. You kn that machine acted as a substitute for the batter p

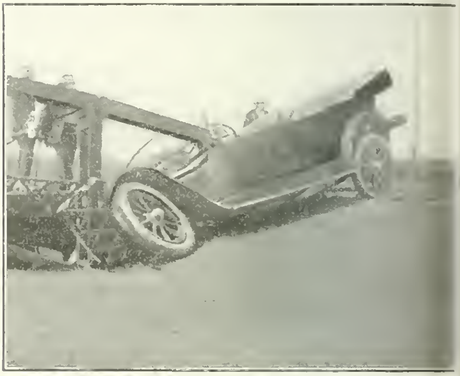


FIG. 1. AUTOMOBILE TAKES PLACE OF END POS

it had smashed. It was wedged in so tight it held bridge up, and a farmer drove a heavy wagon over fore we got there to rope off the bridge.

"Here's a picture of another accident that happ in the county last year. A notoriously reckless dr intoxicated, coming at a high rate of speed down road, hit the lattice handrail at the side of a little b span. He caught it between his wheel and the spr and tore it out of the concrete it was embedded in carried it 60 ft. The impact slewed his machine ar end for end and upside down and up again. The dr was killed.

"Here's a traction-engine accident. The engine separator crossed this span at noon, threshed a farn grain, and then at the end of the day started bac get a set-up for the next day's work. Engines like had been crossing the bridge every year, but this t this one went through. That's a 29-ft. span, 16-ft. r

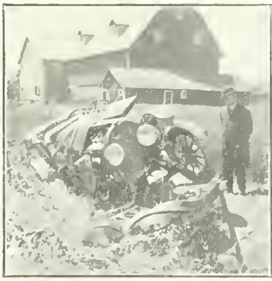
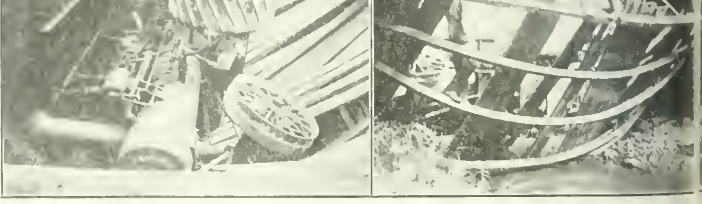


FIG. 2. AUTO CARRIED AWAY LATTICE RAILING



FIGS. 3 AND 4. TRACTION ENGINE WENT THROUGH BRIDGE OF 7-IN I-BEAMS

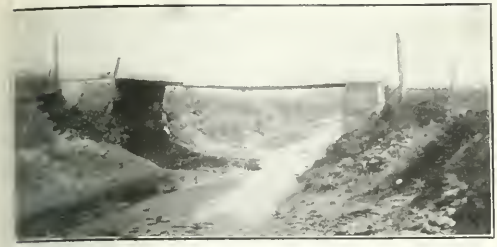


FIG. 5. FARMER'S BRIDGE OF LIGHT RAILWAY RAILS

ay and is carried by seven 7-in. I-beams. No, the lanks weren't fastened to the beams: there's a strap to old them down at the ends. The beams just rested on he abutments at the ends, and one abutment had been aised with a couple of planks between I-beams and iasonry, and these had rotted and let the beams turn ver.

"Yes, we've got quite a number of those spans. A umber of years ago a farmer-contractor filled the county ull of them, all with that typical T-iron handrail. He ut in 7-in. beams always, regardless of span, using six n short ones and seven on the longer ones. Of course, hen he built them, they didn't have 15-ton road rollers, nd their heaviest traction engines weighed three or four ons. Now we use 12-in. beams at that crossing, embed ie ends in concrete backwalls and put on a plank and reosote-block floor.

Some Weak Ones That Stand Up

"Some of the farmers call our bridges extravagant, iough. Here's one that the owner built on one of is farm roads for $50. Its span is 19 ft., 12-ft. roadway, and it is carried by five railroad irons, 3 in. deep, nd over that 4 in. of concrete. It sags about 1 in.; it I guess he drives over it, and I've seen several cows i it. It shook when I walked over it. Strange what iings will stand up.

"We've got a concrete culvert on one road, which takes action engines and everything else that comes. The an is 5 ft., and the top slab is 8 in. thick and was esigned to be reinforced. The reinforcement hadn't me when the forms were finished; and as the conactor thought it would be strong enough anyway, he lled the forms with plain concrete. There's only 12 in. cover over, but it has never even cracked."

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Experiences with Unemployed on Road Rock Breaking

By Norman R. Martin*

During the winter of 1914-15, incident to the very istressing hard times and the wet, harsh weather, comaratively speaking, for southern California, there were great many men out of employment. Some were esidents of our own county, and others had sought uthern California for one reason or another. It was nperative that something be done, and work was given any hundreds of these men on the county roads, cleanig up the weeds from highways, etc. They were paid 2 per day. In this manner the county spent something ke $207,000. I believe it is fair to assume that this was not exceeding 50% efficient labor—not perhaps because the men were not capable, but because of the character of the work and the fact that the supervision was not as efficient as it might have been.

In order to obviate this condition and also to demonstrate that in my opinion a large percentage of the men involved did not want real work, the plan of rock breaking was developed. The County of Los Angeles does a great amount of highway building, these roads having concrete base. From 3,500 to 4,000 tons of broken rock is required per mile of highway. When broken by machinery, this rock costs approximately 60c. per ton, laid down on the work. The thought was to have this same rock broken by hand on the ground and paid for at so much per cubic yard instead of by the day rate, and then from an "Unemployed Fund" absorb the difference between what it cost to break by machinery and what it cost to break by hand, which experience developed was about 30c. per ton. In this way practically two-thirds of the amount of money expended was diverted to value-received labor and practically one-third was absorbed from an "Unemployed Fund." Breaking the rock at so much per cubic yard took care of the men who were not so strong physically as others and also made the men produce the goods. The camp was run by the Road Department, and the men were furnished by the Department of Charities. The men paid the camp 25c. per meal. The lodging was furnished by the county, but the bedding was furnished by the men.

One of the most important features in connection with this trial was to demonstrate who wanted to work and who did not. This policy also eliminated a great many applicants from the Outdoor Relief Division of this department.

Whereas more than 6,000 men were registered in the winter of 1914-15, less than 1,600 registered in the winter of 1915-16. All were offered work, and less than 900 accepted, notwithstanding the fact that the average man could earn $2.50 per day. The county spent $207,000 in 1915-16 and last winter spent less than $25,000, accomplishing the same result.

It might be interesting to note that from careful records kept we ascertained that practically one-third of the men involved would not work; one-third would work enough to keep body and soul together and get a few dollars ahead to leave the section and get away from the work; and practically one-third were good and willing workers.

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*Superintendent of Charities, County of Los Angeles, 121 emple St., Los Angeles, Calif.

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Roughening Concrete Floor for Resurfacing

By Charles A. Hirschberg*

A change in plans for dry dock No. 1, Balboa terminal of the Panama Canal, necessitated the resurfacing of 113,120 sq.ft. of concrete floor. It was deemed advisable to chip the floor before placing the mortar finish on the old concrete, and a more rapid means was sought than that of the hand chisel and hammer.

Two standard Ingersoll reciprocating tripod drills, air operated and of 3⅝-in. cylinder diameter, were called into use. The tripods were altered as shown in Fig. 1. At the end of each tripod leg an extension was welded, as shown at *A*, a hole being drilled at *B* to take the trunnion of the hand-made fork *C*, which carried an axle at *D*. An old pulley wheel *E* was mounted on each axle.

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*Ingersoll-Rand Co., 11 Broadway, New York City.

The complete apparatus is clearly shown in Fig. 2. The drilling machine is thrown back slightly, so that the crossbit strikes the concrete at an angle, presenting only bit corners to the surface as the steel rotates. With each blow struck, the recoil tends to move the machine and tripod, thus materially assisting the helper in keeping the machine moving. The bits used were of the standard cross type, 8 in. in diameter. It was found that one machine, operated by two men, did as much work in 8 hr. as 50 men could do by hand, and all the work was therefore performed with the two machines.

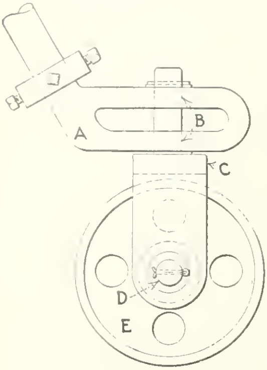


FIG. 1. TRIPOD AS ALTERED

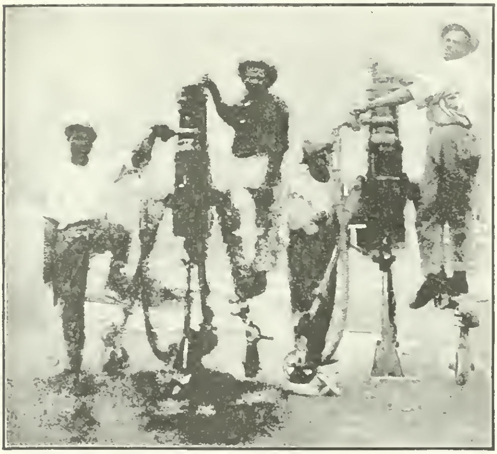
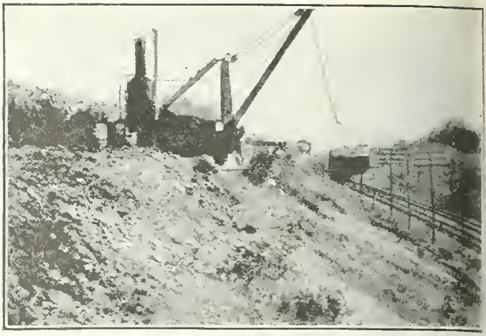


FIG. 2. TWO TRIPOD DRILLS USED TO ROUGHEN CONCRETE FLOOR

Acknowledgment is made to Z. T. Stagg, Jr., who was in charge of this work, for the data.

FINE AGGREGATE

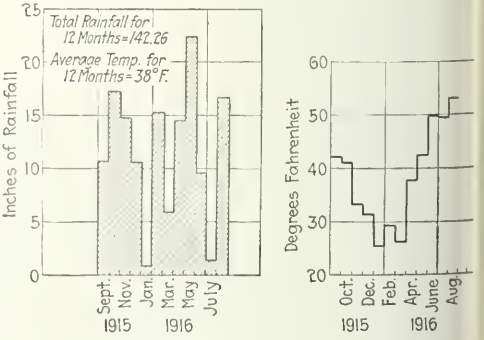
The Somersaulting Bridge shown on p. 560 of the issue of Sept. 21, 1916, in the sketch was not shown sufficiently agile. It is reported now that the post marked A in that sketch was pulled up by the roots and turned completely over the other post, which acted as a pivot, its base remaining in the original position.



DITCHING AND TRIMMING A CUT ON THE BALTIMORE & OHIO R.R.

Trimming Cuts on the B. & O. R.R.—A traveling derrick with skips was used in clearing a long cut on the Baltimore & Ohio R.R. near Muirkirk, Md. The north side of the cut for about 2,500 ft. had been badly gullied, and the material washed down had clogged the track ditch. The cut is about 30 ft. deep. At the top of the slope was installed a derrick car consisting of a timber platform or truck mounted on fo wheels and carrying a boiler, a 15-hp. double-drum hoistin engine and a stiff-leg derrick with 30-ft. boom. This car ra on a wide-gage track, which was picked up in the rear an relaid ahead as the work progressed. The material excavate was loaded into open flat boxes of 12 cu.ft. capacity, which th derrick raised and dumped to form a broad flat fill about 4 f from the top of the cut. This bank serves to stop drainag toward the cut and renders a top ditch unnecessary. The pla and work are shown in the accompanying view. The ditch wa cleared out and the slope dressed to a uniform surface. Th slope was then covered with street sweepings and sown wi grass seed to form a permanent protective covering. The for and organization were as follows: 1 foreman, 1 engineman, 1 men trimming the slope and filling the boxes, 1 or 2 men guy lines to guide the loaded boxes up the slope and haul th empty boxes back into position, 1 man at top of slope to tr the boxes and spread the material in the fill, 2 men shiftin track, 1 cart and driver to haul coal and water, 1 water bo 1 night watchman. This force could handle about 400 box per day. The cost was less than 60c. per yd., as compared wi 90c. estimated for contract work. This method of working w planned by H. M. Church, Division Engineer of the Baltimo & Ohio R.R., and the above information is slightly condens from an article by him in the "Baltimore & Ohio Employe Magazine." Mr. Church states that for seeding the slopes mixture of alsack clover, blue grass, alfalfa and oats is use After seeding, the surface is covered with about 6 in. of stre dirt or street sweepings from the large cities, this bei shipped in cars and distributed by teams and men with whee barrows. This method has been found very satisfactory, a after the first season it is easy to maintain the slopes. case of the slopes being cut by water during heavy stor before the seed takes root it is necessary to go over the wo again.

A Rainfall of 142 In. in Alaska—The accompanying cha of rainfall and temperature for 12 months from Septembe 1915, at Latouche, Alaska (Lat. 60° 02′ N., Long. 147° 53′ W has been sent by B. H. Dow, of Seattle. The total annu rainfall was 142.26 in., and the average temperature was 3 F. The extreme variations in rainfall as from 22.4 in. f May to 1.5 in. for July, are notable.



Editorials

:oad Improvement in Missouri

Missouri, it will be remembered, was one of the first ıtes to establish "highway improvement" by annual good ads' days—spectacular, picnic affairs when the governor the state wields a pick and shovel to the accompaniment a brass band and movie operators, and everybody shows s patriotism by putting in a day or two of labor mproving" the roads and having a good time generally. ll this has its purpose and is a legitimate means of stir- ng up enthusiasm. Let the good work go on.

Still, it is a kind of interesting coincidence that we ıd Clay County, in this same State of Missouri, voting bond issue of $1,250,000 for road improvement and then ving the state's legal lights discover that under the law ıthorizing the bonds no part of the sum thus raised can paid for engineering supervision, and that under the w this engineering work must be performed by a Deputy ɔunty Surveyor, whose salary must not exceed $4 per ıy.

We make a motion that the $1,250,000 be expended for juid refreshments at the next two annual "good roads' ıys."

*

ɅIn Engineer's Plan To Prevent Strikes on Public Utilities

The engineering profession is taking great interest at ıe present time in the proposition that engineers ought occupy a more prominent position and wield a larger ıfluence in public affairs. It is of especial interest, ıerefore, to record that a distinguished engineer has orked out a plan for the prevention of strikes in the ɔeration of railways and other public utilities. This lan is to be submitted by the Merchants Association f New York City to the Chamber of Commerce of the 'nited States with the recommendation that a general ferendum vote on the plan shall be taken.

The originator of this plan, Henry R. Towne, was 'resident of the American Society of Mechanical Engi- eers in 1889. He has long been President of the Yale Towne Manufacturing Co., of Stamford, Conn., and he as for several years President of the Merchants Associa- on of New York.

The most important element in Mr. Towne's plan is the rovision that every employee of a public utility cor- oration should have a definite written contract for a tated term of service. During that term he should be either at liberty to quit his service with the company, or should the company be free to discharge him. If ither party to this contract breaks it, a stated money enalty should be forfeited to the other party.

The company should have, however, the right to ter- ıinate the contract because of "misconduct" by the em- loyee, to be defined in the contract, and also, in the ase of certain classes of employees, because of slack busi- ıess, in which case however the employee should receive ither thirty days' notice or two weeks' pay and immediate release. The company may also terminate the contract because of the disability or superannuation of the employee, subject to such pension provisions as may exist. An employee should also have the right to terminate the contract because of valid family or personal necessity, or because of illness. The employee could also terminate the contract for any cause on giving fair notice, say thirty days, without penalty, if the company consented.

These and other details suggested by Mr. Towne will of course be varied more or less to suit special circumstances of different employments. The underlying basic idea on which his proposition rests is that in the operation of public utilities, where the public has a right to continuous service, the old idea that the employer has a right to discharge a man without notice, for any reason or no reason, should be done away with, and also the idea that the employees, either singly or in combination, are free to quit without notice.

The recent threat of a nation-wide railway strike, with the surrender of the Government to the railway brotherhood demands, has had one valuable result. It has brought home clearly to the mind of every thinking man the conviction that in some way or other the right of the public to uninterrupted service on public utilities must be established. If there was any disposition to forget this lesson, the strikes which have occurred during the past month on street railway lines in various parts of the country have served to fix it firmly in the memory of everyone.

The right of the public to control the capital engaged in the operation of public utilities is now so firmly established that no one thinks of denying it. The man who invests his money in a railway or a public water-supply or an electric lighting plant does so with the full understanding that the public authorities have the right to control the service which he must render to the public and fix the prices which he may charge.

The next step must be to establish the equal right of public control over the labor engaged in public utilities. Until this is done, fully and completely, the public must expect to suffer, at longer or shorter intervals, more or less inconvenience, loss and destruction owing to interrupted service, which may on occasion rise to the proportions of a national calamity.

There is no doubt whatever that this is the logical way to prevent strikes on public utilities, but the question is, How can this plan be put into operation? Labor organizations will exert their united influence against such a proposition. The capital invested in public utilities has to yield certain of the rights and privileges which it enjoys when engaged in private industry and submit to public control. It does this willingly because of the other privileges which it receives. What privileges can be given to the employee of a public utility company that will so compensate him as to make him also willing to submit to public control and to relinquish his right to strike?

A partial answer, at least, to this question is furnished in Mr. Towne's plan described in the foregoing. It is a real and important advantage to the workman to have a definite written contract of employment for a definite time. He is given something that he has never before possessed—a legal right to his job. This in itself is a very great gain.

It is of interest in passing to note how tardy has been the recognition by employers generally that an employee has any right to his position, and that the employer has not the moral right as well as the legal right to discharge a workman without notice, often for no other reason than a fit or ill-temper on the part of a foreman.

It is, of course, evident that for the successful working of Mr. Towne's plan or any other plan to prevent strikes a strong arm of the public authority must step in to see that justice is done by both sides. Mr. Towne's plan proposes first a board of arbitration, constituted by joint action of the company and the employee, authorized to supervise the relations between the two and pass upon any matter of dispute between them. An appeal from decisions by this joint board would lie either to some existing public utility commission or to a special board created for that purpose.

It is of interest to note further that Mr. Towne, who has for many years taken an active interest in labor questions, preserves in his plan the right of collective bargaining, permitting the employees to have membership in any lawful organization without discrimination on the part of the company, giving the employees the right to request concessions in wages, hours of work, or conditions of service, either alone or in combination with others. He distinctly specifies, however, that the employee, in consideration of these privileges, shall respect the right of the public to interrupted service and not combine with others to cause its interruption.

In presenting this plan before the Merchants Association, Mr. Towne disclaimed that it was complete or final. He presented it rather as an outline of the principles which must be established in custom and in law if the public is to be protected from great loss and disaster.

The question what can be done to protect the public from the calamity of a nation-wide railroad strike or the people of a city from the deadlock resulting from a street railway strike or the interruption of other public utilities is a question which urgently demands solution. The so-called eight-hour law, pushed through Congress at the close of its session under whip and spur, settled nothing, nor do the successes of the one side or the other in winning or defeating an isolated strike settle anything.

No question is ever settled until it is settled right. This question will not be permanently settled until the rights of the public are made superior to the rights of both employer and employee, and until sufficient concessions and privileges are granted to each of these parties to make them willing to accept in good faith the superior rights of the public.

Engineers who believe that the members of their profession are destined to occupy positions of larger public influence may well be gratified to have the plans of an engineer for settling this grave public question brought forward by the Chamber of Commerce of the United States. There is further testimony to the public's appreciation of the engineer's opinion on other than technical questions and to its belief in his judicial fa
ness in the appointment of General Goethals as Chairm
of the Commission to study the operation of the Adams
eight-hour wage law, and, in the general public appro
with which that appointment has been received.

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Coal Wealth of United State and Industrial Supremacy

At this time, when so much interest is taken in
question as to the future position of the United Sta
in international trade, great importance attaches to
statistics of the world's coal resources presented at
recent meeting of the British Association for the
vancement of Science by the Committee on Fuel Econo
This committee was made up of scientists and engine
of international fame, including such men as W.
Bone, J. A. F. Aspinall, Sir Hugh Bell, Dr. Dug
Clerk, Sir Robert Hadfield, Dr. H. S. Hele-Shaw,
Charles Parsons and Benjamin Talbot. The commit
in opening its report said:

> It can hardly be questioned that the chief material b
> of the great industrial and commercial expansion of G
> Britain during the past century has been its abundant supp
> of easily obtainable coal, which, until recent years, has g
> us a position of advantage over all other countries. It is
> equally true that we can no longer claim any advantage
> this respect over our two closest competitors. If anyth
> ought to arouse public opinion to the gravity of the situat
> it is surely afforded by the statistics on the world's
> resources issued by the International Geological Congress
> the year 1913. This estimate gives the geographical distr
> tion of the world's total probable reserves of coal of all ki
> available within 6,000 ft. of the surface, amounting in al
> 7,397,533,000,000 metric tons.
>
> The fact that the available reserves of coal in Great Bri
> only amount to about one-fortieth, while those of the w
> British Empire do not amount to more than about one-fou
> of the world's estimated total, is one which ought to
> brought home to everyone responsible for the economic de
> opment of our national and imperial resources. The Un
> States, whose competition in the immediate future
> probably be much more severely felt than ever bef
> possesses more than half the estimated world's coal, an
> regard to quality and cost of production she probably c
> pares favorably with Great Britain.

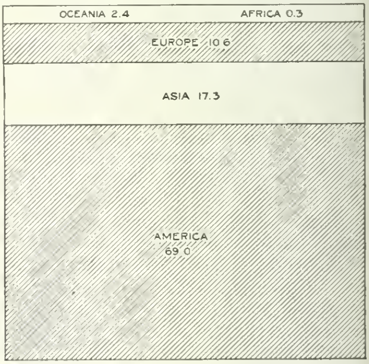
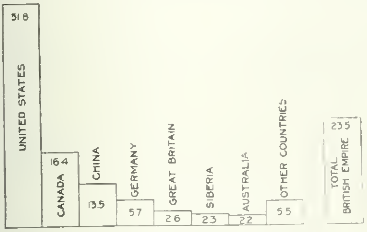


FIG. 1. PERCENTAGE OF THE WORLD'S COAL DEPOS
ON THE DIFFERENT CONTINENTS

Two diagrams from the report of the Internatio
Geological Congress are reproduced herewith, show
the geographical distribution of the world's coal sup
It will hardly be questioned that the fuel resources o
country are more important than any other influence
determining its future industrial position. It is t

at for certain industrial operations the development of ydraulic power and its utilization by means of elec-icity can to a limited extent take the place of coal; it it is to a limited extent only, and there is every ason to believe that the future manufacturing industies of the world will have their geographical location rgely governed by the existence of cheap fuel.

In its stores of other mineral fuel, such as petroleum id natural gas, the United States also, so far as is at esent known, exceeds any other country in the world. he enormous increase in the use of both liquid and solid el has already produced a world-wide increase in the rices of these fuels and is destined to produce a much eater increase in future. The importance of the United tates' vast fuel reserves, therefore, in giving her an adintage over other nations in international competition certain to be much more potent in the future than has been in the past.



IG. 2. PERCENTAGE OF THE WORLD'S COAL DEPOSITS POSSESSED BY VARIOUS NATIONS

It is a narrow point of view, however, to study these atistics solely with reference to the competition of one ition with another. The British association's commite uses these statistics to urge the importance of more onomical utilization of fuel, and the same lesson needs be taught in the United States.

For the future welfare of the world's population the nservation of natural resources is a matter of vastly reater importance than even the question of supremacy the world-wide struggle of races and nations now going i. The wasteful use of natural resources, of which the resent generation is guilty, is destroying the chances of fe and prosperity for many millions of unborn peoples. Not only are present methods of burning coal exceedigly wasteful, as for example the coking of coal in ie beehive oven; but a large proportion of the coal in ie mines is rendered forever unavailable in the process of iining simply because, as the British committee puts it, under present individualistic conditions it does not pay bring all the coal to the surface. A larger profit on ie capital of a colliery company can often be earned v working the better class of coal and leaving the less aluable grades underground."

In 1905, a British Royal Commission on Coal Supplies eported that of the 167,000,000 tons of coal then used by reat Britain, between 10,000,000 and 60,000,000 tons ould be saved if economical methods of using the fuel ere adopted. While the United States possesses enorious reserves of fuel supply, it has already exhausted a certain extent the most conveniently worked deposits, that the cost of coal to the consumer has materially dvanced over that prevailing a quarter-century ago, and he advance is probably permanent. Therefore, notwithstanding the enormous reserves of fuel which the United State possesses, conservation of the coal supply—means to mine and burn coal with maximum economy—is justified commercially at the present day.

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Lessons from Ohio Cities

Some Ohio cities are puzzled to know how they are to pay their running expenses. A few years ago the state limited the tax rates to 1% on the assessed valuation. Another state requirement makes it the duty of every municipality to make annual provisions for the retirement of its bonded indebtedness when it matures.

This last named law appears to have been unenforced until recently. On Aug. 4 of this year the Supreme Court of Ohio handed down a decision requiring the Cleveland Budget Commission to appropriate a sufficient amount to meet the annual sinking fund charges in accordance with the law. This decision, it is stated, will require the city to devote $1,500,000 of this year's tax levy to sinking fund payments. At the same time it brings home to other cities the necessity of meeting their sinking-fund obligations.

There can be little question as to the wisdom of this law and of its strict enforcement; but, coupled with the law limiting the amount of money which can be raised by taxation, Ohio cities find themselves in a quandary where to find the money for current expenses. It is reported that Toledo's Mayor and principal officials had to go without their salaries in August while other city employees entitled to over $1,800 a year got only half pay.

It seems unlikely that such a state of affairs could have arisen if these cities had been in the habit of living up to their sinking-fund obligations and had followed well recognized budget procedure. Much hardship may have been worked by the 1% tax limit but its existence was no secret, any more than the sinking-fund requirement. Both should have been taken into account when the appropriations for the current year were made.

If most of these Ohio cities are not lax and wasteful in the conduct of their affairs, it would be surprising. The chances are that the larger part of their work and supplies cost more than they would under efficient management, that municipally-owned utilities that ought to be self-sustaining are being run at a loss, and that the deficiency, often unknowingly, is being made up in the general tax rate.

The conditions reported and conjectured are not peculiar to Ohio—more's the pity—except that so low a tax limit is probably unusual, and that Ohio is more progressive than most states in its supervision of municipal affairs. It has had a state audit of municipal accounts for a number of years and is therefore in better position to bring its cities and villages to book than are most other states. The probabilities therefore are that Ohio cities seem to be in an uncommonly bad plight largely because of investigation and publicity that is lacking in many other quarters. The whole subject is one that should make a strong appeal to engineers, whether in city or private practice. Public improvements cannot be provided and maintained and the wants of city dwellers supplied if municipal affairs are not conducted on a sound financial basis and at least some approach toward a dollar's worth of work secured for every dollar spent.

Letters to the Editor

The Quebec Rocker Stresses

Sir—There could not have been news more unexpected in the engineering world than the news of the failure during erection of the suspended span of the Quebec Bridge. Engineers the country over were assuming that the construction and erection of this, the largest of all bridges, would be executed in such a way as to make a failure of this kind practically impossible.

Your issue of Sept. 21, 1916, gives such a complete record and arrangement of evidence as to leave no possible doubt of the immediate cause of the accident. Now that the event is a thing of the past, some evidence may be added to the total of our experimental knowledge on the behavior of steel castings in flexure and shear. [Stress calculations here given by the author are superseded by the slightly more accurate figures given by the article in *Engineering News* of Oct. 5, 1916, which appeared after this letter was written. He points out the high shearing and bending stresses.—Editor.]. The weakening effect of the pin slots in these arms is tremendous because of their location, which happens to be on the tension side and at the outer edge.

If the reaction of 1,185 tons is the static load reaction then there should be a considerable increment added for the effects of lifting the truss. This 1,185 ton reaction is truly a moving load so far as the rocker arms are concerned, and should by all the rules of practice be increased by 50% in proportioning the rockers. As these rockers were of what is known as low-carbon steel castings, the flexural strength at the yield point probably would not have reached 30,000 lb. per sq.in. In view of the fact that the rockers had been repeatedly stressed beyond the yield point, previous to the day of failure, it seems remarkable that not one of them showed signs of failure or distortion before. G. L. BILDERBECK,

Rivers, Harbors and Bridges Commission.
New London, Conn., Oct. 2, 1916.

*

High Stresses at Center of Quebec Rocker Casting

Sir—The calculations of the rocker castings under the suspended span of Quebec Bridge, given on page 651 of *Engineering News* for Oct. 5, 1916, make no reference to the stresses existing in what was apparently the weakest section of this casting—namely, the transverse section immediately under the center line of the upper pin. Have you any information as to what unit stress was computed by the designers or the Board of Engineers in this particular section? FRANCIS P. WITMER.

85 Clinton St., Brooklyn, N. Y., Oct. 9, 1916.

[Apparently the midsection stress was not computed by either the St. Lawrence Bridge Co. or the Board of Engineers.—Editor.]

Sir—In *Engineering News* of Oct. 5, 1916, the cause of the disaster to the Quebec Bridge has been traced to the breaking of the steel rocker at the southwest end of bridge. The stresses computed by the St. Lawr Bridge Co., the Board of Engineers, and *Enginee News*, were determined for a section at the root of cantilever. The maximum bending moment on the ing is at the center line of the upper pin, and the stre at this point should not be overlooked.

Assuming the distribution of the pressure on the lo pin to vary as a parabola, which is between the triang and uniform-load assumptions, the computations for bending moment at the center are as follows:

Calling p the pressure per lineal inch of pin on middle $9\frac{1}{2}$ in. of length of the lower pin, the total sure on the $9\frac{1}{2}$ in. length is $9\frac{1}{2}p$, and the pressur the two bracket arms is $2 \times \frac{2}{3} \times 16\frac{1}{4} \times p = 21$ then the total pin reaction is $31.16p = 2{,}370{,}000$ lb. gives $p = 76{,}000$ lb. The bending moment at the ce then is $\frac{2}{3} \times 16\frac{1}{4} \times 76{,}000 \times 10.85 + 4\frac{3}{4} \times 76{,}00$ $2\frac{3}{8} - 1{,}185{,}000 \times 2 = 7{,}438{,}000$ lb.-in. This ass that the upper pin distributes its load equally ove 8-in. diameter.

As the diameter of the pin hole is slightly larger that of the pin [0.02 in.], and the edges at the top o casting are only $\frac{3}{4}$ in. thick, it is questionable if good engineering practice to consider the pin as t ferring the compressive stresses between the two canti ends. If no stress is thus transferred by side pre across the pin, the whole moment at the center mu resisted by bending on the net section of the rocker. section modulus is 152, and the stress in the extreme at the bottom is $7{,}438{,}000 \div 152 = 48{,}800$ lb. sq.in. The stress in the extreme tension fiber at the of the cantilever is $822{,}000 \times 6.1 \div 182.5 = 27{,}4$ per sq.in.

Assuming a uniform distribution of the load o lower pin instead of the parabolic, the tension i extreme fiber at the center of the casting is 10,100,0 152 = 66,500 lb. per sq.in.

6119 Ross St., S. A. KEA
Germantown, Philadelphia, Penn., Oct. 11, 191

[Taking account of the maximum tension at of rocker length, in comparing with the computatio the designers, reveals even more remarkable condi than were indicated in *Engineering News* of Oct. 5,

The section modulus at center is 152.7 in.^{3}, while at root of bracket is 187.5 in.^{3}, so that the central se is about 20% weaker, in spite of having the grea width of $26\frac{1}{2}$ in. These section moduli are for the or tension edge; those for the compression edge are higher—247.4 at the central section and 228.6 at r bracket, so that the maximum compressions are i cases 25% to 40% lower than the tensions. Of c even apart from this the tensions would be the dang stresses.

Besides being weaker, the central section has a l bending moment to resist. Depending on the precis tribution of the pin reaction, the excess of the ment over that at root of bracket ranges from 30% to 0%. The following figures, computed for the load of 370,000 lb., are illustrative:

Uniform Distribution of Pin Reaction—Moment at t of bracket 7,450,000 in.-lb.; moment at center 10,00,000. Stresses at root of bracket, 32,600 compression l 39,700 tension. Stresses at center, 40,700 compresn and 66,000 tension. Here the tension is 66% greater the center than at root of bracket.

Triangular Distribution on End Portions—Moment at t of bracket 4,050,000 in.-lb.; moment at center 6,275,0. Stresses at root of bracket, 17,700 compression and ,600 tension. Stresses at center, 25,400 compression l 41,100 tension. The tension is 92% greater at the ter.

Bridge Company's Distribution—With uniform reacn on length of 25.1 in., extending 7.8 in. out from root bracket, the moment at root of bracket is 2,872,000 -lb.; moment at center 5,066,000. Stresses at root of cket, 12,500 compression and 15,300 tension. Stresses center, 20,500 compression and 33,200 tension. The sion is 119% greater at the center. The same ratio ds for the design load of 3,000,000 lb., though the esses then are about 27% higher.

ompany's Method Applied to Center—To give 20,000 per sq.in. tension at center, moment at center must 3,054,000 in.-lb. Actual load (2,370,000 lb.) must be tributed uniformly on length of 18.30 in., or a protion of 4.4 in. beyond root of bracket. The tension root of bracket then is only 6,600 lb. per sq.in., making excess at center 200%. Design load (3,000,000 lb.) st be distributed uniformly on length of 16.11 in., s projecting only 3.32 in. beyond root of bracket. The sion at root of bracket then is only 1,260 lb. per sq.in. king the center tension 4.7 times the tension at root of cket, an excess of 370%.

While thus the figures for the midsection are of deterning importance, the peculiar shape of the rocker kes it likely that an irregular section is the weakest; example, a break passing through the transverse ter line at one end and thence somewhat obliquely to opposite root of bracket might be a probable occurce. Also, the wedging pressure of the upper pin might of influence in directing the path of fracture. The ting is in fact subjected to such a complex set of esses—both direct and secondary—that analysis can y lay emphasis on the need for ultraconservative design such a case.—Editor].

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Philadelphia Water Rates

Sir—I inclose copy of a proposed ordinance regulating ter charges in Philadelphia; also a copy of a letter ich I presented at a hearing on the subject. In this ter I took the position that the City Councils are forlden, by the city charter, to meddle in the conduct of water-supply by the Department of Public Works.

The meeting amply justified this provision of the city rter. A score or so of men sat, for an afternoon, rkening counsel by words without knowledge and hear pleas from self-seeking manufacturers, who, getting ir water far cheaper than in most other cities, are vertheless panic-stricken when the city proposes to add raction to what must be a very small portion of their tlay.

And the Water Bureau Chief, who could adjust all these matters far better and who seems to be the designated official for the purpose, had to dance attendance upon the committeemen and hear the wearisome discussion.

Rather than bother with such masses of complication as that exhibited on the blanket-sheet, would it not be better to make our water-supply "as free as air" to the consumer, throwing the entire burden upon the same people as taxpayers, but of course with a meter upon every connection and a prohibitory fine for waste?

JOHN C. TRAUTWINE, JR.

257 South 4th St., Philadelphia, Sept. 30, 1916.

[The Philadelphia lawyers will have to decide whether establishing water rates is an executive function with which the city charter forbids the Councils to meddle. The significant thing seems to be that at last there is a fair prospect that meters will be used to curtail the notorious water waste of Philadelphia.—Editor.]

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Asphalt-Pavement Patents

Sir—In your issue of Sept. 7, 1916, p. 434, the last sentence under asphalt-paving history is a question as to whether any pavement of the type mentioned has been patented in the United States. I think the patents granted to Edward M. Chadbourne, of San Francisco, Calif., are on a pavement of this type. His patents are the following: 956,940; 965,562; 982,217; 994,092, 1,103,127.

LEONARD L. HOHL.

Sausalito, Calif., Sept. 16, 1916.

⁂

Chicago's Heavy Street Traffic

Sir—An item on p. 597 of *Engineering News* of Sept. 28, gives traffic figures on Fifth Ave. at 42d St., New York City, which is claimed to have the heaviest traffic in the world.

Pardon us for presuming that Chicago can beat these figures, but the following figures were taken from the *Chicago Tribune* and are an efficient counting by the Police Department: State St., between Madison and Washington St., Chicago, on July 19, 1915, had 11,671 vehicles passing between 8 a.m. and 6 p.m., or 1,167 per hr.; on Rush St. bridge, Chicago, on July 13, 1915, there were counted 13,600 vehicles between 9 a.m. and 6 p.m., or 1,511 per hr.

If the traffic on Rush St. bridge had been taken from 8 a.m. to 7 p.m., a much greater figure per hour would have resulted, in my estimation, for from 8 o'clock to 9 o'clock in the morning and from 6 o'clock to 7 o'clock at night are very congested periods.

L. S. BRODD.

111 West Washington St., Chicago, Oct. 10, 1916.

NOTES AND QUERIES

Public Improvements Are Proposed in Honolulu, and the municipal government of that city has requested the chamber of commerce and other civic organizations to discuss a proposed loan plan, whereby the government would bond the city for $1,000,000 for certain public improvements, including sewer and water systems, new roads and a city hall. The waterworks department has recommended out of the funds thus obtained the following items: The sum of $150,000 for a filtration plant for the Uuanu Valley reservoirs, $150,000 for a sewerage system for the Waikiki district and $80,000 for water meters. The mayor has proposed $100,000 for the purchase of a lot and construction of a city hall and $100,000 for roads.

Electric Railway Men in Annual Convention

Men interested in all phases of the electric-railway industry—operating officials, engineers, accountants, claim agents, traffic men and supply manufacturers—gathered at Atlantic City, N. J., for the thirty-fifth annual convention of the American Electric Railway Association and its subsidiary organizations. This was the first convention which has been held since the manufacturers were taken into the organization on the same basis as railway companies. This was the first time that the exhibit of electric-railway appliances and the entertainments have been under the direct control of the main association instead of the independent manufacturers' association.

More than ever before, the convention reports pictured the detailed progress of committees in charge of the coöperative efforts of the electric railways thus joined—in matters of administration, publicity, public relations, technical education, standard practice, valuation, compensation for carrying mail, electrolysis, etc., but in comparatively few cases were important developments reported at their climax.

Valuation Nomenclature

One of the most important reports was that of the Valuation Committee (J. N. Shannahan, Newport News & Hampton Ry., chairman) giving a bibliography complete to Jan. 1, 1916, and a list of 21 terms (defined by C. G. Young, Consulting Engineer, New York City) which covered all that were thought necessary in valuation work. In another appendix was a paper by P. J. Kealy (Kansas City Railways Co.) defining the various "overhead charges" which properly could be loaded upon bare construction expenses to obtain truly complete cost figures. Typical allowances for engineering and superintendence, organization and legal advice, interest during construction, contingencies, etc., were cited. It was advocated that overhead items definitely apportioned on depreciating property be amortized but that other overhead charges enter permanent capitalization.

Publicity Doctrines

The subject which aroused the most interest was that of "Publicity," informally but interestingly presented by Ivy L. Lee of New York City, formerly Assistant to the President of the Pennsylvania R.R. His argument was that publicity was the key to successful public dealings but that it must be full and frank and in no way dissembling. A utility entering on a policy of publicity must be prepared to furnish the best service possible under the situation.

The discussion consisted of questions largely; the session was a little startled by the statement of T. N. McCarter, President of the Public Service Corporation, Newark, N. J., that he sometimes felt that the public did not care whether it was fair or not—that possibly the fairness of the people could not be relied on.

This same topic was taken up by A. B. Leach (A. B. Leach & Co., bankers, of New York City) in a later address on "The Financial Development of Electric Railways." But Mr. Leach reiterated his firm faith in the fairness of the people and attributed any existing hostility toward utilities to lack of knowledge.

The committee on Public Relations (Chairman, Allen, Syracuse, N. Y.) reported that the ambitious licity program proposed by earlier committees—tributing literature, furnishing lecturers, newspaper vertising etc.—had not been carried out through fa to secure the necessary funds. On account of the gr of local company periodicals and other publicity the committee recommended that the best and most nomical effort which the association could make wou to establish a bureau for supplying local companies authentic data, important commission decisions, no addresses, etc., for assisting in supplying speaker local meetings, and articles for newspapers periodicals.

Social Insurance

A subcommittee of the Public Relations Comm (J. D. Mortimer, Milwaukee, Chairman) presented view of the development of protection and betterme surance schemes to be found in various countries. not discuss the desirability of such insurance but sl what had been done—by governments, employees' izations, employers, coöperative associations, and u writers—what could be provided for certain sums, errors were prominent, etc.

Future of Electric Roads

F. J. Sprague (Consulting Engineer, New York in an address on "The Physical Development of El Railways," held up the use of electric traction on lines as the one bright spot in the future of railroading—through financial advantage there.

The Committee on Taxation Matters (Chairman, Lyons, Boston Elevated Railway Co.) reported gen continued increases in the burdens placed on electri ways by states and municipalities—direct taxation, cars, more paving, more support of regulating co sion, more detailed reports, shorter hours of lab creasing cost of workmen's compensation acts, etc.

Engineering Association

The Committee on Power Generation recommend adoption of the American Society of Mechanical neers Boiler Code as standard, and the conventi cepted it.

The Committee on Buildings and Structures (man, C. F. Bedwell, Public Service Ry., Newark, presented several designs of steel, concrete and fences for rights-of-way, of modern oil houses, of im expansion joints for reinforced concrete, a new f contract and general specifications.

The Committee on Heavy Electric Traction (man, E. R. Hill, Consulting Engineer, Pennsylvani New York City) offered tables of the characteris electric locomotives in use on important steam an tric railways of the world.

The Committee on Equipment (Chairman, W. G Brooklyn Rapid Transit System) reported revised ards for wheel contours, steel-wheel designs, brak axles and journal parts. Progress in matters of c tilation and lighting and painting was reviewed w recommendations.

The Committee on Power Distribution (Chairm L. Cadle, New York State Rys., Rochester, N. fered revised standards for overhead construction ad information on third-rail construction, etc. Its mt notable contribution, however, was a monograph on theory and design of reinforced-concrete poles—based its own studies and experiments. This section of the ort discussed such topics as the theory of beam flexure lied to reinforced-concrete poles, derivation of flexure mulas, effective distance of reinforcing, allowable pole ling, pole dimensions at any section, and computations strength.

NEW OFFICERS

he following important officers elected are noted from complete slates:

merican Association—President, L. S. Storrs, president he Connecticut Co., of New Haven; vice-presidents, T. S. iams, president of the Brooklyn Rapid Transit System, York City; J. J. Stanley, president of the Cleveland Rail- Co.; J. H. Pardee, president of the Eastern Pennsylvania ways Co., Pottsville, Penn., and Richard McCulloch, presi- of the United Rys., of St. Louis.

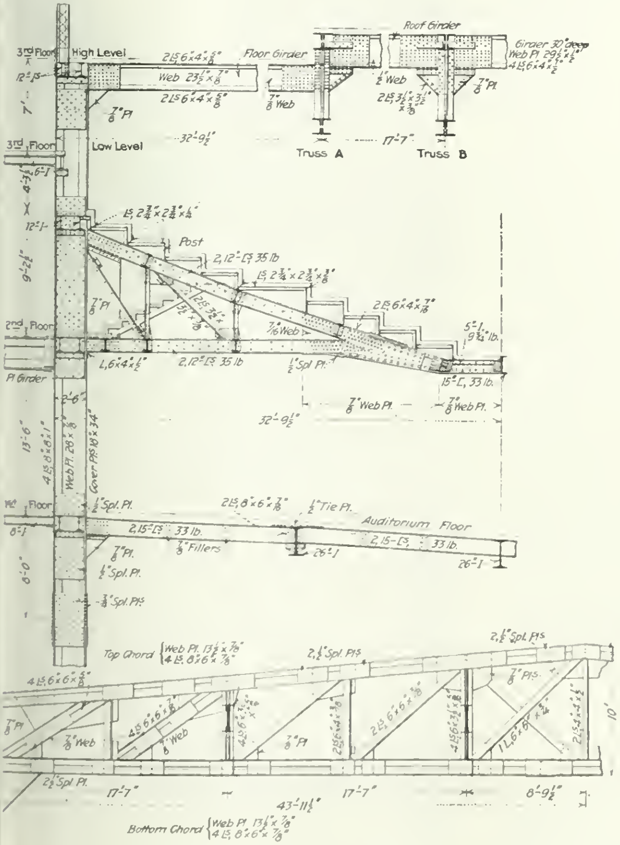
ngineering Association—President, F. R. Phillips, Pitts- h Rys.; vice-presidents, G. W. Palmer, Jr., Bay State et Ry., Boston; W. G. Gove, Brooklyn Rapid Transit em; E. R. Hill, Pennsylvania R.R., New York City.

ransportation and Traffic Association—President, L. C. lley, Stone & Webster, Houston, Tex.; vice-presidents, H. Collins, Fonda, Johnstown and Gloversville R.R., Glov- ille, N. Y.; R. P. Stevens, Mahoning & Shenango Valley Ry., ngstown, Ohio; L. H. Palmer, Eastern Pennsylvania Rys., sville, Penn.

Taking Care of Eccentric Load from Balcony Brackets

In designing the new Huntington High School, the architect, Verus T. Ritter, of Huntington, W. Va., planned for an auditorium with a large balcony, the overhang being about 32 ft. Conditions were such as to make it desirable to carry this balcony without either column supports below or hanger supports above. The brackets were therefore detailed as pure cantilevers from the columns, which put an enormous bending and overturning moment on the columns.

The construction is sketched in the drawing herewith. C. O. Gilbert, of Pittsburgh, Penn., who was structural engineer for the architect on this work, provided columns 30 in. deep which he designed to be capable of transferring the bending from first floor line to roof line, a height of about 33 ft.; this was equivalent to neglecting the uncertain amount of lateral support given by the intermediate floors in that part of the building back of the auditorium. The overturning moment was absorbed at the floor line by the auditorium floor steel, acting in tension, and at the roof line (or high third-floor level) by the compressive resistance of the roof slab and also by bending in the roof girders.



Roof Truss "A"
("B" somewhat lighter Sections)

The roof girders, on account of their unusual functions in this structural system, were detailed with joints capable of taking bending, as indicated in the drawing. The stress was carried through the posts of the trusses on which they are supported by means of large gusset plates, and additional strength at the joints was obtained by placing brackets against the truss posts, under the girders. The auditorium ceiling contains two trusses of the kind shown, spaced about 35 ft. Transverse to them are four lines of girders or purlins, spaced 17½ ft., the room thus being about 88x100 ft. The wall opposite that in which the balcony columns are set contains no steel. The roof girders merely rest upon this wall. The thrusts from the balcony bracket columns do not continue to the end of the girders, however, but are transmitted from the girders into the roof slab and thence go into the side walls, whose strength longitudinally is ample to carry this thrust as a shear between roof line and first-floor line. This structure was built during the past year. The steel contractor was the Riverside Bridge Co.

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The Value of the Street Railways of Minneapolis has been estimated at $25,914,308 by F. W. Cappelen, city engineer, in a report to the city council. The valuation was made for use in connection with the drafting of a franchise to take the place of one that expires in 1923. The main items in the estimate are $21,152,221 for cost to reproduce new, $4,270,230 for development to a going-concern basis; and $491,308 for water-power leases to July 1, 1923. The valuation cost $14,900.

Building Second Half of the Susquehanna Bridge

SYNOPSIS—The Cumberland Valley R.R. crossing at Harrisburg is being transformed from a single-track steel truss bridge into a double-track reinforced-concrete arch bridge. The south half was built last season without interrupting traffic, and the steel trusses were taken down. The north half is now under construction. Two months' work was lost when a flood in June, 1916, washed out the service trestle, which is a vital factor in the erection.

The second half of the Susquehanna bridge of the Cumberland Valley R.R. at Harrisburg, Penn., is being erected by practically the same method as that employed on the first half last year—that is, from a working trestle. The pneumatic-concreting plant has been abandoned, however, and all concreting is being done by buckets hauled on flat-cars and handled by locomotive cranes. The contractor has about 100 men at work at the present time and expects to finish by December.

Prior to 1915 the Cumberland Valley crossed the Susquehanna at Harrisburg on a single-track deck-truss bridge of 22 spans of 170 to 185 ft. The bridge is being transformed into a double-track concrete-arch structure of 45 spans averaging 76 ft. In carrying out this very large program the old piers were used, being jacketed with concrete as well as extended in length to carry a wider bridge, and between each pair a new concrete pier was built. The railway put in all the footings in three months in the fall of 1914. The first half of the bridge was completed in 1915, as fully described in *Engineering News* of Mar. 23, 1916, p. 537.

At the close of the 1915 season the contractor stored his plant on an island crossed by the bridge. Here also were located the mixing plant and construction office. This island was an important factor in the work.

In building the first or south half a working trestle was built alongside the bridge extending from the island to the Lemoyne bank. The river bed is limestone, making it impossible to drive piles for the trestle, which therefore was erected on sills laid on the rock bottom. The deck carried two tracks for the dinkeys and bucket cars, the two inner rails being of standard gage to suit the locomotive crane that set and shifted the forms and poured the concrete.

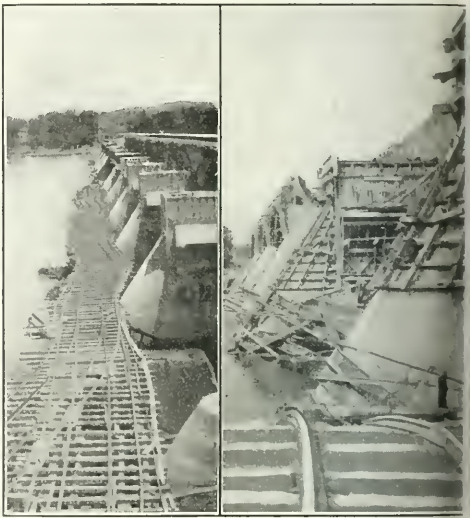
JUNE, 1916, FLOOD COST TWO MONTHS' WORK

Work on the north half started in April, 1916. First, a trestle was built along the north side similar to the one that had been on the south side. The stringers for the trestle were 70-ft. I-beams, used without any punching or riveting, so as to have maximum scrap value afterward.

As soon as the trestle was in place from the island to the east bank, concreting started on the "umbrellas," the piers having already been carried up to springline. One arch had been concreted when a flood came down, damaging the trestle and causing considerable anxiety. The trestle was immediately lashed to the bridge, a it was hoped that it would hold. This flood was o a feeler, however. On June 16 a real flood appear which speedily wiped out most of the trestle and seriou weakened the remainder. The steel stringers were be around the piers by the swift current, necessitating t extensive beam-straightening work described in *Engine* *ing News* of Aug. 31, p. 386.

All work had to be discontinued until the water we down: then the 2,000-ft. trestle was reconstructed, t straightened I-beams being made to serve again.

The plan of attack on the second half was to be simi to that originally devised for the south half, except th



FIGS. 1 AND 2. EAST CHANNEL TRESTLE FOR T SUSQUEHANNA BRIDGE AFTER THE JUNE FLOOD

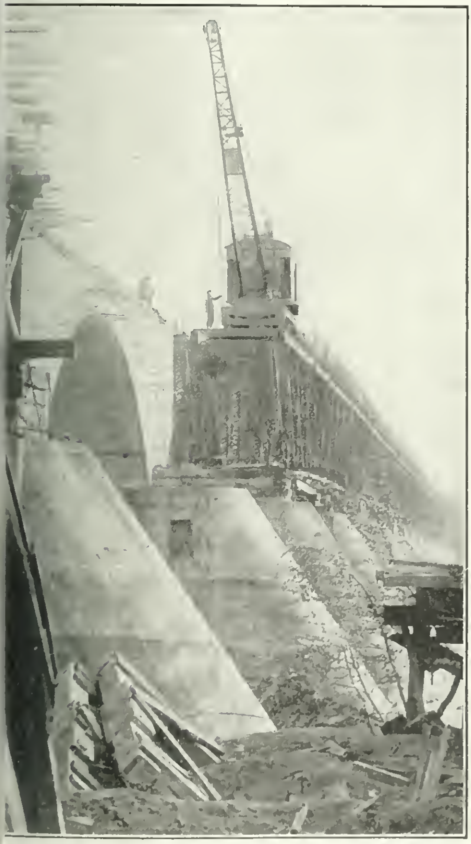
Fig. 1—Shows racked trestle remaining after flood washed out the greater part. Fig. 2—Steel stringers wrap around the middle pier in view

work was to start at the Harrisburg end and proc toward the island. As the concreting progressed, service trestle was to have been torn down and erec from the island toward the Lemoyne end, so that by time the east-channel spans of the bridge were finis the west-channel spans would be well under way.

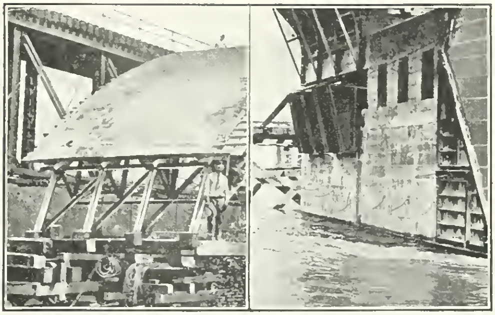
The effect of the flood prevented the execution of logical plan. Instead of working from the east ba concreting is going on wherever possible. On Aug. nine arches had been poured east of the island. the west-channel spans no work had been done ab springline. On Sept. 16, twenty-three arches had b poured, completing the east-channel spans.

Last season, when work ended on the south half, steel arch forms were left in place under the arches concreted. Now when it is decided to pour a certain a on the north half, the center already in place under south half of the same span is pulled by a crane to w position. Some of the spans are 77 ft., and some are ½ ft. The same centers can be used for either by e simple expedient of blocking the lagging. There are even sets of Blaw steel centers, six spandrel-wall forms, ur umbrella forms and four coping forms. The lagging the centers is made up of two thicknesses of 8x2-in. nks. This lagging will be sold when the contract is mpleted. As there are so many more arches than h forms, it is usually necessary to pull a center from completed arch to the site of another arch. First, center is jacked up so as to remove the blocking under when it is let down on rollers made of 3-in. pipe ed with grout to prevent crushing of the rollers. A ck-and-fall is attached to each of the front corners the form, the two lines running to snatchblocks and ing secured to the trestle deck, then to the front of ocomotive crane, to which the block-and-fall is fastened. e crane is propelled forward or backward, and the nter is drawn onto trucks of dump-cars and transported its next position.

The first arch of the east end has a span of 69 ft., d for concreting this a tin-covered wood center has n erected on the job. This same center will be used concrete the two arches on the extreme west end.



IG. 3. SOUTH HALF OF THE SUSQUEHANNA BRIDGE, SHOWING STEEL WORK STILL IN PLACE



FIGS. 4 AND 5. MOVING A STEEL ARCH CENTER TO NEW POSITION. STEEL BRACKET SUPPORTS FOR CENTER

Fig. 4—The center is conveyed on trucks of Western dump cars. When the trucks were not in requisition they were usually stored in the river, from which they were fished by crane when needed. Fig. 5—The brackets and center are on a south span. New brackets will be installed on the north and the form will be pulled over on them by crane running on the north trestle

These two arches are also of 69-ft. span and are located on the farther side of a railway crossing. A separate concreting plant on the west bank will furnish concrete for these two spans.

One mixing plant is used, and only one method of handling is employed—by bucket and crane. The plant is located on the island and is supplied with material by means of a high trestle, which extends from the bridge over the bins. There are two sand bins, two stone bins and two Hains mixers of ½-yd. capacity each. It has been found, however, that with the method adopted to move the concrete, only one mixer is required. The concrete for the arches is 1:2:4; that for the piers is 1:2½:5. The mixer discharges directly into 1-yd. Insley buckets (two on a car hauled by a gasoline locomotive). When both buckets have been filled, the dinkey moves forward off the siding and onto the trestle, proceeding to the point of concreting.

The concreting routine above springline is as follows: First, the umbrellas are poured, then the arch, then the arch spandrel wall, the pier spandrel wall, the arch coping and the pier coping. Concreting is carried on at only one point at a time.

Progress—the Outlook for Completion This Year

There are 45 umbrellas, arches and spandrel walls to be placed, and only 9 of these units had been finished on Aug. 17, at which time there remained but three months open to the contractor this season. On Aug. 17 there was 16,000 cu.yd. to be placed, and concreting was going forward at the rate of 5,000 cu.yd. per month. In the week commencing Aug. 7 there was placed 1,150 yd., while the total for August was 5,500 cu.yd. The rate of placing during the actual process of concreting is 1 yd., or 2½ batches, every 2 min.

Last season, with day and night shifts, 8,000 yd. of concrete was placed per month in September and October. Since Aug. 1 a night shift has been employed to erect forms.

By the middle of September several hundred feet of the new trestle (toward the west bank) had been erected. Although it was October before the east end of the present trestle could be dismantled and the 70-ft. I-beams released, there were enough spare beams to go ahead with the new trestle. In September the railway forces began filling the east-channel arches with rough stone, preparatory to laying tracks.

The Robert Grace Contracting Co., Pittsburgh, is represented on the job by F. P. Kemon; for the Cumberland Valley R.R., Crosby Tappan, Engineer of Construction, is in charge under the general direction of Thomas B. Kennedy, Engineer.

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American Society of Municipal Improvements Convention

The twenty-third annual convention of the American Society of Municipal Improvements, held at Newark, N. J., Oct. 10 to 13, will mark either the first step in its regeneration or prove a blow to its prestige which will be hard to recover from—all according to the use made of the experience by the new committee, under George W. Tillson, consulting engineer, of Brooklyn, N. Y., which will be appointed to revise the constitution and by-laws of the society. The passing of the motion made by Prof. Arthur H. Blanchard, of New York City, for the appointment of this committee may perhaps prove the most important business transacted by the convention.

The work of the convention was handicapped by an overloaded program, so that many papers were postponed from day to day, or omitted altogether. The three most important subjects considered were paving, sewage disposal, and garbage and refuse disposal. The proper presentation and adequate discussion of any one of these subjects would have taken all the time of the convention.

PAVEMENTS AND ROAD BUILDING

One of the most important subjects taken up was the necessity for limiting the loads, speed and size of vehicles. A paper with this title was read by E. W. Stern, chief engineer of the Bureau of Highways of the Borough of Manhattan, New York City. The damage done to West 42nd St., New York City, by 19-ton motor trucks, described in *Engineering News* of last week, formed the principal theme of this paper. The discussion brought out much information in regard to ordinances to prevent such damage, but it seemed that these laws are very difficult of enforcement. It was voted to have the matter referred to the Traffic Committee of the society for drafting a proposed law.

Other papers read were: "Business System Applied to Street and Road Management," by Will P. Blair, secretary of the National Paving Brick Manufacturers' Association, Cleveland, Ohio; "Resurfacing Old Brick Pavements with Sheet Asphalt at Columbus, Ohio," by T. H. Brannan, superintendent of asphalt; "The Proper Oil for Treating Creosoted Wood Blocks for Paving," by P. C. Reilly, Indianapolis, Ind.; "Concrete-Paving Experiences," by K. C. Gaynor, Sioux City, Iowa; "The Maintenance of Pavements," by C. D. Pollock, consulting engineer, New York City. George C. Warren, president of Warren Brothers Co., Boston, Mass., described, with moving pictures, the famous Columbia Highway in Oregon and also read a paper on the passing of macadam roads. There were many other papers read by title only.

The chief features of interest to paving engineers were the reports of the subcommittees on various kinds of pavements. That on sheet-asphalt pavements, Francis P. Smith, New York, chairman, reported the specification
adopted last year with only minor changes. An attemp
was made on the floor of the convention to have thi
specification amended by adding thereto an entirely in
dependent specification in which a distinction was mad
between the so-called natural asphalt and residual asphal

The present standard specification of the society is
"blanket" specification under which, it is held, any goo
paving asphalt may come in, although it is provided tha
the contractor must name the brand he intends to us
The proposed additional specification would have require
separate bids on natural and residual asphalts. Th
attempt to have this adopted led to a long wrangle, whic
was ended only by a roll-call vote on whether or not
should be adopted against the advice of the subcommitt
and of the chairman of the general committee on standar
specifications. The proposed adoption was defeated by
vote of 33 yes to 59 no.

The subcommittee on wood-block pavement, E. I
Dutton, Minneapolis, Minn., chairman, reported a specit
cation for creosote oil, which has been or will soon l
accepted by five national engineering societies, includi
the American Society for Testing Materials. There w
the usual opposition from material manufacturers, b
the report was adopted. The specification is very near
the same as that adopted at the convention in Dayt
last year. A specification for water-gas tar as a preserv
tive is included, but is not yet recommended by t
subcommittee. Provision is also made for a bitumino
cushion or bedding course, and for float and coke tes
of the oil, which are new.

The subcommittee on bituminous paving, Linn Whit
Chicago, Ill., chairman, used its influence to have t
bitulithic specification adopted by the Dayton conventi
last year omitted from the standard specifications f
the ensuing year, but a motion to this effect was table
after a rather acrimonious discussion. In the main, t
specification for asphaltic concrete pavement was lit
changed, except to make the clauses covering the asphal
cement the same as those under sheet asphalt.

The subcommittee on brick pavements has eliminat
the rattler test and has adopted a specification for
sand-cement bedding or cushion course, which is reco
mended "where proper sand cannot be obtained."
specification has yet been adopted for the so-call
monolithic type of construction. The reports of the ot
subcommittees on paving contained little new or differe
from the specifications now in force.

STREET CLEANING AND REFUSE DISPOSAL

Under the subject of garbage and refuse disposal
paper read by Gustave R. Tuska, consulting engine
New York City, on the reduction plant now buildi
on Staten Island for the treatment of all New Yo
City garbage, was of interest. Whether this plant w
be completed and operated or not is a matter now bef
the state authorities; if built it will cost $3,000,000 a
will be the largest and most up to date in the world.

Garbage collection and incineration in the small Phi
delphia suburb of Sewickley, Penn., were described
Edward E. Duff, borough engineer. The principal feat
of interest was the method of collection by transportati
in the householders' cans, a duplicate can being left wh
the filled can was taken away. Other papers were re
by title only.

"Street Cleaning in Savannah, Ga.," was the subject a paper by E. R. Conant, chief engineer of the city. e stated that most published material on street clean- g was of little value because the local conditions were ldom given in sufficient detail. He has employed what calls an efficiency timekeeper—a young technical aduate—who gathers and tabulates itemized cost data. lushing: Its Place in the Street-Cleaning Field" was e subject of a compendium by R. W. Parlin, of the ureau of Municipal Research, New York City. A paper "Some Public Health Aspects of Refuse Collection," Charles Saville, Director of Public Health, of Dallas, x., was read.

WHAT HAPPENED TO ACTIVATED-SLUDGE SYMPOSIUM

The evils of an overloaded program and of permitting tertainment features to squeeze out real discussion were ikingly illustrated by the fate of the four papers on tivated sludge. This is a subject of prime interest and portance. At great labor and with the coöperation of ny engineers in various parts of the country, George Hammond, Brooklyn, N. Y., had collected descrip- ns of 11 activated-sludge plants, experimental and per- nent, prefaced the description with a valuable historical iew and ended his paper of 55 printed pages with ligest of conclusions. In addition, T. Chalkley Hatton l prepared a paper of 12 printed pages on his work at lwaukee; Harrison T. Eddy, Boston, Mass., had itten a paper describing experiments on sheepskin nery wastes, and Gustav J. Requardt, Baltimore, l., had summarized experiments made there with the ivated-sludge process in one of the large Imhoff tanks. e four important papers named were scheduled with others on sewage treatment for 2 p.m., Wednesday. e scheme was to read all the papers, then have a neral discussion. The large attendance at this session wed the great interest in this group of papers.

What happened? First, of all, the session opened late— usual at this and other conventions. Then two papers subjects foreign to this session were presented. They used interest and suggested discussion, but the chair- n announced that discussion must be postponed to the rning session. At 3 p.m. the four activated-sludge ers came on, supplying material enough for two full sions. The chairman announced that the session must e at 4.30, so the meeting place could be transformed a banquet hall, and that the discussion on these ers also would have to be continued at the morning ion. This morning session, with four papers of its and postponed discussion on six papers, it should noted, was scheduled for 9 a.m., but at 10.30 the nbers and guests of the association were due at a way station some blocks away to take an excursion n. The net result for the activated-sludge symposium a hasty presentation of the four papers. This in lf did not so much matter, as all were printed in ance, but the authors and their auditors all felt the te of the occasion. Discussion directly after the sentation of the papers was impossible. In fact, even ir hurried presentation was interfered with by a start begin moving banquet tables into the room. The ry of the Thursday morning session gave no oppor- nity for satisfactory discussion. The net result was loss of a splendid opportunity for a live, informing ussion of one of the most important subjects before nicipal engineers today.

The whole incident was all the more disheartening because George T. Carpenter, Pawtucket, R. I., chairman of the Committee on Sewerage and Sanitation, had not only secured a valuable collection of papers on sewage treatment, but also, realizing that the papers could not be adequately discussed without advance printing, had succeeded in getting all but one of the papers in time to print in advance.

OTHER MUNICIPAL SUBJECTS

A paper on "The Engineer and the Public: A Discussion of the Work of Bureaus of Municipal Research and State Leagues of Municipalities," by Edward T. Paxton, secretary of the Bureau of Municipal Research and Reference, University of Texas, led to a discussion of bureaus of municipal research in general and some criticisms of their work. It was said that their young employees were very free in destructive criticism of city public-works departments and that in most cases the fault lies with the city charter and laws under which the departments labored, rather than with inefficiency in the departments themselves.

"Water-Supply" was the subject of a committee report, J. W. Ackerman, chief engineer of the water-works of Auburn, N. Y., chairman, and a paper by Roger DeL. French, principal assistant engineer, R. S. and W. S. Lea, consulting engineers, Montreal, Que., discussed breaks in cast-iron pipe. The Newark water-supply was described by Morris R. Sherrerd, chief engineer of the Department of Public Works. "Recent Developments in Street-Lighting Theory and Practice," was the subject of a paper by P. S. Millar, general manager of Electrical Testing Laboratories, New York City. Many other papers were crowded out by the extraordinary length of the program.

FINANCIAL CONDITION—NEW OFFICERS

The financial condition of the society is in a healthy state. The membership has largely increased—about 35% since the last convention. The attendance at the convention was nearly 400, and altogether the society appears in a flourishing condition.

The officers elected for the year 1917 are: President, Norman S. Sprague, Pittsburgh, Penn.; treasurer, F. J. Cellarius, Dayton, Ohio; secretary, Charles C. Brown, Indianapolis, Ind.; and chairman of the Committee on Convention Arrangements, George A. Carpenter, city engineer, Pawtucket, R. I. The place chosen for the next convention is New Orleans, La.

The City of Newark did much to make the convention an enjoyable one. The city tendered the members and guests a banquet on one evening, and the greater part of one day was devoted to an excursion to the new port of Newark and to a steamer trip around Manhattan. Another half-day was devoted to an automobile trip through the Essex County parks.

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Injuries from Inhaling Exhaust Gases from gasoline locomotives used in mine drifts or tunnels are discussed in "Coal Age" of Sept. 30. A number of cases are cited where the poisonous effect from the exhaust gases discharged by gasoline locomotives in mines caused illness among the workmen and finally compelled the use of the machine to be discontinued. When a motor is working perfectly, securing complete combustion, the gas discharged is almost wholly CO_2 and has very little effect on health. A gasoline engine, however, due to improper adjustment or other causes, will often discharge unburned gasoline vapor in large quantities and its exhaust may contain at times carbonic oxide, the dangerous character of which is well known.

Virgil Gay Bogue

A wireless dispatch received in New York City, Oct. 15, recorded the death of Virgil G. Bogue, a civil engineer of international reputation, while en route from Mexico to New York on board the steamship "Esperanza." Mr. Bogue was in his 71st year, having been born at Norfolk, N. Y., July 20, 1846.

Mr. Bogue graduated from the Rensselaer Polytechnic Institute in 1868. His first professional work was as assistant engineer of Prospect Park, Brooklyn, N. Y. After a year there he resigned to become an assistant engineer of the Oroya Ry. in Peru, famous as reaching the highest altitude of any railway in the world. Later he was manager of the Trajille Ry. of Peru.

After two years in South America he returned to the United States to become assistant engineer of the Northern Pacific R.R. In locating this line across the Cascade Mountains in Washington he discovered and named Stampede Pass, through which the line is built. He remained with the Northern Pacific to supervise the construction of the road through Idaho and Washington until 1886, when he was appointed chief engineer of the Union Pacific R.R. After serving five years in this capacity Mr. Bogue resigned to take up private practice as a consulting engineer with offices in New York City. Since then he had been connected with many notable railway and transportation problems. He was a member of the commission appointed by President Harrison to investigate methods of improving the navigation of the Columbia River in Oregon. For three years he was consulting engineer to the Governor of New Zealand in connection with a proposed railway across South Island. Mr. Bogue was also prominently identified with New York City engineering problems. For a number of years he was consulting engineer of the Department of Public Works and was a member of the commission appointed by Mayor Strong to determine the feasibility of operating surface cars on Brooklyn Bridge. His other railway work after his retirement as chief engineer of the Union Pacific was important and country-wide. He made an examination and report on the cost of reproducing the lines of the Southern Pacific Ry. in Oregon; he prepared plans for water-front improvements at Seattle and Tacoma, Wash.; he made an examination and report on the cost of revisions and improvements of the Tehuantepec National Ry. of Mexico and of its port facilities. Another notable work was a report on the economics of the Denver, Western & Pacific Ry. He also made an investigation and report for the
Canadian Pacific Ry. on the economics of the existin
line from Calgary to Vancouver, B. C., as compared wit
a proposed revised line and other routes. He was con
sulted on many other intricate and comprehensive railwa
problems.

Virgil G. Bogue

With the beginning of one of the most recent transcon
tinental railways, the Western Pacific, Mr. Bogue agai
became an active railway officer. From 1905 to 1909 h
was Vice-President and Chief Engineer of this compan

He was elected a member of the American Society o
Civil Engineers in 1869. He served on the committ
on standard rail sections, 1891-1893, and was a direct
of the society at the time of his death. He was also
member of the Western Society of Engineers, of t
American Railway Engineering Association.

Mr. Bogue was married in 1872 to Miss Sybil Estel
Russell, of Canton, N. Y. He had three children.

*

Robert Swan

Robert Swan, Director of the Department of Publ
Works of Pittsburgh, Penn., died from heart disea
Oct. 14. Until the day before he had been regularly
his office and his sudden death came as a shock to
many friends and acquai
ances. He was born in t
City of Allegheny in 18
His education was received
the public schools of the
and at the Western Univers
of Pennsylvania (now the U
versity of Pittsburgh), wh
he was graduated in engine
ing in 1877. In 1880 M
Swan became city engineer
Allegheny. In 1896 he joi
the T. A. Gillespie Co., g
eral contractors of New Y
City and Pittsburgh, becom
Vice-President and Gen
Manager of the company.
his 17 years with this c
pany he was connected w
many of the most notable
gineering projects of the
including portions of the
skill Aqueduct, the enla
ment of the Erie Canal i
the New York State Ba
Canal and the Aspinwall
ter filtration plant of the
of Pittsburgh. In the fal
1913 Mr. Swan was appoi
by Mayor Armstrong of P
burgh to the office of Dire
of the Department of Pu
Works. An appreciation of his work here is best
pressed in the Mayor's own words:

> I place his engineering ability combined with his gif
> common sense second to none in this country. He was
> only great as a technical man, but he had the talent of b
> able to explain his plans and ideas in such a way as to m
> them understood by the humblest layman. In addition to
> gift he knew how to handle men, get the greatest amoun
> work out of them and at the same time retain their loy
> and respect. He was big at heart as well as of brain, an
> was actually loved by those who came in contact with him

He is survived by a widow, a daughter and six sons

News of the Engineering World

Iowa-Illinois Water-Works Men Hold Meeting

A joint meeting of the Iowa and Illinois sections of the American Water-Works Association was held Oct. 10 and 11 at Davenport, Iowa. About 50 members and guests were registered.

The majority of the papers dealt with the operating side of water-works service. Prof. J. H. Dunlap (University of Iowa), in a paper on sanitary drinking fountains, remarked that most of these are little better than the old-fashioned drinking cup. A paper on "Experience with Trenching Machines on the French and Russian War Fronts," was read by A. E. Miller, of Des Moines.

The second day of the meeting was devoted to a round of visits to the water-works and filter plants of the United States arsenal and the three cities of Davenport, Rock Island and Moline. The meeting closed with a dinner at Moline, at which an address was delivered by Leonard Metcalf, of Boston. His subject was the relation of public-service commissions and public-utility corporations.

The Iowa section held a business meeting, at which the following officers were elected: Chairman, C. R. Henderson, Superintendent of the Davenport Water Co.; Secretary, Jack J. Hinman, Jr., University of Iowa, Iowa City, Iowa. The Illinois section will elect officers at its February meeting.

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Two Turner Patents Defeated

Defeat of the Turner "mushroom" floor patents in a suit against the Lauter Piano Co. and the American Concrete Steel Co. was recorded by a decision of Judge Orr in the United States District Court at Trenton, N. J., on Oct. 11, 1916. The suit related to a building erected in Newark, N. J., and claimed infringement of both the Turner patents 1,003,384 (claims 1, 5, 10, 11, 16, 17) and 985,119 (claims 4 and 8). The decision declares all these claims invalid.

The narrow or specific patent, 985,119 was previously before the Circuit Court of Appeals of the Eighth Circuit, which declared claims 1, 4 and 6 invalid; Judge Orr adopts this decision. The broad patent, 1,003,384, was involved in Drum vs. Turner, also in the Eighth Circuit, and was there decided to infringe the Norcross patent, 698,542. Judge Orr adopts this view also and then declares that in consequence the Turner patent is anticipated and invalid. The substance of the decision follows:

Both patents relate to the reinforcement of concrete in the construction of buildings. The reinforcement of concrete is necesary, of course, to give the material the strength to resist the strains to which it may be put. It is not ordinarily reinforced to enable it to resist ordinary compression strains, because the vast remains of Roman civilization disclose an extensive use of concrete in construction where the effect of compression strains have been apparently negligible. Where, however, the horizontal section of the concrete mass is short and the vertical section is long and compression is vertical (as in a column), there must be reinforcement. Tensile strains and shearing strains, if they are differentiated, must be taken care of by reinforcing the concrete in the places where such strains are to be found. The character and location of such strains are determined empirically by many, but can be and more often are with reasonable accuracy determined by engineering methods. The ordinary material used in reinforcing concrete is iron or steel, because of its great tensile strength. It is used in the form of wire netting, in the form of bars and in other forms. Sometimes the reinforcing rods are unattached to each other and sometimes they are attached in order to preserve the framework of the reinforcing material until it may be embedded in the concrete. The rods are sometimes twisted, but often bent at proper angles, in proper places, in order that they may be better held in place by the compression of the concrete. We therefore have in this case patents, which upon their faces give monopolies in the use of ordinary materials for structural purposes, in the combination of such materials and in the engineering or mathematical problems relating to such construction. Where such conditions exist, the weight to be given to the patents as prima facie evidence of their validity is considerably weakened. If there could be a presumption that the Patent Office examiners had knowledge of what was going on throughout the country in the uses of ordinary materials for structural work, according to diversified, engineering opinion, the weight to be given to the patent should be as great as in the case of a machine or other form of mechanical apparatus.

It is unnecessary to refer to the specifications of the several patents at great length. It is significant that the patentee places emphasis upon the necessity of placing his reinforcement where the stresses are to be found. He states in one place that in warehouses and similar buildings the load is naturally concentrated around the columns; otherwise the aisles or passageways would be obstructed. That he therefore should have placed most of his reinforcing material around and connected with the columns which support the flooring is what any other thoughtful engineer might do.

From the foregoing observations it seems plain that neither of the patents is of a broad fundamental character. The claims of Patent No. 985,119, which are in suit, are as follows:

4. In flat-slab and column construction of concrete the combination of a concrete slab, concrete columns in vertical alignment above and below the slab, column reinforcement extending continuously through a vertical line of columns, cantilever heads separate from the column reinforcement, comprising, each, crossed rods embedded in the slab and extending laterally outward from the column in different directions, rods extending from said head downward into the column and groups of rods extending crosswise of the head through the slab from column to column in direct and diagonal lines, said rods being toward the bottom of the slab between columns.

8. In flat-slab and column construction of concrete the combination of a plurality of concrete columns and vertical reinforcements therein, of a separate and distinct set of reinforcing elements embedded in the column and principally supported thereby, the ends of said separate set of reinforcing elements being separated so as to radiate from the column into the floor slabs toward substantially all parts thereof, and a concrete floor slab embedding and supported by said radiating means.

This patent was the subject of litigation in the Eighth Circuit (211 Fed. Rep. 466). The Circuit Court of Appeals held that claims 1, 4 and 6 of the patent were invalid. The decision of that court was proper, notwithstanding the earnest efforts of counsel for the plaintiff in the present case to diminish the effect thereof.

Claim 8 of that patent which is now involved in the present litigation is not so different from claim 4 as to lead this court to think that it should be sustained.

We therefore conclude that the claims of Turner Patent No. 985,119, which are involved in this litigation, are invalid

The claims of Turner Patent No. 1,003,384, which are involved, are as follows:

1. An arrangement of reinforcement for a column-supported flat plate floor of concrete, comprising a plurality of circumferential cantilever members, respectively situated in the upper part of the slab at the columns and projecting therefrom, and reinforcing means extending from member to member in multiple directions through the space between said members, and filling, or substantially filling such space.

5. An arrangement of reinforcement for a column-supported flat plate floor of concrete, comprising multiple belts

or rods that extend from column to column in two directions directly, and in two directions diagonally, portions of said belts being beyond the columns on opposite sides and forming cantilevers, the rods running in intersecting directions crossing at the columns in the upper part of the floor, and the cantilever-forming portions of rods of one belt supporting rods of another belt, the area between the columns being covered, or substantially covered, by reinforcements.

10. In a structure of reinforced concrete comprising columns, and a flat plate floor slab, the combination of an open frame consisting of crossed rods at the top of a column extending partially into the slab contiguous to the column and belts of rods extending crosswise of said open frame and passing through the slab directly and diagonally in straight lines from column to column.

11. The combination of concrete columns, and a flat plate floor slab of concrete supported directly thereon, horizontally arranged bars in the slab at the top of the columns, and supported thereby with their free ends extending outward into the slab from the columns forming cantilevers, and belts of reinforcement extending in multiple directions through the slab from support to support, and supported by said cantilevers.

16. The combination of concrete columns, and a flat plate floor slab of concrete supported directly thereon, horizontally arranged upon frames embedded in the concrete at the top of the columns extending transversely of the column axis, belts of reinforcement extending in multiple directions through the slab from column to column and supported by said frame, the belts being of a width to substantially cover the area between the columns.

17. In a reinforced-concrete structure, the combination of supports, consisting of columns of concrete, and a flat plate floor slab of concrete supported directly thereon, belts of reinforcement extending through the slab to the supports in four directions, said reinforcements having a thickness of four belts over the support in the upper part of the slab, a thickness of two belts in a diagonal direction midway between the supports in the bottom part of the slab, a thickness of one belt midway between the supports directly from one support to the other in the lower part of the slab and a set of reinforcements extending transversely of the column axis and projecting beyond the tops of the columns.

This patent has been the subject of litigation also in the Eighth Circuit (Drum vs. Turner, 219 Fed. Rep. 188). It is there held that a construction substantially after the manner pointed out in the specifications of Patents 985,119 and 1,003,384 issued to Claude A. P. Turner, Feb. 21, 1911, and Sept. 12, 1911, respectively, was an infringement of claims 1, 3 and 4 of Patent 698,542, issued to O. W. Norcross, Apr. 29, 1902.

This court is satisfied that the conclusions reached by the Court of Appeals in the Eighth Circuit in the case last cited should be adopted. Strenuous efforts on the part of the plaintiff to diminish the effect of that decision must fail. The Norcross patent is set up in the present case as an anticipation of the patents in suit. It seems clear that if a construction in accordance with the patents in suit would infringe the Norcross patent, that the Norcross patent must be an anticipation of the patents in suit. The effect of this decision is not weakened by the decision of the Court of Appeals of the First Circuit in the case of Turner vs. Quincy Market Cold Storage and Warehouse Co. (225 Fed. Rep. 41). That case principally decided that a tenant occupying under lease, a building, the construction of which embodies a patented feature, is not necessarily a "user" of the invention in such a sense as to be an infringer. Further consideration of the prior art either as found in structures, patents or publications offered in evidence on the part of the defendant would but unnecessarily lengthen this opinion.

The claims of both patents which are relied upon by the plaintiff in this suit are invalid. The bill must be dismissed at the cost of the plaintiff. Let a decree be drawn.

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Street Cleaning Society Meets

The Society for Street Cleaning and Refuse Disposal of the United States and Canada held its second annual convention in New York City, Oct. 13 and 14. Although not yet very numerous in membership, the society has earned recognition in promoting technical knowledge of street cleaning and refuse disposal.

Papers were read on "Street Cleaning by the Wet System," by G. H. Hanna, former street-cleaning commissioner of Cleveland, Ohio; "Street-Car Flushers," by A. T. Rhodes, street commissioner of Worcester, Mass.; "Hand Sweeping," by Richard T. Fox, Chicago, Ill.; "The New York Anti-Litter League," by R. Ross Appleton, treasurer of the league; "The Horse in Street-Cleaning Work," by Dr. D. J. Mangan, New York City Department of Street Cleaning; "Accidents and Diseases," by Dr. S. I. Rainforth, New York City; "Control of Material and Supplies," by A. Schreiner, New York City; "Testing Apparatus," by John F. O'Toole, Pittsburgh, Penn.; and "Chicago's Problem," by A. W. Miller, Chicago, Ill.

The meetings were held in the convention hall of the Department of Street Cleaning Building at 140 West 20th St. A halfday was spent at the Department's school of instruction on the East Side, a new departure in street-cleaning work.

The present officers—John T. Fetherston, street-cleaning commissioner of New York City, President, and J. R. Buchanan, of the New York Street Cleaning Department, Secretary—were reëlected.

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Slag Cement Is To Be Permitted in New Orleans paving work, following a recent order of the Council. The order states that specifications to govern the installing of subsurface drains, curbs, gutter bottoms, etc., and paving or repaving of streets with whatsoever kind of material, will be amended, so as "to permit the use of a new brand (commonly known as steel or slag) of cement" in the concrete foundations in all kinds of roadway pavement and in the brick masonry forming part of manholes, etc. It is expected that slag cement from Birmingham, Ala., will be used, as a company there has offered to sell in New Orleans its first-grade cement for 85c. per bbl. f.o.b. Birmingham.

Two Pavement Contracts at Bismarck, N. D., to the amount of nearly half a million dollars were recently let. A contract for 43,600 sq.yd. of bitulithic pavement was let to Hanlon & Okes, Minneapolis, Minn., for $114,872. The price was $2.38 per sq.yd. including a 5-in. concrete base. This is to be laid on the business streets and is to be completed by Nov. 1 of the present year. The other contract was for 149,400 sq.yd. of sheet asphalt at $331,568 and was let to the Ford Paving Co., Cedar Rapids, Iowa. The price was $1.90 per sq.yd., for a 5-in. concrete base, 1 in. of binder and a 1½-in. top. This is to be used on residence streets and is to be completed by Oct. 1, 1917.

New Steel Works for Norway—Two new companies for manufacturing steel plates for ships and other shipbuilding requirements have recently been formed in Norway, according to the United States consul at Christiania. One of these will have an initial output of 80,000 tons, including 30,000 tons of ship plates and 30,000 tons of rolled sections. The other company will produce 20,000 tons annually. Most of the materials for Norwegian shipbuilding were supplied by Germany before the war. There is an abundance of iron ore in the country, but the high prices of fuel for its smelting and working have previously discouraged the development of the steel industry the ore for the past 10 years being exported.

Crushed Stone Is Dutiable according to a recent decision of the United States Board of General Appraisers in the test case filed by the Great Lakes Dredge and Dock Co., the MacArthur Brothers Co., and others, of Cleveland, Ohio. The Custom House authorities required 20% duty on the product under the section of the tariff laws specifying "earthy or mineral substances wholly or partially manufactured, and articles and wares composed wholly or in chief value of earthy or mineral substances, not especially provided for." The litigants claimed free entry under the specification "minerals, crude, or not advanced in value or condition by refining or grinding or other processes of manufacture, not especially provided for." Earlier custom decisions have granted free entry, but in 1906 the courts ruled against the custom authorities. The present test case was brought about in an attempt to upset these legal decisions.

To Arouse Interest in City Planning the Indiana Real Estate Association conducted a city-planning campaign from Oct. 9 to 18. The scheme was to visit every city having a real estate board and a number of other places besides, the visits to be made by various officers and members of the association. To have something specific and suggestive to lay before the real estate and other people of each city, the following addresses on city planning were made: "City Planning in Indiana," by Albert H. Schaaf, Fort Wayne, Ind., Chairman City Planning Commission, Indiana Real Estate Association; "The Civic Idea," by Richard B. Watrous, Secretary of the American Civic Association, Washington, D. C. "The Essentials of City Planning in American Cities," by Flavel Shurtleff, Secretary, National Conference on City Planning, Boston, Mass. Lee J. Ninde, Fort Wayne, Ind., is president of the Indiana Real Estate Association, and Scott R Brewer, Lemcke Building, Indianapolis, is secretary.

PERSONALS

C. R. Thomas, of Wilmington, N. C., has been appointed Division Engineer of the Kentucky State Highway Department.

J. L. Wilson, of the University of Michigan, has been appointed Professor of Electrical Engineering at Queens University, Kingston, Ont.

L. S. Eaton, of Cornell University, has been appointed Assistant Professor of Mechanical Engineering at Queens University, Kingston, Ont.

A. C. Norton, recently Chief Engineer of the R. Hardesty Manufacturing Co., Denver, Colo., is now President of the Norton Engineering and Contracting Co., 2046 Vine St., Denver.

A. M. Mutersbaugh, formerly Engineer of the Highway Department of Calcasieu Parish, Lake Charles, La., has been appointed Engineer of the Sewerage Board of St. Charles, succeeding J. E. McCorkle.

James C. Travilla, former Street Commissioner of St. Louis, Mo., has been appointed Receiver for G. A. Heman, General Contractor, of St. Louis, against whom involuntary bankruptcy proceedings were recently filed in the Federal District Court.

Stuart S. Neff, recently Construction Engineer of the engineering department of the Baldwin Locomotive Works, Philadelphia, Penn., is now Engineer of Construction of the Ferrocarril de Samaná y Santiago in the Republic of San Domingo, W. I.

H. G. Sparks, recently Division Engineer of the Chicago & Eastern Illinois R.R., at Salem, Ill., has been promoted to be Assistant Superintendent of the Chicago division of the railway. He is succeeded as Division Engineer by A. W. White, formerly Office Engineer at Chicago.

Alfred J. Stevens, M. Can. Soc. C. E., recently in charge of the Manitoba district of the Department of Public Works of Canada, has been transferred to Windsor, Ont., relieving Col. H. J. Lamb, M. Can. Soc. C. E., who is with the Overseas' Forces of the British Army in France.

Prof. E. Mörsch has been called to the Stuttgart Technical College as Professor of Structural Engineering. He leaves the firm of Wayss & Freytag, Neustadt a.d. H., with whom he has been associated for a number of years. Dr. Mörsch was Professor of Statics and Bridges at Zürich from 1904 to 1908.

A. H. Jewell, formerly employed at the filtration plant of the Toledo, Ohio, city water-works, has been appointed Assistant Engineer of the Kansas State Board of Health, with headquarters at the State University at Lawrence, Kan. He is a graduate of the Michigan State Agricultural College and of the University of Michigan.

Robert F. Olds, Assoc. M. Am. Soc. C. E., formerly Consulting Engineer at El Paso, Tex., has been appointed General Superintendent of Construction of the Philadelphia district of the Samuel Austin Co., of Cleveland, Ohio. Mr. Olds graduated from the University of Maine in 1906 and has had a variety of experience in different parts of the country.

James R. Elliott, M. Am. Soc. C. E., has become associated with George S. Baton & Co., Civil and Mining Engineers, Pittsburgh, Penn., which will hereafter be known as Baton & Elliott, Civil, Mining and Consulting Engineers, Pittsburgh. Mr. Elliott returns to Pittsburgh after an absence of ten years in California, Arizona and Utah. The new firm will specialize in reports and development of mining properties.

OBITUARY

William H. Newley, a public works contractor, of Indianapolis, Ind., died Oct. 6 as the result of a collision between a trolley car and the automobile in which he was riding

William J. Bradley, President of the American Dredging Co., of Camden, N. J., died Oct. 13 at the hospital of the University of Pennsylvania. He was prominent in New Jersey politics and was twice president of the State Senate.

E. M. Butz, an architect and civil engineer, of Pittsburgh, Penn., died Oct. 4 at his home in that city. He was one of the promoters and the designer of the Columbia Iron and Steel Co.'s plant at Uniontown, Penn., of which he was for a time General Manager.

Ralph Tolles Norton, a prominent railroad contractor, died at Audubon Sanitarium, New York City, Monday, Oct. 9, following an operation. He had been associated with the Carter Construction Co., F. M. Ferguson Contracting Co., Degnon Contracting Co., and at the time of his death he was a member of the firm of Norton, Head & Denneen, which firm had a few months since completed the contract for the construction of the Mill Creek Joint District Sewer in St. Louis, Mo. Mr Norton was a member of the Engineers Club and the Railway Club in New York City and of the City Club of St. Louis. He leaves a widow and four children.

Leonard W. Rundlett, M. Am. Soc. C. E., for many years City Engineer of St. Paul, Minn., and for two years Commissioner of Public Works of Moose Jaw, Sask., Canada, died Oct. 15 at his home in St. Paul. He was one of the best-known municipal engineers of the Northwest and had a large circle of friends and acquaintances. He was born in Brunswick, Maine, in 1846. He went to St. Paul when he was 25 years of age and for three years was employed by the St. Paul & Pacific Ry. After that he became connected with the city engineering department as an assistant to the City Engineer. Subsequently he became City Engineer and served almost continuously in that office until 1911, when he left to become Commissioner of Public Works of Moose Jaw. His service as Engineer of the St. Paul water department covered 27 years. After two years at Moose Jaw he returned to St. Paul, where he maintained an office for private practice until taken ill last June. He is survived by a widow and one daughter.

Prof. Levi L. Conant, head of the department of mathematics of the Worcester Polytechnic Institute, Worcester, Mass., was killed Oct. 11 by an automobile truck, which ran over him while he was hurrying to take a car from his home to the Institute. He was born in Littleton, Mass., Mar. 3, 1857. He took his A.B. degree at Dartmouth in 1879 and the A.M. degree there in 1887, being awarded also the degree of Ph.D. by Syracuse in 1893. He was Professor of Mathematics in the Dakota School of Mines, 1887-90, and became Professor of Mathematics at the Worcester Polytechnic Institute in 1891. He was Acting President there, 1911-13. He was a member of the Worcester School Committee many years and its chairman in 1909. He was a member of the Massachusetts State Board of Education, 1909-14. He was a Fellow of the American Academy of Arts and Sciences, a member of the American Mathematical Society and of the London Mathematical Society. He was author of "The Number Development," "Original Exercises in Plane and Solid Geometry" and "Plane and Solid Trigonometric Tables." He was editor of the "Journal" of Worcester Polytechnic and a contributor to many educational and scientific journals.

ENGINEERING SOCIETIES

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Annual convention at Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 30-Nov. 4. Annual meeting at La Salle Hotel, Chicago. Secy., J. A. Andreucetti, C. J. N. W. Ry., Chicago.

AMERICAN MINING CONGRESS.
Nov. 13. In Chicago, Secy., J. F. Callbreath, Munsey Bldg., Washington, D. C.

AERO CLUB OF AMERICA.
Nov. 13. Annual meeting in New York City. Secy., Wm. Hawley, 297 Madison Ave., New York City.,

NATIONAL COMMERCIAL GAS ASSOCIATION.
Nov. 13-18. Convention in Atlantic City, N. J. Secy., Louis Stotz, 61 Broadway, New York City.

RICHMOND RAILROAD CLUB.
Nov. 13. Annual meeting. Secy., F. O. Robinson.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H Roth, 1110 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Central States Division of the American Water-Works Association held its 20th annual meeting last week at Cleveland.

The American Road Builders' Association will hold its annual meeting on Nov. 3 at the Automobile Club of America, 247 West 54th St., New York City. In the evening a dinner will be held in the grillroom. The secretary is E. L. Powers, 150 Nassau St., New York City.

The American Association of Engineers held a dinner at Chicago on Oct. 6, at which there was an attendance of 1,200. The meeting was called to order by E. V. Hill, chairman of the Chicago Chapter, who turned the chair over to A. H. Krom, chairman of the national membership committee. The principal address was by C. F. Harding, professor of electrical engineering, Purdue University, on "Marketing Engineering Ability." John Erickson, who has held his position as city engineer through numerous changes of political administrations, discussed that portion of Professor Harding's address which referred to tact. Others who took part in the discussion were Dabney H. Maury, L. K. Sherman, W. H. Roscrans and H. B. Wild. Arthur Kneisel, national secretary, talked on ethics for engineers and explained how the association was working on this problem.

Appliances and Materials

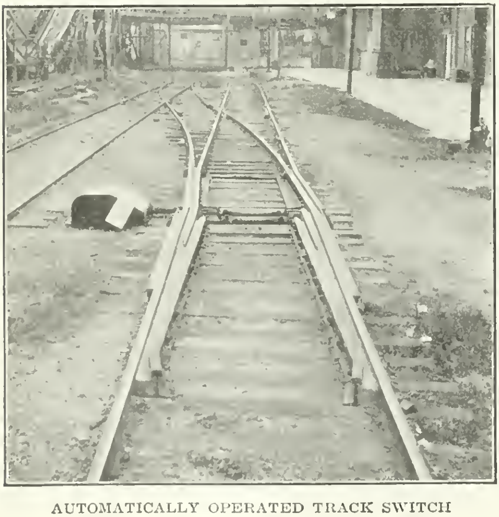
New Railway Track Switch

A new railway switch that is being tried experimentally is of the stub-rail type, but with features intended to avoid the objections that have made the old style of stub switch obsolete.

Each side of the switch consists of a pair of rails bolted together, with fillers between them, and pivoted at the toe to a base plate that extends the full length of the switch and carries the ends of the fixed rails. In this way the variation in width of the open joint, owing to expansion and contraction, is minimized, and creeping of the switch rails is prevented.

The two sides of the switch are connected by tie-rods, or in this case plates, in the usual way, and the operating rod is attached to one of the base plates. This rod is connected to a crankshaft, which may be operated by hand mechanism or automatically by an electric motor.

As a precaution against derailments, should a train trail through an open switch, a device similar to those of the old Tyler and Cooke stub switches, has been added. In the illustration, for example, a train coming from the main track into the switch, as shown, which is set for the siding, one wheel flange is held against the inside gage line by the guard rails, while the flange of the opposite wheel is led into a groove on the outside of the main-line rail, mounts an incline to the level of the head of the rail and drops into its place on the gage line.

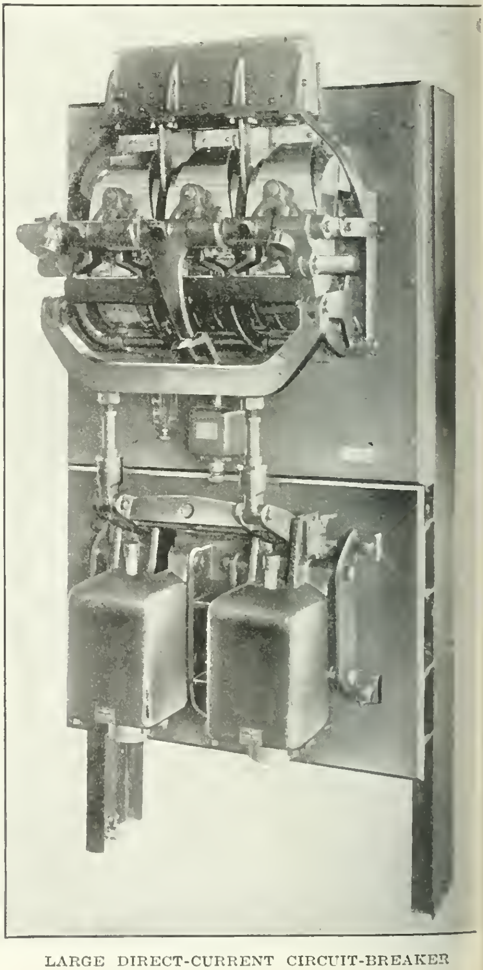

AUTOMATICALLY OPERATED TRACK SWITCH

The new switch is the invention of Ira A. Call, of Denver, Colo. The experimental installation shown is on the Brooklyn Rapid Transit Co.'s electric line near Brighton Beach (New York).

* * *

A 20,000-Ampere Direct-Current Circuit-Breaker

Probably the largest circuit-breaker is one of the solenoid-operated type recently developed by the General Electric Co. for controlling direct-current circuits of unusually high capacity. The normal continuous rating is 20,000 amperes. This circuit-breaker is one of four of the same capacity built for the Aluminum Co. of America for installation at Massena, N. Y. The closing and opening movements under normal conditions are controlled by a single-pole double-throw control switch mounted remote from the breaker on the switchboard or in some other convenient location. On overload or short-circuit the breaker opens automatically by means of a direct-acting trip. The breaker is mounted on a 2½-in. slate panel. The solenoid mechanism is supported by a steel base.


LARGE DIRECT-CURRENT CIRCUIT-BREAKER

Engineering News

VOLUME 76 OCTOBER 26, 1916 NUMBER 17

Draining North Holland After January's Great Flood

By Jan Spaander*

North Holland, which with the Frisian Islands separates the Zuyder Sea from the North Sea, is partly a nudbank and partly a pit whose bottom is at or below he level of the ocean bottom near-by. It was reclaimed y man from shallow ocean waters, and now supports one f the densest populations in the world. The sea's erosion n the west and accretion on the east cause the whole eninsula to shift eastward at the rate of a mile in three enturies. This as made it of onstant interest o the geographer nd the engineer. Tremendous dike reaks on Jan. 14, 1916, in which the ea temporarily egained part of ts former domin-ons, followed by emarkable and uccessful human vork in restoring he "polderland" o its dry state, ave again cen-ered the world's ttention on North Iolland. The bot-om of the North ea is an exten-ion of the gently loping German lains. In prehis-oric times a wide trip of the shal-ow beach waters as cut off from e rest of the ocean by the joint action of wind and aves, which threw up an uninterrupted sandbank from ape Gris Nez in France to Cape Skagen in Denmark nd blew it together into high dunes. The stretch of ater inside the dune belt was soon transformed by the vers into a freshwater lake.

The same actions can yet be seen along the Frisian lands. The German Haffen on the shores of the Baltic, d, in a sense, the Australian lagoons, remind one of it. The shallow lake between the dunes and the mainland s gradually transformed into soft marshland by dying water-plants. Storms and floods broke through the belt in several places, scouring lakes out of the soft marshland and refilling some of these again with rich clay. In this way the Zuyder Sea was formed in the thirteenth century, and the appalling losses at this time caused the people to combine to "polder", the land, to surround small areas with dikes and provide drainage. The means and ends employed to polder and to drain depended upon local conditions. Thus North Holland consists of sandy areas along the dune belt, sea-clay regions (the highest of which are level with high water), marshland (below mean sea level) and "lakes" or areas level with or lower than the bottom of the sea. To reclaim the higher clay lands hardly any skill was necessary. A simple inclosing dike built out from the dunes was sufficient. Sluices, self-opening to the outside, regulated the outflow of water. The few drainage channels supplied the earth to build the first dikes. The marshland and lower clay lands, however, required pumps to remove the water. The windmill (Fig. 1), which was utilized for this duty, is still extensively employed. The four-vane windwheel drives, through wooden bevel gearing, an Archimedes screw, also made out of wood. The whole mill can be turned against the wind by means of the pole brake and rope, as shown in the section. The water-lifting screw of the windmill lifts the water over the dike and discharges it into the sea or into an inside "bossomwater" (bossomwaters are the interconnected canals which surround polders and "dry" lakes).

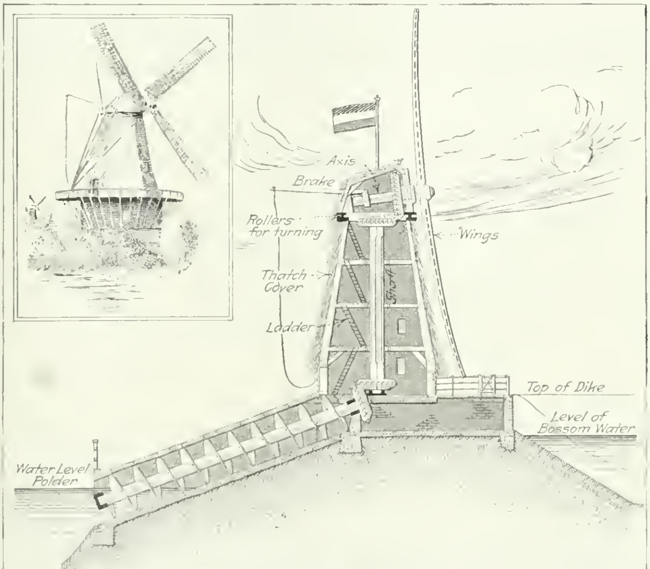


FIG. 1. SKETCH OF DRAINAGE WINDMILL

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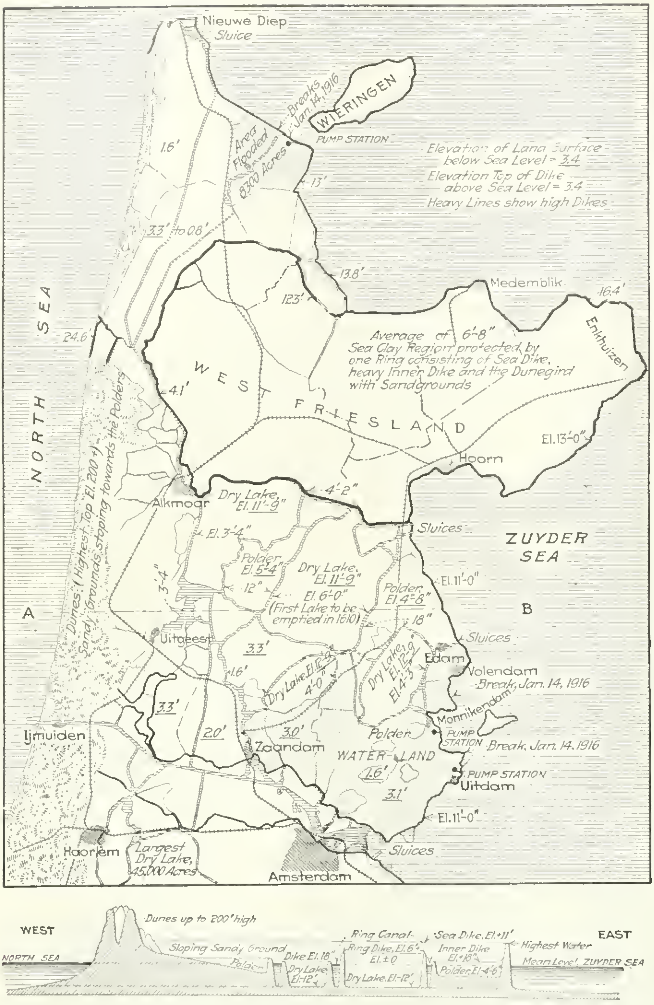
*618 45th St., Brooklyn, New York City.



Section A-B

FIG. 2. MAP AND PROFILE OF NORTH HOLLAND

The aspect of a marshland polder is different from the high sea clay. The latter is provided with few canals, which often are dry. The polders, on the other hand, are traversed by substantial draft canals leading to the mills or more modern pump stations. Between, the land is divided by main canals, and then there is the endless subdivision by ditches, about 10 ft. wide and 100 to 200 ft. apart. The rectangular pieces of land thus formed are again divided by unlined gutters, but these are usually dry, their bottom being slightly above polder watermark.

This elaborate system of drainage works is kept in order by the farmers, and they are so convinced of the danger of the surrounding sea that they themselves impose heavy fines for slight shortcomings in this work. As the land has been formed by the water, it is plain that all tracts of one polder are at the same level.

The last areas taken from the sea were the lakes. An engineering genius born in the sixteenth century was much troubled by the "moving" of Holland. The dunes rolled landward and had to be stopped by means of plantation. The lakes and the Zuyder Sea grew land on the west side, just as it still happens today, and the storms broke it away on the east shores. An old Roman castle, now in the North Sea, proves that the average speed of the movement of the country was 1 mi. in three centuries. Leeghwater (empty water), that was the appropriate name of the engineer, offered to empty the lakes, and it was his luck that an obscure sea captain, by the name of Pete Hein, captured the Spanish silver fleet, bringing in such unheard-of wealth that the "crazy" project could be carried out. The reclamation of the lakes left Holland as shown by the map and profile, Fig. 2. Every polder and every dry lake is surrounded by a dike and a ring canal. These ring canals are all interconnected and together form the bossomwaters to store the water in till outside tides allow drainage through sluices, which also serve shipping. That the inhabitants always have been aware of the great danger of living in such a pit is best demonstrated by several "stretches" of cities and villages along inner dikes. This secures them against direct drowning in case of floods, and this accounts for the ease with which tens of thousands escaped the recent flood disaster. On Jan. 13, 1916, western storms drove the North Sea water into the narrow bottle-neck of the Zuyder Sea and filled the latter to the brim. An inside storm of more northern direction attacked the dikes, which are not built to withstand this very extraordinary combination. The typical dike, shown by Fig. 7, comprises a sand core covered by a clay mantle, the lower two-thirds of the outside slope paved with large stones. It is not designed to be overtopped. In January the waves rolled over the top, tearing out the soft inner slope. The view, Fig. 3, shows the result—the outside of the dike still standing, but the inner slope washed out.

The inrushing water churned deep holes in the soft marshland and widened the initial holes to from 10 to 130 ft. The adjacent polders were filled within a few hours. The village of Volendam, 3,000 inhabitants, partly built in a small dry lake, was submerged to the roofs (see Fig. 1) within two hours after the church bells all over the country sounded their warning. The polders not directly affected were filled up by secondary flooding: after the bossomwaters were loaded to the tops of the inner dikes, the low polders filled as rapidly as a saucer pressed down in a bucket of water.

The two main sections flooded, shaded in the map, Fig. 2, have areas of 35,000 acres and 8,300 acres. That

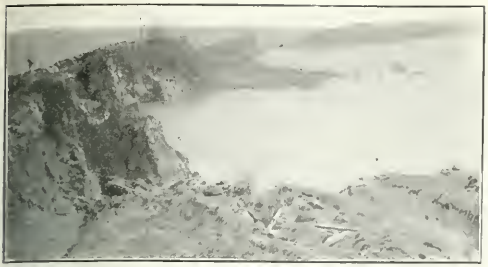


FIG. 3. A DIKE BREAK: INNER FACE SCOURED OUT BY OVERFLOW

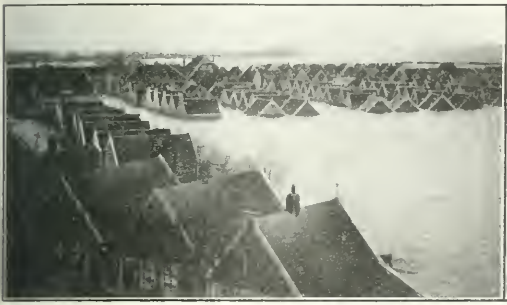


FIG. 4. THE FLOODED VILLAGE OF VOLENDAM

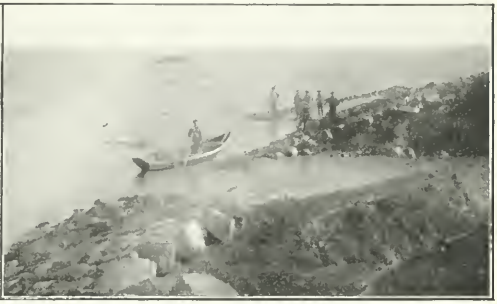


FIG. 5. DIKE REPAIR IN PROGRESS

the bigger lakes did not fill is due to the strength and height of their dikes. The polderland behind Zaandam was saved by building several miles of miniature cofferdam along the Zaandam River, of parallel plank walls with clay filling between.

The great dry lakes now were threatened with disaster f even a slight eastern storm should occur. Their inhabitants already had fled, taking their cattle with them. The chief engineer of the Water State, Mr. Reigersberg, aw that quick action was needed to save these lands. There was no time for the usual formalities of letting ontracts, but direct arrangements were made with private oncerns.

The work to be done included repairing the dikes, draining the water to mean sea level through the sluices and building large pumping stations to pump out the rest of the water.

The many breaches in the dike had to be closed. In many cases the rapid current through the breach had scoured out a deep hole, sometimes over 40 ft. deep. On this account the first closure was made not in the breach itself but by a semicircular inclosing dike built in the sea outside the breach.

On account of the constant flow of current in or out, the sand which was to form the core of the dike had to be held by brush mattresses. These are usually about 135 ft. long, 35 ft. wide, and 16 in. thick. They are woven along shore, floated out to their site, loaded with stone and sunk. The current soon fills them and covers them with sand; then a new mattress is sunk over it, to be followed by a third and sometimes a fourth, the latter being built in place since the sand is then already above low water.

Except for the sand deposited in and over the mattresses by the currents, the sand for the main structure of the dike had to be brought from the higher portions of the Netherlands, being carried by barge to Monnikendam and from there by temporary railways along the dikes to the place where needed. The same is true of the clay required for the outer faces. Above the mattress base the sand core was covered on both slopes by heavy layers of clay built up to 7 ft. above mean sea level and the lower part of the sea slope was paved with stone.

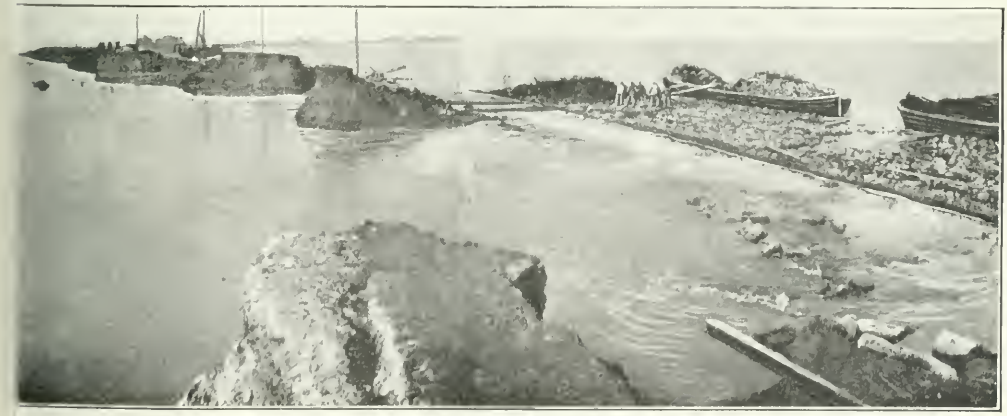


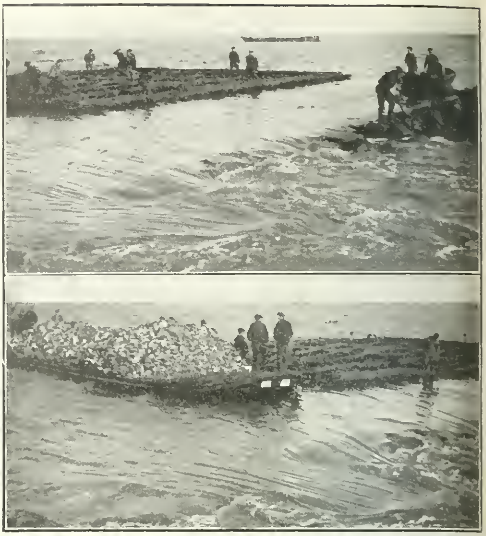
FIG. 6. SEAWARD VIEW OF KATWOUDE BEACH, WITH MATTRESS WORK IN PROGRESS

During the closure operations a small opening was left in the closure dike acting as an outlet sluice. This hole was closed at a favorable low tide.

The emergency closure dikes completed, no time was lost in filling the breach in the regular dike and reinforcing the entire length of dike whether damaged or not. The dikes are being made higher and are also being strengthened by an inner berm along which is carried the roadway formerly run along the top of the dikes. This berm and roadways are expected to be an important protection against washouts from overtopping in future.

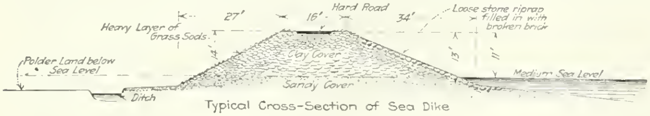
As soon as the dike repairs were well under way, draining through the several outlet sluices at the ends of the bossomwaters started, the speed of the current being as high as the canals could stand. The outside tides were not altogether favorable for the work, and near Amsterdam three large suction dredges, of combined capacity 27,000 cu.ft. per min., were put in action to spout the water over the dikes.

In the meantime large pumping plants were built and erected. The Werkspoor Co., builder of a well-known marine Diesel engine, headed a combination of manufacturers to carry out this part of the work.


FIGS. 11 AND 12. FLOATING MATTRESS TO PLACE AND LOADING IT FOR SINKING

How the Pumping Problem Was Solved

A superficial calculation made it clear that the existing pumping stations were entirely inadequate. Those of the southern section, Waterland, for example, had an aggregate capacity of 28,000 cu.ft. per min. The total water to be removed from the surface of Waterland below the lowest level of sluice drainage amounted to 3,500,000,000 cu.ft., exclusive of the contents of the smaller dry lakes. If the drainage was to be completed within three or four weeks, a pumping capacity for Waterland of at least 105,000 cu.ft. per min. was required. The first two questions which arose were: Is it possible to build suitable pumps of such large capacity within a few weeks? Can motive power be provided? Within four days Werkspoor offered the authorities a design of large centrifugal pumps, which could be built and put


27'
16'
Hard Road
34'
Loose stone riprap filled in with broken brick
Heavy Layer of Grass Sods
Clay Cover
13'
Polder Land below Sea Level
Medium Sea Level
Sandy Cover
Ditch
Typical Cross-Section of Sea Dike
FIG. 7. SECTION OF SEA DIKE

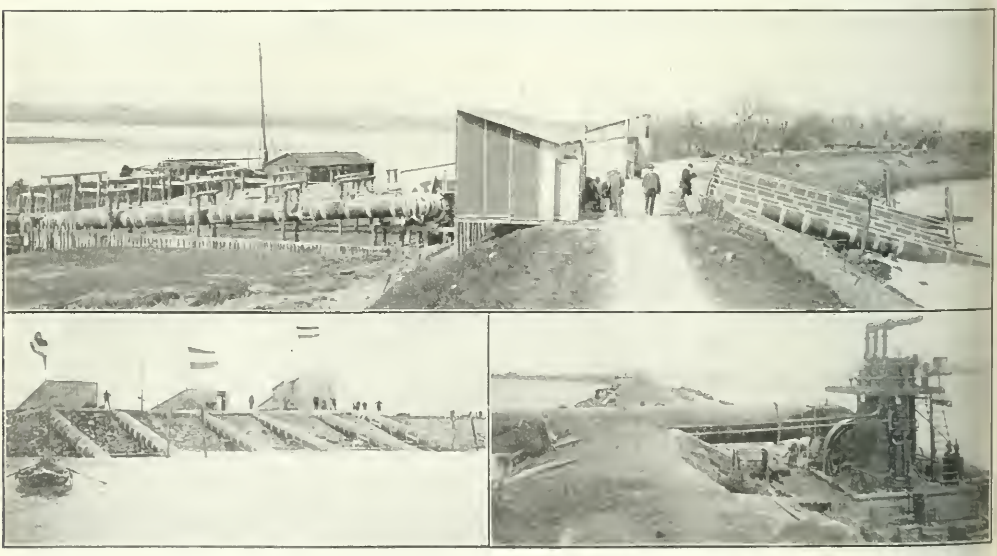

FIGS. 8 TO 10. HUGE TEMPORARY PUMPING PLANTS

Fig. 8—Three-unit plant at Uitdam. Fig. 9—Full-capacity discharge, Uitdam. Fig. 10—Diesel-engine plant, Northern Polder

in action inside of four to five weeks. The Kennemer Electric Works had enough cable on hand to reach Waterland from the Amsterdam municipal electric station. Motors offered by manufacturers decided the size of units: One group of pumps was to be driven by a 300-hp. motor, ne by two 160's, and the other two each by a 250.

On Feb. 8 the government accepted the Werkspoor roposal. The few weeks available excluded all compliited castings. The main parts had to be built out of eel sheets and rolled sections (see Fig. 14).

The casing sheets, $\frac{13}{32}$ in. thick, were joined by flame elding, which insured tightness under the condition of acuum operation. The casing was stayed against the ward pressure by stay-bolts and stiffeners. Cast-iron overs, clamped together by through bolts, closed the penings through which the impeller was inserted. The ne cover serves as collar for the suction elbow; the other ver carries the bearing of the impeller shaft. This tter has a spherical seat, which makes the alignment of e shaft independent of the casing, so that the latter uld be adjusted to position after the shaft was lined up all four bearings. To prevent any air entering at the erical socket a rubber gasket in a V-groove is used as king. There was not the slightest heating found.

The shaft is flanged to carry a 7[illegible]-in. steel disk provided the center with a cone of $\frac{1}{4}$-in. sheet. The impeller des, slightly curved, are riveted to the disk by means angle iron.

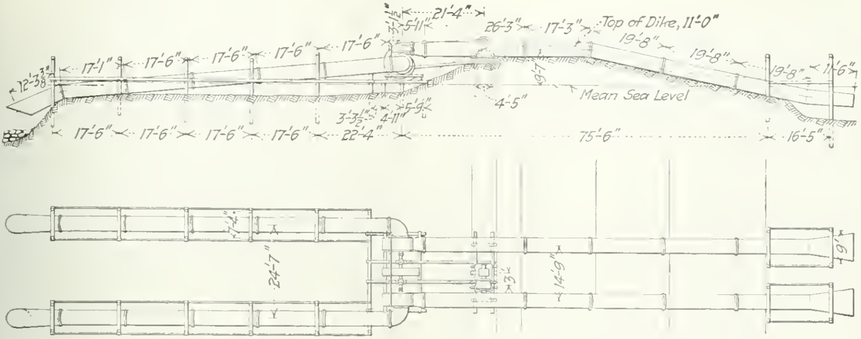
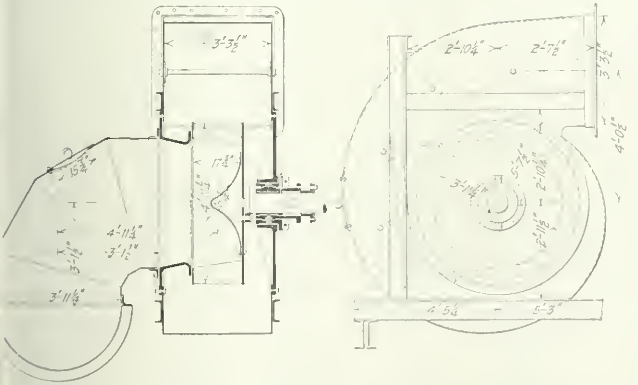


FIG. 13. CROSS-SECTION OF MONNIKENDAM EMERGENCY PLANT



IG. 14. SPECIAL CENTRIFUGAL PUMP BUILT FOR EMERGENCY DRAINAGE

The 48-in. suction and 40-in. discharge for the pumps were made out of $\frac{1}{4}$-in. riveted sections. The pumps have all a one-side suction intake. Two pumps are mounted on one shaft carried by the two spherical cover bearings and two center bearings alongside the main pulley. The interconnection neutralizes the axial pressures of the pumps. The pumps were kept apart by channel-iron framing, and this whole unit was carried by four heavy wooden beams. Sixteen piles 30 to 50 ft. long completed this light foundation. The vacuum in the pumps for starting was produced by small electric air pumps, and though this took several hours there was no objection.

One of the two larger groups, placed near Monnikendam, is shown by Fig. 13. The remaining three groups were put near Uitdam (Figs. 8 and 9), where wide existing main "drafts" supplied ample opportunity for suction at top speed. The capacities of the pumps were 7,000 and 4,900 cu.ft. per min. at a head of 3 ft. 4 in. However, at the beginning the head was smaller, and the aggregate output was in excess of 50,000 cu.ft. per min. The progress of the work is best indicated by the dates. On Feb. 8 the work was started; on Feb. 17 the outfit was ready for erection in the Werkspoor yard, and on Mar. 2 the pumps were ready for shipment. Transportation was by flat-bottomers; the riveted pipes were closed at the ends and floated to their destination. On Mar. 31 the pumps started pumping. This was by no means all the work done. The shipyard Conrad in the meantime had built a similar pump of 10,500 cu.ft. per min., with 60-in. pipe, to be driven by a 300-hp. Diesel engine. This outfit was for the northern section, the Anna-Paulona Polder, which could not be reached by electric cable on hand. This pump was similar to the others; but it had a two-sided intake, and the impeller had fan blades on either side to do away with axial forces. This unit was set on a foundation of 40-ft. piles. Its transportation and erection constituted a difficult feat.

Three smaller pumps, of 2,800 cu.ft. per min. each, were built for the deeper lakes in the Waterland polders.

By May 1 all the polders had been drained. Before the end of the same month the lower lakes were also emptied. The smaller flood of 1825 took over 1½ years to drain.

Placing a Steel Frame in an Old Wall-Bearing Building

The recent reconstruction, at Lincoln, Neb., of a six-story wall building with interior timber framing into a fireproof steel-frame building with concrete floors was a piece of work which involved several interesting engineering problems. The building is the home office of the Security Mutual Life Insurance Co. The contractor for the steel erection, which included foundations and all important structural problems, was John Westover, Inc.

The owners decided to reconstruct the building, preserving as much as possible the old walls. It was also decided to work on but one-half of the building at a time, so that the other half could be occupied during reconstruction. These schemes were followed out though subsequent experience showed there was little if any economy in them. Because of the timber frame bay-windows, little of the original walls was utilized (dark portions, Fig. 3).

The chief problem was one of foundation. Owing to the subsurface structures and other complications the wall footings could not be extended under the street, so that the new wall piers had to be set inside the old walls and on foundations of I-beam grillages and concrete. Details of the column footings are shown in Fig. 2 together with a plan of the foundations for the entire structure. Because of the insufficiency of the pier footings the upper two stories of the structure are cantilevered from the interior columns.

The scheme of reconstruction was to convert the existing six stories into eight stories and to add two more stories. The existing floors were left in place except such places as had to be removed to erect the steel framework, or were occupied by the steel. A 92-ft. steel-boom stiff-leg derrick was erected on the roof, so that its load

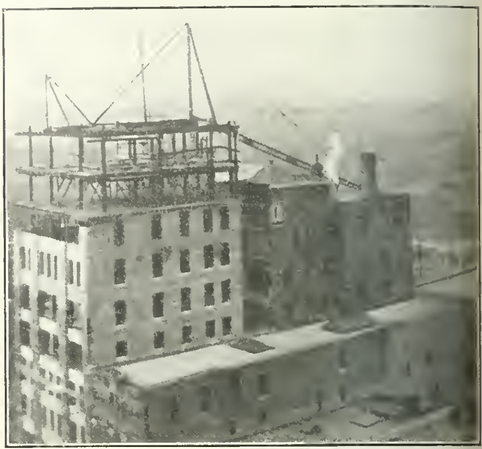


FIG. 1. RECONSTRUCTION OF SECURITY LIFE BUILDING, LINCOLN, NEB.

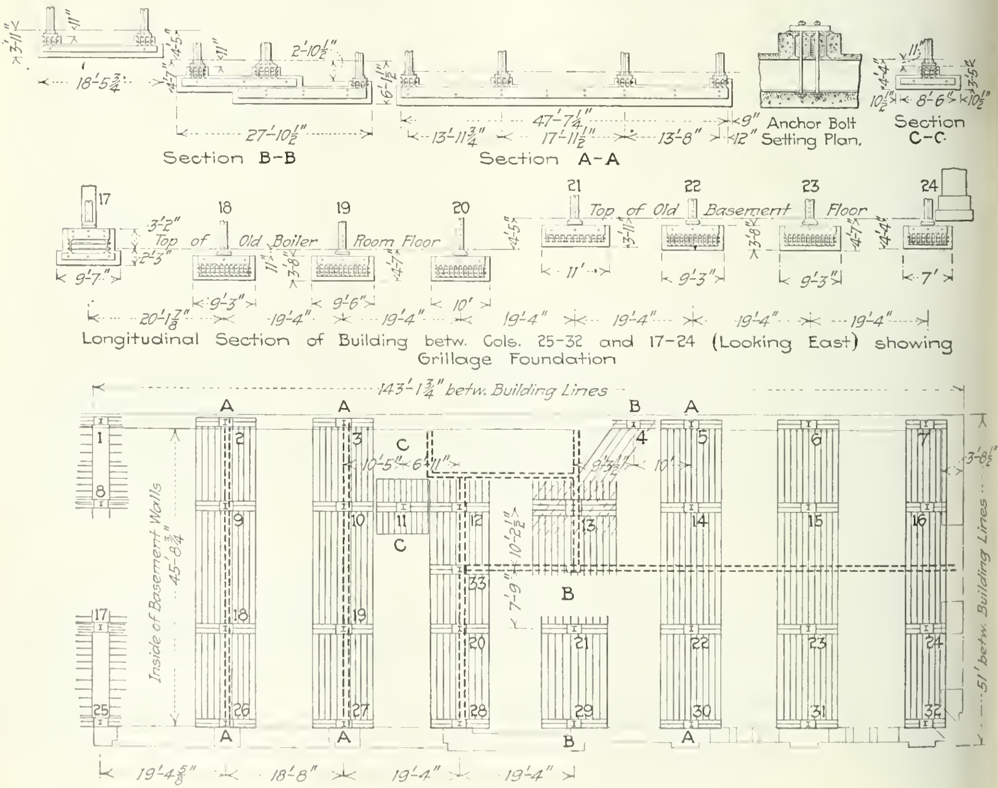


FIG. 2. DETAILS OF FOUNDATIONS FOR NEW STEEL FRAME; SECURITY LIFE BUILDING, LINCOLN, NEB.

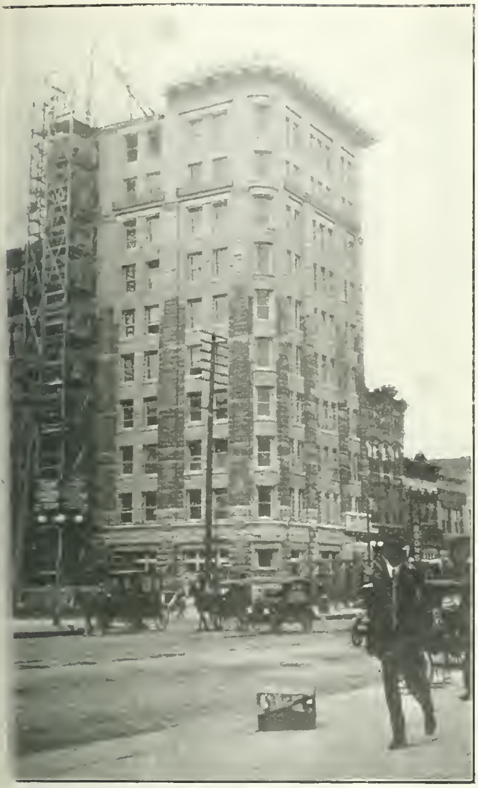


FIG. 3. RECONSTRUCTED HALF OF BUILDING

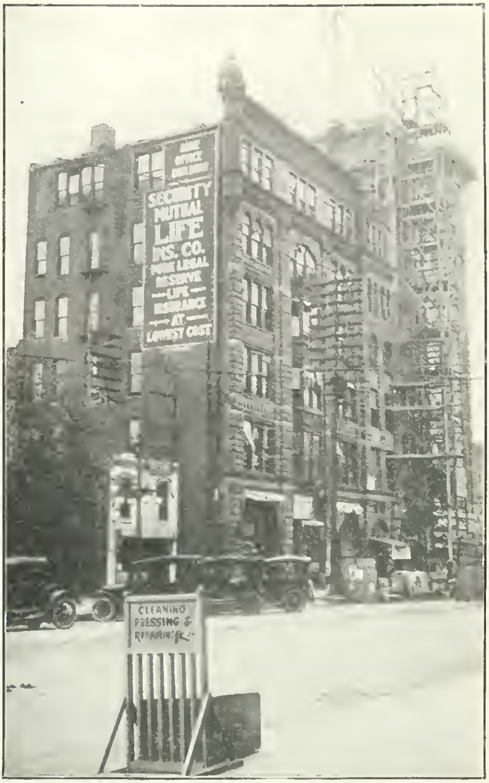


FIG. 4. HALF OF ORIGINAL BUILDING

s carried on the outside and partition walls. The s were anchored by steel cables to the frame of the ilding several stories down. The steel was delivered an alley behind the building and the 92-ft. boom was essary to reach from the half of the building under struction completely over the old half of the structure. When the foundations had been prepared, the steel me members were hoisted to the roof and let down o place through holes cut in the roof and floors. The el frame was thus placed before the old floors were noved. In the first half of the building reconstructed, tition walls were so arranged as not to cause serious onvenience during the erection of the steel, but in second half of the building, as shown in Fig. 2, the tition walls had to be removed first and the old floors ried temporarily on falsework.

eep-Well Condensing Water

eep-well water has occasionally been used for supply- condensers. The temperature of such water is prac- lly constant the year through, and averages about 60° being perhaps a few degrees cooler in northern lati- es and slightly warmer in the south. With this nearly stant temperature the condenser may be considerably aller, and the quantity of water circulated may be con- rably less than where cooling towers are used; and bably it will average less the year round even where river water is at hand for condenser purposes. The first of these gains will reduce both the investment cost and the fixed charges on the condenser equipment. The second may not only bring about a greater saving in the amount of power required to operate the condenser apparatus, but may also result in a higher vacuum being maintained, which in these days of the steam turbine and the struggle for the last fraction of an inch of vacuum obtainable to increase the efficiency of the turbines served, will warrant an investigation as to whether well water is available for the purpose. In a number of cases the possibility of marked advantage has been disclosed.

It is stated that water recooled for condenser use, either by the use of the spray nozzle or by cooling towers, will rarely average better than 85° F. through the six summer months, and condenser capacity must be provided amply large for this temperature even though the yearly average temperature is less. With the best cooling tower or spray plant a vacuum of over 26 in. is rarely maintained in the summer time, and about 27 in. in the cold months, whereas with 60° water and a much smaller condenser equipment 28 to 29 in. of vacuum may be had in summer as well as in winter. The gain in efficiency may not only warrant additional investment in the cooler water supply, but may also warrant the pumping of the reduced amount of water against approximately three times as great a head as that used in the average cooling-tower installations.

Several such installations have been made by the Layne & Bowler Co., of Memphis, Tenn., and Mr. Layne states that an installation of this kind made about 16 years ago (where the deep-well pump is operated by belt power from the main compound condensing engine) is operating as efficiently today as when first installed. He suggests that many plants (especially in the South) which get along very well during the winter on lake, pond or river water, might profitably augment their supply for the hot months by means of deep wells. At a plant of 7,000,000 gal. capacity for cooling water, now being installed in Ohio, investigation showed that the temperature of the surface water in summer averages 80° while that of the well water is only 50°.

⁂

Aids To Estimating the Cost of Vitrified Pipe Sewers

By W. G. Kirchoffer*

The computations necessary for making an estimate for a pipe sewer of given diameter and depth have not, as a rule, been made by means of formulas and diagrams. Numerous attempts have been made to show these relationships on a single job or locality by means of diagrams. Coffin and Warren, independently, prepared diagrams of work done in Massachusetts (*Engineering News*, Jan. 2, 1896, page 2); and the firm of Riggs & Sherman, of work done in Michigan, Indiana and Ohio. Charles P. Chase, Clinton, Iowa, has derived constants for fixed costs. All these diagrams and tables were based on local work and provided no means of varying the estimate according to soil and other local conditions.

As long ago as 1901 I prepared and published a diagram, similar to the ones mentioned above, for the cost of sewers 6 to 20 in. in diameter and from 6 to 18 ft. deep, by plotting some 300 prices on sewers wherein the depth and size were known. (Copyrighted in 1901; published in the *Wisconsin Engineer*, January, 1901, p. 67.) This diagram was found useful as a means of comparison between the cost of sewers for different sizes and depths, but there was no means of taking into consideration the variations of soil, price, etc., as above referred to.

Later I found that all the data of my diagram could be represented by a single formula, with a factor which could be varied to suit the variations in soil and other conditions. In this formula

C = The cost of sewer in cents per foot;
D = The depth of sewer in feet;
S = The diameter of sewer in inches;
X = A factor dependent upon the character of the soil and method of handling it.

$$C = X\left(\frac{D^2 + 10S}{53 - S}\right)$$

Table 1 gives the values of the functions in the parentheses for various values of S and D. That is to say, the cost of any sewer of size and depth chosen is equal to X times the table factor for these conditions. To estimate the cost of any sewer, choose a value of X as described later and multiply it by the table factor. For illustration, the table factor for S = 8 in. and D = 9 ft. is 3.5. If X is chosen as 20 the cost per foot is 3.5 × 20 or 70c.

TABLE 1. CONSTANTS FOR ESTIMATING COST OF PIPE SEWERS IN CONNECTION WITH LOCAL VARIABLE, FACTOR X*

Depth of Trench, Feet	Size of Pipe, Inches						
	6	8	10	12	15	18	20
4.0	1.60	2.10	2.70	3.30	4.40	5.60	6.50
4.5	1.70	2.20	2.89	3.40	4.50	5.70	6.65
5.0	1.80	2.30	2.90	3.50	4.60	5.80	6.80
5.5	1.90	2.40	3.00	3.65	4.75	5.95	6.95
6.0	2.00	2.50	3.10	3.80	4.90	6.10	7.10
6.5	2.15	2.60	3.20	3.95	5.05	6.30	7.30
7.0	2.30	2.80	3.40	4.10	5.20	6.50	7.50
7.5	2.45	3.00	3.60	4.30	5.40	6.70	7.70
8.0	2.60	3.20	3.80	4.50	5.60	6.90	7.95
8.5	2.80	3.40	4.00	4.70	5.85	7.10	8.20
9.0	3.00	3.60	4.20	4.90	6.10	7.40	8.50
9.5	3.20	3.80	4.40	5.10	6.35	7.70	8.80
10.0	3.40	4.00	4.60	5.30	6.60	8.00	9.10
10.5	3.60	4.20	4.80	5.50	6.85	8.30	9.40
11.0	3.85	4.40	5.05	5.80	7.10	8.60	9.70
11.5	4.10	4.65	5.30	6.10	7.40	8.90	10.00
12.0	4.35	4.90	5.60	6.40	7.70	9.20	10.40
12.5	4.60	5.20	5.90	6.70	8.05	9.50	10.30
13.0	4.85	5.50	6.20	7.00	8.40	9.90	11.20
13.5	5.10	5.80	6.59	7.35	8.75	10.30	11.60
14.0	5.40	6.10	6.85	7.70	9.10	10.70	12.00
14.5	5.70	6.40	7.20	8.05	9.50	11.10	12.40
15.0	6.00	6.75	7.55	8.40	9.90	11.50	12.80
15.5	6.35	7.10	7.90	8.75	10.30	11.90	13.30
16.0	6.75	7.45	8.25	9.15	10.70	12.40	13.60
16.5	7.10	7.80	8.65	9.55	11.10	12.90	14.30
17.0	7.45	8.20	9.05	9.95	11.50	13.40	14.80
17.5	7.80	8.60	9.45	10.35	12.00	13.90	15.30
18.0	8.15	9.00	9.85	10.80	12.50	14.40	15.80
18.5	8.55	9.40	10.25	11.25	13.00	14.90	16.40
19.0	8.95	9.80	10.70	11.70	13.50	15.45	17.00
19.5	9.35	10.20	11.15	12.20	14.00	16.00	17.60
20.0	9.75	10.60	11.60	12.70	14.55	16.55	18.20
20.5	10.20	11.10	12.10	13.20	15.00	17.10	18.80
21.0	10.65	11.55	12.60	13.70	15.50	17.70	19.40
21.5	11.10	12.00	13.10	14.20	16.10	18.30	20.00
22.0	11.55	12.50	13.60	14.70	16.70	18.90	20.70
22.5	12.05	13.00	14.10	15.20	17.30	19.50	21.40
23.0	12.50	13.50	14.60	15.80	17.90	20.20	22.10
23.5	13.00	14.00	15.10	16.40	18.50	20.90	22.80
24.0	13.55	14.55	15.70	17.00	19.10	21.60	23.50
24.5	14.05	15.10	16.30	17.60	19.70	22.30	24.20
25.0	14.55	15.65	16.90	18.20	20.40	23.00	25.00
25.5	15.10	16.20	17.50	18.80	21.10	23.70	25.80
26.0	15.65	16.80	18.10	19.40	21.80	24.40	26.60
26.5	16.20	17.40	18.70	22.00	22.50	25.20	27.40
27.0	16.75	18.00	19.30	22.70	23.20	26.00	28.20
27.5	17.35	18.60	19.90	22.40	23.90	26.80	29.00

*X = factor dependent upon nature of work.

Those who are not familiar with the use of such a table may be materially aided by working backward from data on previous work they have done, as follows: A contractor has laid a 10-in. sewer 8 ft. deep at a cost of 65c. per ft., and he now wishes to bid intelligently upon a 12-in. sewer 9 ft. deep. The table factor for the 10-in. sewer 8 ft. deep is 3.8; 65 ÷ 3.8 = 18 = X. If the work on which he wishes to bid is of the same character he should use 18 as a value of X, but if the work was estimated to be 10% more difficult, then he should use 19.8 for X. The table factor for a 12-in. sewer 9 ft. deep is 4.9. The estimate would then be 4.9 × 19.8 = 97c.

The relationship of the factors in the formula are also shown by the accompanying diagram. The diagonal scale at the right shows the magnitude of the factor which is to be chosen for the particular piece of work, and is the same as X in the foregoing formula for the cost of sewer.

Suppose it is desired to estimate the cost of a 12-in. sewer 10 ft. deep, assuming a factor of 22. From the intersection of the vertical line through 12 in. with the horizontal line through 10 ft. pass diagonally upward to the right, parallel to the diagonal lines sloping upward in the direction, until the line marked 22 (sloping downward to the right) is intersected. Then pass vertically down to the bottom of the diagram where we read $1.16 per ft. In some problems the factor line will lie below the intersection of size and depth lines, in which case it will be necessary to pass downward to the left in place of upward to the right.

The selection of the factor must be based on the character of the work, current prices for labor and materials. In my own practice a determination has been made from work already constructed by working backward after the contract has been let.

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*Sanitary and Hydraulic Engineer, Madison, Wis.

To show how closely work may be estimated the fol-owing facts are given: At Antigo, Wis., the estimate on wo miles of 24-in. intercepting sewer was $19,888, and he contract was let for $19,885. At Prairie du Chien, Vis., 25,410 ft. of 6-, 8-, 10- and 12-in. sewers were stimated by this method at $20,116, and the contract as let for $20,482. At Boscobel, Wis., 15,600 ft. of -, 10- and 12-in. sewers were estimated to cost $15,215 nd the contract was let for $15,350. At none of the bove places was the estimate given out previous to the losing of the bids.

For Wisconsin conditions, where the excavation is made i gravel clay with no water or quicksand, I have found iat a constant of about 20 gives close results. In sandy oils and shallow trenches where sheeting was not re-red, a constant as low as 15 has given an estimate al to the contract price.

BLE 2 VALUES OF X DERIVED FROM LOCAL CONDITIONS

Location	Factor From	Factor To	Character of the Soil and Condition
lord	22	26	Clay, gravel and boulder; wages high
land Center...	21	22	Mostly sand, deep trenches, sheeted; wages medium
. .	15	20	Sandy clay; wages medium; labor conditions good
ston. .	14	20	Sand, sandy clay, some water; labor conditions good; pipe prices medium
ngton...	13	22	Gravelly clay, $\frac{2}{10}$ laid in concrete
arge. . .	17	23	Sandy clay, some water, sheeting
torium, Wales .		35	Clay, 2 mi. inland; have to board laborers
outh........	20	27	Clay, gravel and boulders
Mills....	16	19	Sand, clay and good digging
h Milwaukee.	20	21	Red clay, machine work
Salem	17	19	Good digging; wages medium

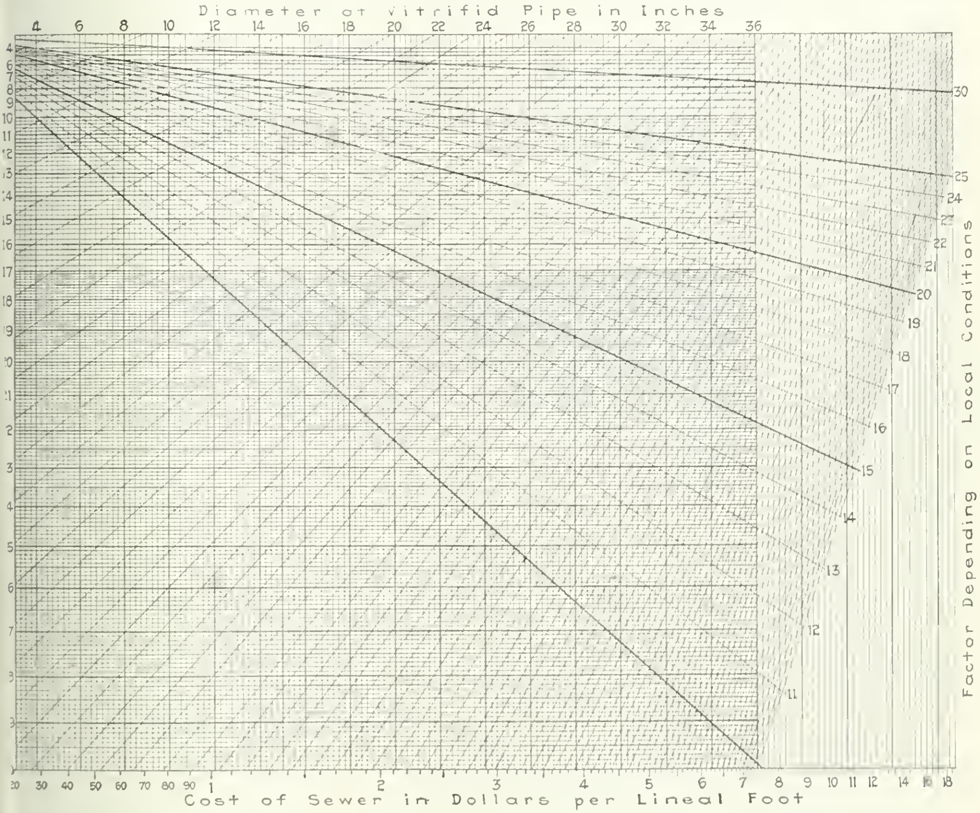
Table 2 shows the factors that have been computed from the cost of actual work done at the cities named. From the data of Table 2, the conclusions are drawn which are expressed in Table 3.

TABLE 3. VALUES OF X FOR GIVEN SOIL CONDITIONS

	Facto
Sandy soil, bracing only required, no water, wages and pipe prices medium	14
Good digging in any soil; work scarce	15
Clay soil, good digging	17
Red clay, no bracing	20
Sandy clay, some water....	23
Sand with water..	20
Red sticky clay..	24
Gravel and boulders; wages high.	26
Clay, gravel, lots of boulders; labor scarce	27
Work inland from railroad; board of laborers and other increased expenses	35

Where the data given would not meet the conditions, but the size, depth and cost per foot of similar work are known, one can work backward from the cost per foot and determine the diagram factor for work under those conditions, which could then be applied to a different size and depth of sewer in similar conditions. The estimates arrived at are supposed to cover the items of trenching, pipelaying, backfilling, pipe and materials for making joints with cement mortar. It does not include manholes, lampholes, catchbasins or flushtanks.

This method of making estimates has not been based on the amount of work that a man can do in a day, nor the price paid him, but has been arrived at by a study of a large number of bids on work where the size of the pipe, depth of the trench and other general conditions



SEWER-COST DIAGRAM, WITH FACTOR TO MEET VARYING LOCAL CONDITIONS were known. It is not based on work so large or of such a nature that steam shovels would be used, or work involving rock excavation or in quicksand of any considerable extent, but is based on work involving the use of vitrified pipe in diameters ranging from 6 to 20 in. and on the ordinary run of soils as we find them in the north central states. It is not supposed to give the actual cost per foot, but the amount that a contractor would bid on work of this kind for the conditions existing at that locality, and the current price for materials and labor.

Where collusion among bidders exists, or where there is a determination on the part of some bidder to get under the other fellows, the table and diagram fail.

I have found this table and diagram very convenient and useful. My office assistants learn how to use it readily. The diagram has not been previously published, and is not in the market. Neither is it copyrighted. I am giving it to the public for what it is worth, and I hope other engineers and contractors will find it as useful as I have.

* *

Connecting Narrows Siphon to Staten Island Main

SYNOPSIS—Land connection between New York City's Catskill Aqueduct siphon under the Narrows and the Staten Island main to Silver Lake reservoir. Pipe laid in a submarine trench of maximum depth of 50 ft. excavated to land end of water-supply pipe line. Two lines of steel sheetpiling driven before excavating started. Special arrangement of piling. New connecting pipe line had to be slid as unit on carefully adjusted track on bottom of trench and fitted in siphon by divers. Special tools used to adjust trackway.

A little over a year ago a 36-in. pipe line 9,800 ft. long was constructed under the Narrows and the great ship channel of the Port of New York, to convey Catskill Aqueduct water from Brooklyn to Staten Island. The connection of the siphon, at a point outside the bulkhead line to a point on the shore above high water, to the main leading from the waterfront to Silver Lake reservoir was accomplished in a manner altogether unusual.

The depth of the siphon varies below mean water from 50 to 72 ft., the pipe being laid in a trench with 8-ft. cover. The connection between the siphon and the main on the Staten Island shore had to be laid at El. —50 for about 100 ft. of its length, the next 150 ft. rising to El. +1.4, where the land connection was made.

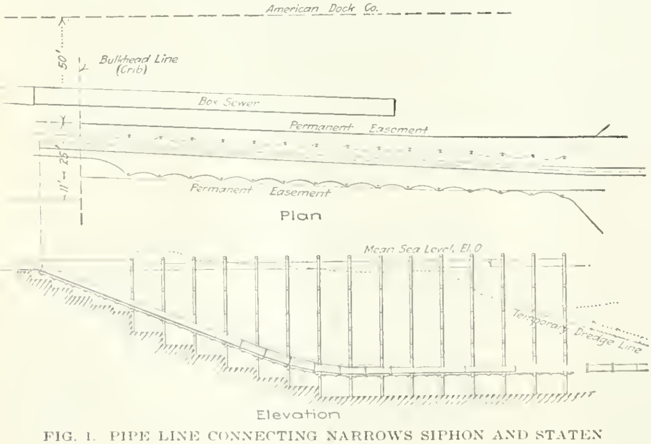


FIG. 1. PIPE LINE CONNECTING NARROWS SIPHON AND STATEN ISLAND MAIN

The profile in Fig. 1 shows the natural slope of the bank and the amount of excavation necessary in order to provide a suitable trench for the pipe. The bottom is sand overlying hardpan. Two parallel rows of Carnegie steel sheetpiling 63 ft. long were put down for a distance of about 120 ft. Thence to the shore the piling decreased in length from 60 ft. to 9 ft. The necessity for the sheeting was due to the narrow right-of-way and to the fact that the existing structures adjacent to the trench would have collapsed unless protected.

The arrangement of the piling was devised by F. T. Llewellyn, of the Carnegie Steel Co., and was put in by the Merritt-Chapman Derrick and Wrecking Co. First a series of master piles of the shape shown in Fig. 2 was put down by a derrick, using guides. The first steel master piles were placed by the derrick traveling on tracks laid on an old dock on the site, but the track arrangement was transferred to caps carried on the master piles themselves. A Hamilton steam hammer weighing about three tons and hanging from the derrick arm drove the piles.

MAINTAINING THE PILES VERTICAL

It was essential that the distance between master piles should be the same throughout their entire vertical length. This was necessary in order to insure that the intermediate piling would meet properly in an arc and without distorting the interlock. Great care was taken to keep the master piles plumb and to prevent their twisting. A timber frame, built and attached to the traveling derrick, was used as a guide for the master piles, as shown in Fig. 6. The intermediate piles were driven by three derricks equipped with steam hammers. A stationary derrick worked on the shore end, a floating derrick operated at the outer end, while a traveling derrick moving along a track built on top of the master piles drove the piling between the stationary and the floating derricks. In driving the intermediate piles, a templet of the proper curve was set between the masters, and the sheetpiles were set against this templet, being arranged as shown in Fig. 7. When an entire bay had been set up, he piles were driven. The sheetpiling was put in in ugust and September, 1915, and no excavating was done ntil this work had been completed. Excavation proeeded in much the same manner as did the pile driving. ll three derricks were employed and were equipped espectively with a 2½-yd. and a 1½-yd. Williams grab ucket and a 1½-yd. Hayward orange-peel.

Transverse Bracing and Laying Pipe Track

As the excavation proceeded, transverse struts were laced between the master piles, as shown in Fig. 2. The vo bottom struts were lowered double, being fastened t ther by long bolts carrying nuts on the upper end. A the excavation proceeded, the bottom struts continued t ower, the nuts having been set to retain the bottom it 2 in. below grade. This allowance was for errors in asurement. It was easier to pull up on the bottom t it than it would have been to let it down. If the bott strut had been left 2 in. above grade extra digging u troublesome adjusting would have been necessary.

'rom this time on until the pipe line had been laid, a f e of eight divers was employed. Four divers worked he daytime and two divers on each of the other 8-hr. w ches. Their first operation was to bring the bottom struts to the correct level. This was accomplished by screwing the nuts down on the bolt, thereby raising the strut to the proper grade. The adjustment of these nuts was not an easy matter, using the type of wrenches available. The contractor's superintendent produced a very simple wrench made from a 1¼-in. iron rod, squared at the working end and turned over twice as shown in Fig. 3. Additional leverage could be obtained by slipping a piece of pipe over the handle. The track or guides down which the connecting pipe was slid was constructed as shown in Fig. 2. It was laid in sections, each two rails in length and built up with crossties.

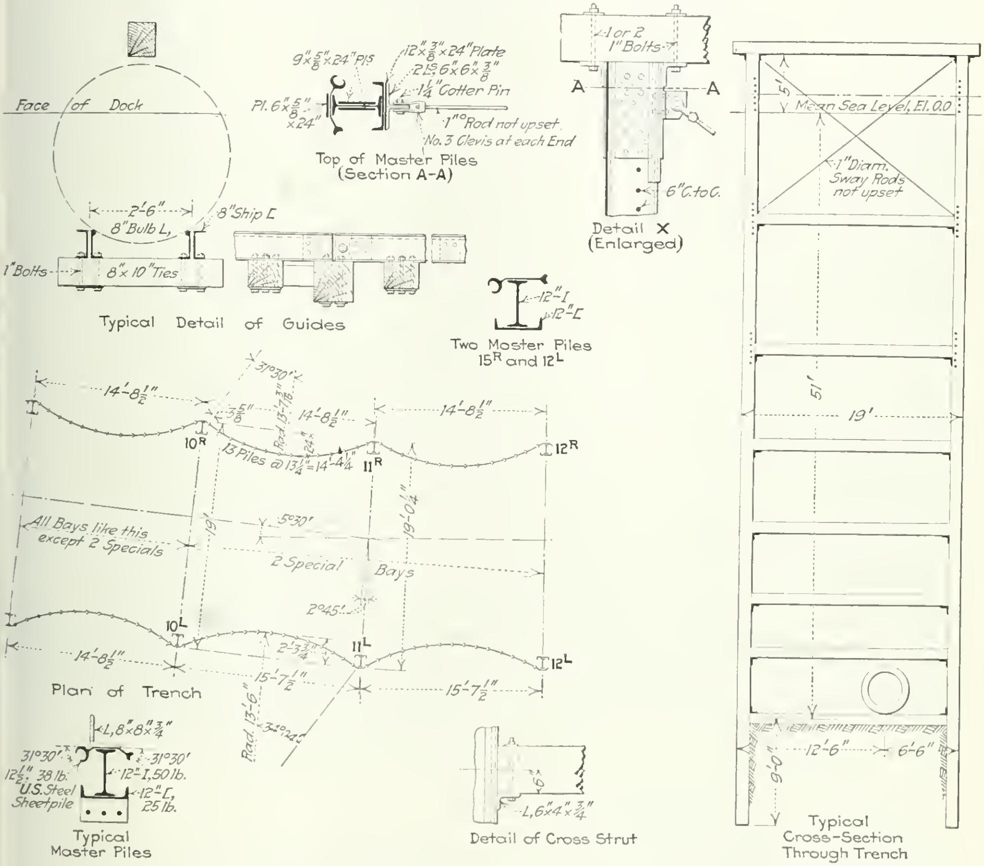


FIG. 2. DETAILS OF TRENCH CONSTRUCTION AND DESIGN OF STEEL SHEETPILING

Track-laying began at the surface and proceeded down the incline to the end of the trench. The sections were placed by divers guided by a plumb bob suspended from the overhead structure. At first an ordinary tunnel plumb bob was tried, but the motion of the diver caused it to deflect so that it was unsatisfactory. A plumb bob that gave entire satisfaction was then devised. It was made of 1¼-in. round iron 6 ft. long, pointed at the lower end and with a hole drilled in the upper. A sketch of the new plumb bob is shown in Fig. 3.

The track sections were slid down the completed track and pulled in place by the diver, who had at his disposal a line from the traveling derrick. The outer 30 ft. of track was special, being designed and built on the job, using common railroad iron.

HOW CONNECTING PIPE LINE WAS LAID

In removing the skid used in laying the pipe across the harbor, the pipe had to be left on an incline with the highest point at El. —35. This end of the pipe had to be lowered to El. —50. A floating dredge was used to remove the material on either side of the pipe. The dredge worked very carefully and as close to the pipe as possible. Divers were sent down and worked the pipe down to the required grade by the use of a water hose, washing away material underneath the pipe. It was impossible to get the exact measurement between the end of the pipe and the end of the pipe track in the sheeted trench, until the pipe was lowered to the proper grade.

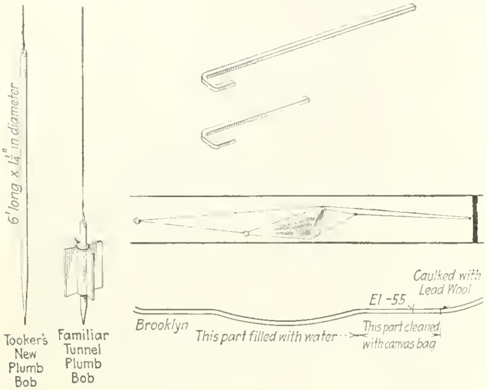

6' long x 1¼" in diameter
Tooker's New Plumb Bob
Familiar Tunnel Plumb Bob
Caulked with Lead Wool
El -55
Brooklyn
This part filled with water
This part cleaned with canvas bag

FIG. 3. SPECIAL TOOLS USED IN WORK

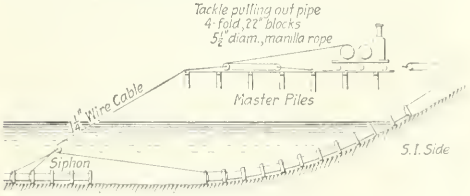


FIG. 4. HOW PIPE WAS SLID DOWN INCLINED TRACK

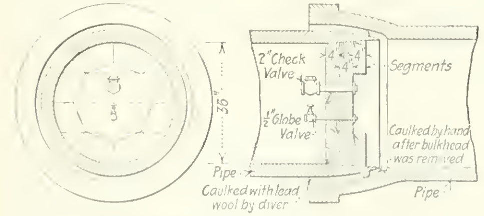

2" Check Valve
4"
4"
4"
Segments
36"
½" Globe Valve
Caulked by hand after bulkhead was removed
Pipe
Caulked with lead wool by diver
Pipe

FIG. 5. TIMBER BULKHEAD IN FORWARD END OF PIPE

The section of connecting pipe was hauled down the incline, being kept from running away by the tackle, shown in Fig. 4. Into the spigot end of the leading pipe a timber bulkhead had been built, as shown in Fig. 5. The bulkhead was penetrated by two short lengths of pipe fitted on the inside with a 2-in. check and a 1½-in. globe.

As the connecting line descended the incline and approached the finished siphon, new pipe lengths were fitted on its exposed end and calked. Finally, the bulkhead end of the line was steered into the bell end of the deep-water line. A diver calked the exterior portion of the joint with lead wool.

Compressed air was directed into the connecting line, passing through the 2-in. check valve and driving the water in the siphon toward the Brooklyn shore. When the water had been driven back as far as possible with the air pressure available, the air was shut off and then

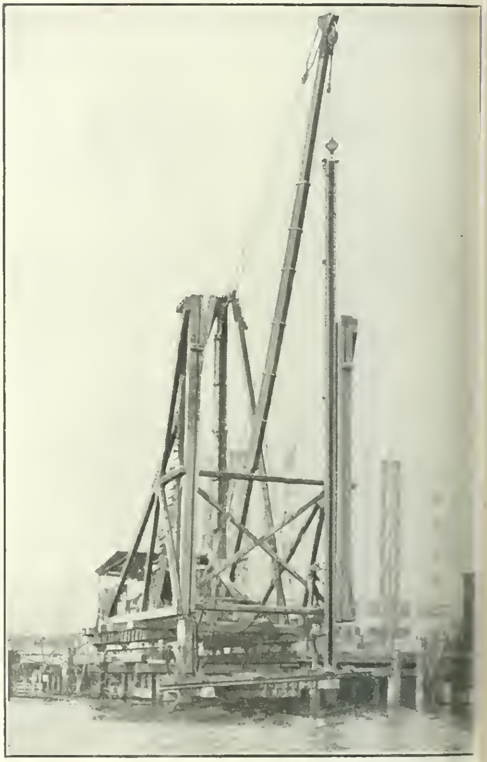


FIG. 6. GUIDE FRAMES USED TO KEEP MASTER PILES VERTICAL

allowed to escape from the siphon by way of the glo valve. The water remaining in the siphon now return a certain distance until a uniform level was establish at about El. —55, leaving a certain length of the sipho dry.

The timber bulkhead was now removed from the co necting pipe and workmen entered the siphon. The latt was found to contain considerable mud in the unwater length, and this was cleaned out by means of a canvas b (Fig. 3) fitted with a hoop at one end and used like dragline. Workmen now calked with lead wool the inn portion of the joint between the connecting pipe and t older submarine line.

The connection having been made to the siphon and t joints being found tight, backfilling was begun. As t work proceeded the transverse struts were removed. T

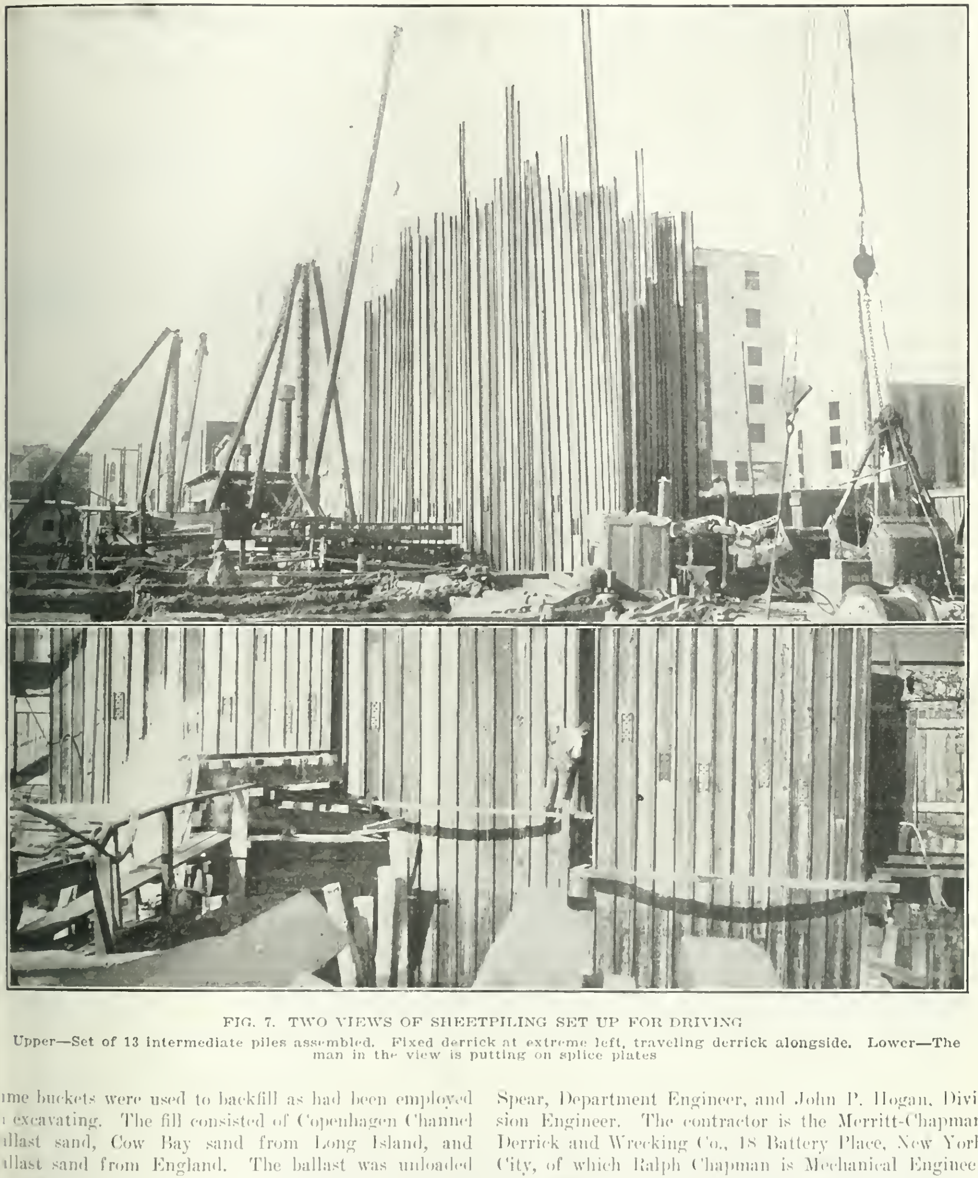


FIG. 7. TWO VIEWS OF SHEETPILING SET UP FOR DRIVING

Upper—Set of 13 intermediate piles assembled. Fixed derrick at extreme left, traveling derrick alongside. Lower—The man in the view is putting on splice plates

ıme buckets were used to backfill as had been employed ı excavating. The fill consisted of Copenhagen Channel ıllast sand, Cow Bay sand from Long Island, and ıllast sand from England. The ballast was unloaded ·om ships onto flat scows, which were towed to the trench nd unloaded by the buckets.

The excavation and the placing of the transverse struts ·cupied the time from September, 1915, to January,)16. Laying the track and pulling the connecting pipe ıto place was finished by the middle of April, while the ıckfilling was practically complete June 1. Since then ıe contractor has been engaged in recovering the sheetles.

The work was done under the supervision of the Board ' Water Supply, of which J. Waldo Smith is Chief Engi·er; Alfred D. Flinn, Deputy Chief Engineer; Walter E. Spear, Department Engineer, and John P. Hogan, Division Engineer. The contractor is the Merritt-Chapman Derrick and Wrecking Co., 18 Battery Place, New York City, of which Ralph Chapman is Mechanical Engineer and I. M. Tooker is Superintendent on the job.

⁂

Iron Ore Mined in the United States in 1915 reached a total of 55,526,490 gross tons, the greatest output made in any year except 1910 and 1913. Shipments (valued at $101,288,984) were a little less than the quantity mined. The latter was an increase of 14,000,000 tons over the output in 1914. The increases in quantity and in value of iron ore shipped amounted to about 40 and 41% respectively. The average value per ton in 1915 was $1.83, compared with $1.81 in 1914. These figures, which are just made public by the United States Geological Survey, were prepared by E. F. Burchard who states that the production of iron ore from the Lake Superior district, alone, in 1916 will possibly be 60,000,000 tons, and that there will probably be an increase in price of 70 to 75c. a ton for this ore.

Concrete Bridge Completed from Suspended Forms

By F. R. Goodman*

A flood that washed out the centering of a reinforced-concrete bridge under construction over the Little Colorado River, four miles east of Holbrook, Ariz., last winter, not only demonstrated the stability of the structure at an age before it normally would have been self-supporting, but forced the engineers to resort to unconventional methods in the erection of the incompleted side brackets.

The arch is a Luten design reinforced-concrete highway structure of 174-ft. span and 20 ft. 9 in. rise. It consists of a single barrel arch rib 8 ft. wide with spandrel walls filled between with earth. The full width of the roadway (16 ft.) has been gained by reinforced-concrete slabs resting on cantilever brackets, spaced 7 ft. on centers. In line with these brackets a reinforced-concrete tie-beam connects the tops of the two spandrel walls.

The construction work was begun by the Arizona State Highway Department, using day labor, on Oct. 29, 1915. The centering is founded on bents of 10-in. piles, five of the piles in each bent being centered under the main arch rib and one under each bracket. On these piles were carried fan-shaped struts which supported the lagging and which were made up of three 2x8's arranged T-fashion and wired together after the well-known Luten patent. The wires were to be cut to allow the arch to be sprung.

Owing to the quantity of concrete in the ring (260 cu.yd.) and the small capacity of the mixing plant, it was decided to cut the ring into transverse sections somewhat narrower than the main arch rib and to make three pourings instead of one continuous run for the entire amount.

A key section was poured first, two spring sections second and the two intermediate sections last. The third sections were poured just as soon as the concrete in the second section had set sufficiently to allow the intermediate forms to be removed. This work was started along toward the end of December. At no time during the pouring of th concrete ring was the thermometer above 40° F., th temperature at 7 a.m., noon and 6 p.m. each day being 16°. 38° and 26° at 7 a.m.: 20°, 40° and 26° at noon: 12°, 40° and 30° at 6 p.m. respectively. Neither material nor water was heated. However, no frozen concrete was allowed to go into the forms The first pouring did not extend to the full 8-ft. wid of the arch rib but only a far as the inside edge of th spandrel wall, and it was th intention to complete th bridge in another operation b pouring the remainder of th rib and its superposed floo and extending brackets o forms resting on the falsework In pursuance of this scheme after the arch ring had set sufficiently to remove the outsid form, the pouring of one spandrel wall and floor bracket was begun and continued until the entire length of th span was completed. Then th other wall was completed i like manner. The concrete w deposited alternately on opp site ends of the span, begn ning at the abutments, so as t keep a uniform loading on th falsework. On Jan. 19, 191 the fourteenth day after th second wall was poured, th arch rib was completed, th

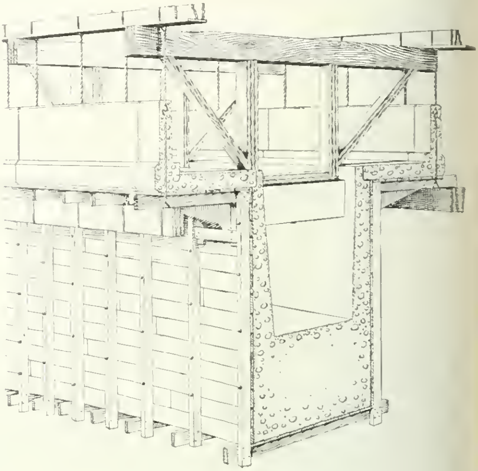
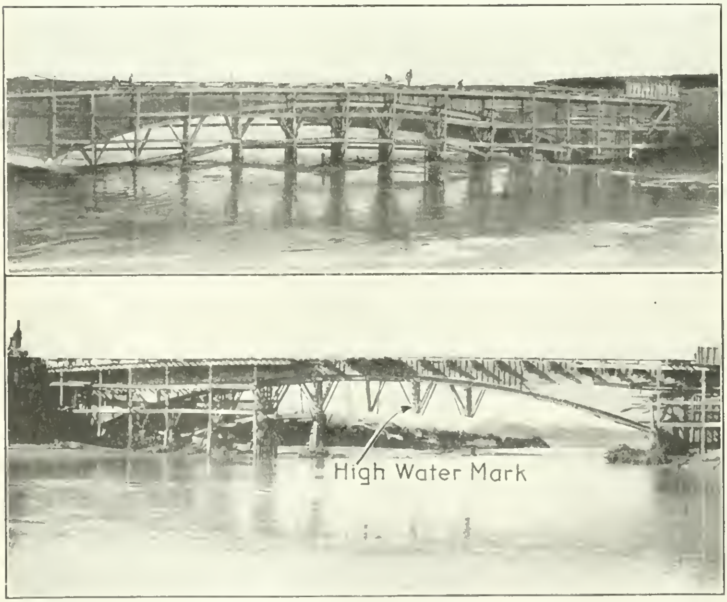


FIG. 3. METHOD OF SUSPENDING FORMS FOR COMPLETING BRIDGE



FIGS. 1 AND 2. FLOOD WASHES OUT FALSEWORK AND CENTERING OF UNFINISHED BRIDGE

spandrel walls were completed, and all of the brackets and tie-beams were in place. On that day a sudden flood in the river took out 8 of the 13 bents of falsework (see Figs. 1 and 2). The Little Colorado River at this point has a fall of approximately 11 ft. per mi. and carries a large amount of driftwood at all high-water stages, but the amount during this flood was excessive. The débris was piled up to within 4 ft. of the crown of the arch. A ottonwood tree about 30 in. in diameter at the trunk tuck broadside, causing the final failure. Notwithstanding the fact that the oldest concrete was only about month old and had been placed in practically freezing veather, the arch stood intact with hardly any deflection.

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*Division Engineer, Arizona State Highway Department, Coconino County, Parks, Ariz

With the supporting falsework gone, the problem of onstructing the floor and the handrail remained. It was mpracticable to drive new centering under the brackets, vhich were considered not to be of sufficient age to warant their being used as the basis of forms to carry the ad to the new concrete, particularly on account of the old weather during which they were poured. It was ecided, then, to suspend the forms for the floor from ie completed work. The method of doing this is shown in erspective in Fig. 3.

Trussed frames were erected on the completed tie-beams nd arch rib and from their outside extremities were hung ngitudinal stringers that in turn carried joists. These ists at the outside rested on the stringers and at the iside were fastened to the studding and lagging of the andrel-wall forms, which had been left in place wired rough and thus were quite capable of holding loads. On ie floor thus built the cantilever slabs were laid.

The labor cost of constructing this suspended falsework as $27, the material used being form lumber taken from e spandrel walls and the arch ring. After a delay of days from the pouring of the last spandrel wall the or slab and handrail were commenced and continued til completion.

The State Engineer of Arizona is Lamar Cobb. T. F. ichols is Bridge Engineer, and the writer was in charge the construction work described.

An Attempt To Standardize Valuation Terms

The Valuation Committee of the American Electric ilway Association, in its report at the recent Atlantic ty convention, proposed a list of 21 words (drawn up by G. Young, Consulting Engineer, New York City) ich it was thought would cover all the terms which it uld be necessary to employ in discussions of valuation itters. This list, which is reprinted below, would replace longer list of 300 odd words whose use has been noted.

OPOSED DEFINITIONS OF WORDS USED IN VALUATION WORK

1. Public utility:

A business operated under a public grant and performing tipulated public service for compensation.

2. Franchise:

The grant by a public authority of the necessary rights do a specific business, and including the use and occupancy some portion of the public lands.

3. Property:

That which is owned by a company or individual by virtue legal rights through possession, title or lease.

4. Ownership:

The legal title to, or possession of, property.

5. Value:

Worth (see definition of worth).

6. Valuation:

Act of determining worth.

7. Worth:

Exchangeable value (Webster).

Including every item of value entering into and affecting the value of a property, tangible and intangible, physical and nonphysical, also every kind of value from whatsoever sources derived, or by whatsoever means or cause affected, favorable or unfavorable, and as of the present time and including full consideration of past performance and future probability.

Notes—(a) It is seen that worth (value) is not constant, but is affected and increased or diminished from time to time by a number of conditions and circumstances.

(b) That worth (value) is dependent, among other things, on earnings and therefore on rates and tariffs charged for the services rendered

(c) That worth (valuation) thus defined cannot be made the basis of the amount on which a reasonable return is to be allowed by courts.

(d) That an appraisement only shows a part of the worth of a property.

(e) The ward "value" should not be used except when worth is intended.

8. Investment:

The total amount of cash, or its equivalent, that has gone into the creation and development of a property, from whatsoever source derived, including new money used for obsolescence and development.

9. Capital:

The total number of shares of a company, preferred, ordinary or otherwise.

Notes—When these shares have a stipulated par or face amount, the total aggregate sum expresses the capital of the company.

(a) The capital face amount of a company may be more or less than the investment, and is divided into more or less shares for convenience of increasing or decreasing the fractional, partnership divisions.

(b) Capital shares have no fixed relation to the investment.

10. Sinking fund:

An accumulative fund, set aside from earnings from year to year, out of which moneys are paid for amortization of investment.

11. Amortization:

The repayment from time to time of part of the investment by means of a sinking fund.

12. Obsolescence:

The state of becoming obsolete (Webster). The replacement of property before it has reached its full period of usefulness due to,

(a) The advance of or changes in the art or process in practice, or

(b) Public legislation or demand.

13. Depreciation:

Is the lessening in worth of physical property due to use or other causes.

14. Appreciation:

The increased worth of any part of a property not due to additions to investment.

15. Maintenance:

The cost of repairs and renewals for the proper up-keep of a property. Maintenance is of two kinds.

Ordinary and deferred:

(a) Ordinary Maintenance—Those repairs which are made each year as needed.

(b) Deferred Maintenance—Those repairs which cannot economically be made each year but which are made at frequent intervals.

Note—Maintenance is a part of the cost of operation.

16. Rate of return:

The percentage rate of return earned and paid on the total investment.

17. Tariff rates:

The charges made and collected for services rendered.

Note—The theory being that the rates should be sufficient to cover all operating expenses, repairs and maintenance, depreciation, obsolescence, rewards of management, legal expenses, accidents, insurance, taxes, and general overhead and miscellaneous expenses; also a stipulated amount for amortization and sinking fund, interest on bonds and other forms of indebtedness, and dividends to cover the rate of return allowable on the total investment.

18. Inventory:

The count or measure of all separate items comprised in a property, including physical property as well as certificates or other evidences of ownership.

19. Appraisal:

A complete study of a property showing the cost to reproduce new, based on inventory, and also showing depreciation.

Note—An appraisal is but one of the factors to be considered in determining worth.

20. Intangibles:

Such items of value of a non-physical nature as such are not represented in the existent property but reasonably constitute a definite part of the assets of a corporate enterprise, such as contractual rights (franchise value), expenses incurred in development of plant or business, damages resulting from condemnation proceedings, etc., etc.

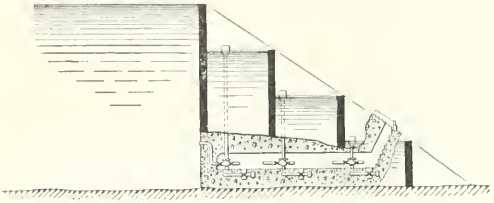
21. Overhead costs:

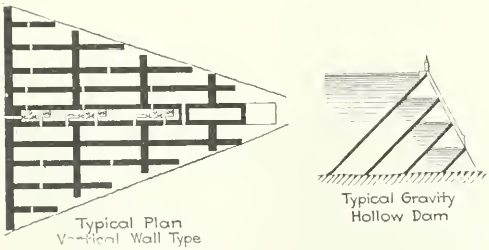
Such general and miscellaneous expenditures, forming a portion of the cost of a property, which, because of their nature, are not or cannot be included in the unit prices.

New Hollow Concrete Dam with Subdivided Water Pressure

Just before the entry of Italy into the European War full plans had been made for the construction at Genoa of a 157-ft. high reinforced-concrete hollow dam of novel type. The construction was held up by the war, but it is stated that it will start as soon as conditions admit. An American patent (No. 1,167,116) of the dam type has been secured by the inventor, Peter Rutenberg, 675 East 170th St., New York City.

The details of a dam of this type are shown in the accompanying drawing, which illustrates the principle, but not necessarily its structural variations. As shown there, the patented design consists of a development of the ordinary hollow reinforced-concrete dam section, so that instead of having one deck there are a number of parallel decks of decreasing height extending back from the reservoir face to the rear of the dam, dividing the structure into a series of intercommunicable water-filled wells formed by the decks and the buttresses.


Typical Cross-Section Vertical Wall Type


Typical Plan Vertical Wall Type

Typical Gravity Hollow Dam

RUTENBERG HOLLOW CONCRETE DAM

The essential element of novelty is that the decks are subjected not to the full head of water retained, but to the difference in head between the water levels on the two sides of each deck. These water levels are maintained at proper elevation by automatic valves placed in the buttresses and intercommunicating between the upstream and downstream wells. Openings in the buttresses assure the distribution of the water along the dam.

The advantages claimed for this type of dam are: (1) A smaller volume of concrete than for the ordinary reinforced-concrete dam. This is due to the fact that while the multiple decks require more concrete than the one deck of an ordinary reinforced-concrete dam (even though each is designed to resist only the increment of head), the buttresses can be made sufficiently lighter to make up the excess in the decks on account of the more thorough bracing insured by the decks. (2) Greater safety, because no one part of the dam is subjected to anything but a small proportion of the total head of water. (3) Less danger of percolation under the dam, owing to this same subdivision of the head. (4) Provision for a safe disposal of flood waters by the waterfall effect, so termed.

The inventor claims that, even should the valves not work, there would be no danger of the lower wells emptying out and leaving the full head of the reservoir to be taken by the upper deck, with consequent failure of that deck and progressive failure of the rest of the dam, because before this happens the lower part of this main deck would break under a head much greater than that for which it was designed, thereby allowing an opening for the water to go into the next lower well, and that this process would continue down through the well and automatically relieve the pressure on any one deck. He does not, however, anticipate any trouble in maintaining the valves in continual working order.

Asphaltic-Concrete Paving at Oak Park, Ill.

A considerable amount of asphaltic-concrete paving is being done at Oak Park, Ill., which is largely a residential suburb of Chicago, with heavy team traffic only on the main streets. There is, however, heavy local and through automobile traffic. The work includes both the construction of new streets and the improvement and resurfacing of old macadam. All work is done under special assessments, and the contractors give a five-year guarantee.

This kind of paving has been used for about five years, and for the present work a special mixture was devised to meet the traffic conditions. It is intended to combin low first cost with permanence, thus reducing maintenan expenses. This was done under the direction of W. F Sargent, Commissioner of Public Works and Chief Engi neer for the Board of Local Improvements. Dudley C Myers is engineer in charge of construction, and H. W Skidmore is chief inspector.

The contractors take the entire work, but generally sub let the concrete curb and gutter to men who make thi a specialty. The engineers exercise close inspection o the work and keep account of the cement that goes int the concrete in order to insure that a sufficient proportio is used. The width of paved street is usually 30 ft crowned to 3 in. above top of curb.

On the work done in 1915, the cost of 2-in. asphaltic concrete paving on 6-in. concrete base was $1.35 per sq ft. ($1.13 per front foot). Where 2-in. asphaltic con crete was laid directly on old macadam, the cost was 91.7 per sq.ft. ($2.93 per front foot).

Asphaltic-Concrete Surfacing

The Topeka mixture used at first did not prove entirel satisfactory, and the conditions were investigated by Leste Kirschbraun, testing engineer, of Chicago, who made la oratory tests with various aggregates. The coarse aggr gate of the mixture adopted is of the same size as th in the Topeka mixture but in larger proportion, whi the mortar or asphaltic cement is practically the same for a sheet-asphalt mixture.

The mix (by weight) is approximately 40 to 55 crushed limestone, 36% sand, 7% stone dust and 7 bitumen, or asphaltic cement. All the stone must pass a ½-in. sieve, with not more than 10% retained on a ¼-in. sieve. The stone-dust filler must be of such fineness that at least 65% will pass a 200-mesh sieve. Where team traffic is carried, granite or crushed gravel is used in place of limestone.

The asphaltic cement is required to meet the sheet-asphalt specifications of the Society for the Standardization of Paving Specifications (now the American Society for Municipal Improvements). The Trinidad asphalt is used principally; also some Mexican (Aztec) asphalt. A common mixture is 75% Trinidad asphalt and 25% Standard road oil. The material must be heated to 300 or 325° F. and then combined with the hot sand, stone and filler (at about 375° F.) in a mixer having revolving blades. This mixer must be so arranged as to retain the heat, but must not expose the material to the direct action of the fire.

The asphaltic concrete is hauled to the work in covered wagons, and is required to have a temperature of not less than 250° F. when deposited. For the work this season the Commonwealth Improvement Co., of Chicago, has used a Cummer one-car railway plant installed on a siding, so that the haul is short (about 1½ mi. maximum). Other contractors have prepared the material at stationary plants in Chicago, delivering it in large motor trucks. Even with a haul of 15 mi. the material would be at nearly 300° F. when deposited.

The asphaltic concrete is deposited directly upon the oncrete base, and spread with forks and iron rakes, being eveled in such a way as to give a finished thickness of in. Heavy rolling of the hot mixture is one of the pecial features of the work. This is done with steam ollers of the tandem type, weighing 8, 10 and 15 tons. A three-wheel 10-ton roller is also to be tried. This use f heavy rollers gives a close initial compression, and the mass is of such consistency and so well anchored by the ough surface of the concrete base that it does not mash ut or flow away under the heavy roller.

After the first rolling, the material is allowed to cool, as the rolling is done continuously cracks are likely to develop. The rolling is then resumed, about five hours per ,000 sq.ft. of surface being required. Lighter tandem ollers are used to finish or iron out the surface.

The asphaltic concrete is laid in one operation, and nished with a brushed coat of dry portland cement. No al coat is applied and no binder course is used, the concrete base being given a rough surface (as noted below) effect a mechanical bond. Nor are sand or screenings pread upon the finished surface, as such a coating is rushed under traffic and blown away without serving any seful purpose. In fact it is objectionable on account the dust thus produced. The work is done continuously as far as possible. Where a joint must be made, e surface of the cold material is dressed to a feather-ge and painted with asphaltic cement before the new ot material is laid.

CONCRETE BASE AND CURB

The subgrade is dressed to conform to the crowning the roadway, and is well compacted with a heavy roller. pon this is laid the 6-in. concrete base, with its top in. below the surface of the finished pavement. This is 1 : 3 : 6 mix, using ½- to 2-in. crushed limestone for the arse aggregate. Fine limestone screenings are used in place of sand, as they make a thicker or more creamy slush. A man with a broom sweeps the excess slush ahead and by skillful use of the broom gives a rough surface to the concrete, with stones projecting ¼ to 1½ in. above the normal surface. These projections form an effective bond, or anchor, for the bituminous top course, so that the binder course is dispensed with, as noted before.

The specifications require the mixer to be run at 14 r.p.m., and each batch revolved for a period of one minute. They also require the use of a spout or boom-and-bucket for distribution, depositing the concrete at a distance of about 14 ft. from the mixer. The angle of the chute is generally 20°.

The concreting gangs average 27 men, with a 1-yd. mixer. With a 50-man gang as much as 2,400 sq.yd. of 6-in. concrete base has been laid in a 10-hr. day. The materials are dumped in piles by motor trucks or dump wagons, and are delivered to the mixer in wheelbarrows. The inspector keeps careful record of the amount of cement per yard of concrete.

The ends of the pavements (where they connect with unpaved streets) and the sides in streets having car tracks (unpaved) are protected by headers of 3x12-in. oak planks. The transverse headers have the upper surface dressed to the crown of the roadway. They are secured by 6-in. cedar posts 3 ft. long, and backed with a layer of crushed stone. This prevents the cutting and disintegration of the asphaltic concrete by wheels passing on and off the paving. In some cases a 4-in. concrete header is used.

The combined curb and gutter is of concrete on a cinder bed, and is laid in 6-ft. lengths. It has a 7-in. curb, the face of which varies in height from 5 in. at the summits to 10 in. at the catchbasin inlets; the 6-in. gutter flag is 18 in. wide. The mix is 1 : 2 : 4, using fine granite screenings and crushed granite of ¼- to 1½-in. size. A 1 : 1 mortar finish (made with the fine granite) is applied, ½ in. thick on the top and face of the curb and 1 in. thick on the gutter. The surface of the gutter has an upward slope of ⅔ in. per ft. to conform to the crowning of the roadway. A ½-in. asphalt-filled expansion joint is made at each summit between the catchbasins.

MISCELLANEOUS FEATURES OF THE PAVING

Where old macadam paving is over 5 in. thick, it is dressed to subgrade and upon it is laid a 2-in. course of new asphaltic-concrete wearing surface.

On streets that are to be repaved, the sewers and house connections are tested with rods, and the connections are opened up at the curb line for inspection. Any necessary repairs are then made. The water and gas mains, electric conduits, etc., are also overhauled before the new work is started. All old iron catchbasins are taken out and replaced with new brick catchbasins; and new brick manholes are built where necessary. The new curb inlets to catchbasins have not only the horizontal grating but also a vertical opening (without grating) in the face of the curb, so that there may be no obstruction by leaves or débris during storms. The horizontal grating (in the gutter flag) is locked down upon its frame, so that it cannot become loose or noisy. All new manholes also are fitted with the Dougherty nonrattling self-locking covers.

Some of the grading for new streets has been done with Maney four-wheel scrapers, a 10-ton steam roller being used to haul them when loading. Difficulty has been found in cutting to exact grade in this way, and to avoid cutting too deep the machines have cut a little above normal, the surface being then trimmed to exact grade by hand. The haul is short, most of the excess excavated material (not required for parkways, etc.) being deposited as fill on vacant lots.

Concrete paving is being used for the alleys, which are generally 16 ft. wide. The concrete is 6 in. thick on a 6-in. bed of cinders. Sometimes the paving is crowned or convex, but it is dished or concave wherever sufficient fall can be secured to carry the water to the adjoining streets. Expansion joints are placed 33 ft. apart.

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Organization of the Baltimore Water Department*

The accompanying chart shows the organization of the Baltimore Water Department. There are five divisions, each responsible for work of a specific character, the head of each division reporting directly to the water engineer, Walter E. Lee.

The new Construction and Maintenance Division, under a principal assistant engineer, represents the consolidation of the former engineering and construction divisions and provides for close engineering supervision of all construction, maintenance and testing work, the previous lack of which resulted in slow and costly construction.

Reporting to the principal assistant engineer, as shown on the chart, are (1) an assistant engineer in charge of construction, who supervises all general extension work of the underground system as well as work in streets in advance of improved paving; (2) an assistant engineer in charge of maintenance, who supervises the installation of house, meter and fire services, and the repair and maintenance of mains and appurtenances (which have been transferred to him by the assistant engineer in charge of construction); (3) a pitometer engineer who is in charge of pitometer tests for the detection and elimination of underground leaks in both mains and house services, and who also has charge of daily house-to-house inspection.

The pitometer engineer also has charge of the installation of curb cocks and boxes, and the testing of mains by hydraulic pressure to double their working pressure before releasing streets to the city paving department for laying new paving.

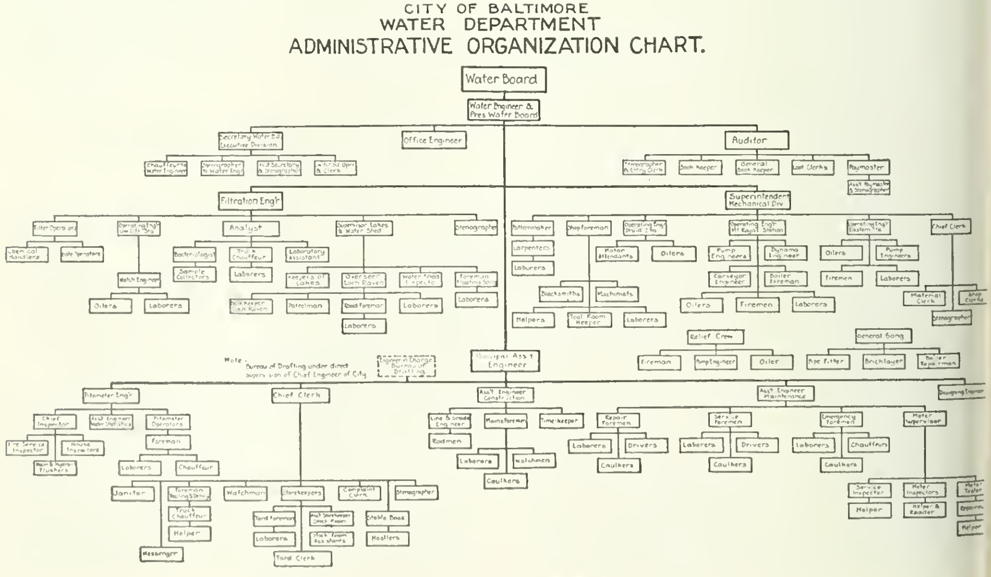
A designing engineer reporting directly to the principal assistant engineer is detailed to have entire charge of power-plant design and equipment, and special work problems.

A chief clerk handles all the office detail, which prior to the reorganization of the Water Department fell directly upon the principal assistant engineer, with the result that instead of five subordinate heads, each in charge of a specific group, reporting to him as at present, there were as many as 24 minor employees reporting directly to him, which left very little time for his attention to engineering matters.

The Mechanical Division reporting to its superintendent embraces the operation and maintenance of the Mount Royal pumping station, which pumps to the western part of the city, the Eastern pumping station, which pumps to the northeastern section of the city and the Druid electric pumping station, which supplies West Arlington, Walbrook, Forest Park and Guilford, an operating engineer being in charge of each pumping station and reporting directly to the superintendent.

A shop foreman is in charge of the machine shop in which general machine repairs are made and overhea expense balanced by the manufacture of hydrants an valves. He also has charge of the machine shop, tool room and blacksmith shop.

A chief clerk is in charge of the office and general work of the Mechanical Division, supervising all shop orders



ORGANIZATION CHART OF THE WATER DEPARTMENT OF THE CITY OF BALTIMORE, MD.

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*From the Baltimore (official) "Municipal Journal."

and keeping records of manufacturing costs and stock and material on hand. Here, as in the Construction and Maintenance Division, the chief purpose was to relieve the division head from being crowded with too great detail, so that attention could be given to more efficient plant operation.

A relief crew, consisting of a pump engineer, fireman nd oiler, "floats" from station to station, thereby eeping up the continuous 24-hr. operation on a relief chedule. A general gang, composed of a pipe-fitter, ricklayer and boiler repairman, also "floats" from one umping station to another, making repairs to boiler ettings, furnace walls, tubes, stacks, piping, etc.

A Filtration Division was organized as a new operating nit following the completion of the new rapid sand-filter lant at Lake Montebello. The scope of the work was nlarged to include the entire watershed, consisting of 08 sq.mi., the storage and pounding reservoir at Loch aven, reserve storage and distributing reservoirs throughut the city, as well as the operation of the Montebello lters proper. This placed the entire water-supply up o the point of distribution directly under the supervision f a trained engineer who could correlate rainfall, stream ow, turbidity and pressure head with the treatment of e water as it passes from the mixing and coagulating sins prior to its being passed on its way through the nd filters.

The operating engineers, one on each 8-hr. shift, are direct charge of the low-lift pumping station, which kes the water from the 12-ft. masonry tunnel under och Raven and pumps it to the filtration plant. Filter erators, one on each 8-hr. shift, are in charge of the ter galleries and the washing of the sand beds, and port directly to the filtration engineer.

A chemist is in direct charge of the laboratory in which e physical and bacteriological qualities of the water are termined, and he also has charge of the truck crew ich hauls the chemicals used at the plant.

A supervisor of lakes and watershed, reporting to the tration engineer, has direct supervision of the patrol r policing) and maintenance of the watershed, and the keep and care of all reservoir properties throughout e city.

The Executive Division, in charge of the secretary of Water Board, handles and distributes the mail of the tire department, transacts its general public business d issues Water Department permits.

The Auditing Division, reporting to the auditor, hans all the billing of work included on order, the issuance specifications and the execution of contracts, the mpilation and analysis of cost data for a summary tement to the water engineer, and gives a close check to all requisitions issued by the five divisions.

In order to eliminate lost motion and obtain more nomical operation, there are held biweekly discussions Water Engineer Lee with the five division heads. ese meetings tie together the work of the Water partment as a whole and coördinate the work of one ision with another to the general efficiency of the artment.

he reorganization of the Water Department has ulted in an enormous reduction in overhead expense, ompanied by the elimination of obsolete and useless itions, and the consolidation of work under assistant gineers and chief clerks.

American Trenching Machines in the European War

A feature of the engineering activities in the great war is the use of American trench-excavating machines to dig the long lines of trenches required for the protection of defensive and reserve positions behind the actual front. The speed and steady work of such machines, and the fact that their use would avoid the necessity of employing large numbers of fighting men for such work, led to their consideration by the British, French and Russian military authorities early in the war. At the recent meeting of the Iowa and Illinois sections of the American Water-Works Association, at Davenport, Iowa, a paper on this use of trenching machines was read by A. E. Miller, of Des Moines, who was in charge of the design and superintended the erection and testing of the American machines in Europe, besides training the men to operate them.

Many special conditions had to be met. One of the first difficulties was in regard to the line of the trench. The machines are adapted for cutting on long straight lines, but for military purposes the trenches were to be in the form of an irregular line, each stretch consisting of three sides of a rectangle, thus protecting the men in the trench from enfilading fire. As the ordinary machine could not turn right angles or turn in 12-ft. lengths, a sawtooth line of trench was adopted, giving room for the machines to swing in turning the angles. Each stretch was 50 ft. long.

The first machine was shipped to England and then to France, where the actual tests were commenced. Here the country was rough, and the lines of trenches lay behind stone walls, along sidehill ground and through woods. For successful work under such conditions special designs of machines would have been required. On the Russian front, however, the country was level and open, and more use was made of long straight stretches of trench. As a result of the tests 22 gasoline trenching machines were ordered. These cut trenches $3\frac{1}{2}$ ft. wide and as deep as 6 ft. They were shipped from Seattle to Vladivostok and thence were forwarded to Moscow, where an assembling and training station was established in charge of Mr. Miller.

The first of these machines was sent to the front in October, 1915, but as the ground was getting frozen, the winter was spent in training the soldiers assigned to the service, there being two enginemen and two helpers for each machine, to provide against accidents. The work of the machines was done at 30 to 250 mi. from the fighting line. Special troubles encountered were drainage in some cases and the caving of the sides in other cases.

Numerous suggestions were made by the engineer officers for a trenching machine that could be used for sapping and trenching at the actual front. This service would require a machine that would travel on the bottom of the trench (instead of on the surface) and be entirely below ground. Such a machine was designed by Mr. Miller; but it is thought that this was not built, although several experimental trenching machines were built in England under the direction of the military engineers. A special difficulty in the design of such machinery is the necessity for combining both strength and lightness, so that the machines will be sufficiently reliable and at the same time readily portable.

In assembling the machines the work progressed very slowly, as compared with American practice, and it was difficult to get men to adopt methods new to them, while men in charge hesitated to accept responsibility without referring the matter to the next man higher up. Among those in higher authority Mr. Miller found a very favorable opinion of American work and methods and a strong desire for closer commercial relations in the future.

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Effect of Seasonal Rainfall on Annual Runoff

By James P. Wells*

It is not an uncommon statement that the amount of annual runoff will be equal to a certain percentage of the annual precipitation. However, from a careful study of the relation between rainfall and runoff it is evident that even on a particular stream the percentage of the rainfall which runs off is different every year. The fact is that on a given stream the seasonal distribution of the rainfall has more to do with the amount of runoff than anything else.

The late G. W. Rafter, for the purpose of a clearer understanding of the relations between rainfall and runoff on New York streams, has taken a year as beginning with December instead of January. This year Mr. Rafter called the water year and divided it into three periods: December to May, he designated as the storage period; June to August, growing period; September to November, replenishing period.

The Flood, Growing and Replenishing Periods

The writer calls January to May, the flood period, June to September, the growing period, and October to December, the replenishing period. Almost always the ground is saturated by the first of January and during the next five months by far the greater portion of the precipitation runs off. The following four months comprise the main part of the growing season, during which vegetation absorbs most of the rainfall and the supply of groundwater is also drawn upon. The rains of the next three months, which comprise the replenishing period, are for the greater part absorbed by the ground to replenish the depleted groundwater supply. These are the average conditions but do not hold true every year. In some years, the ground becomes saturated by the end of November and in others the groundwater supply is low until February of the next year or even later.

It can easily be seen that the runoff will be affected by the distribution of rainfall as to seasons.

Rainfall and Runoff on the Chemung River Basin

The effect on runoff of the distribution of the precipitation throughout the year is illustrated by the records for the Chemung River watershed for the years from 1907 to 1912. The Chemung River drains the hilly country in the southern-central part of New York state. It is described in Water Supply and Irrigation Paper No. 109 as follows:

> The topographic features of the drainage basin are, as a rule, bold and broad, the hills rise within a short distance of the stream several hundred feet on either side, and the upland plateau is to a large extent wooded, with impervious soil, no lake storage and few marsh areas. Tributaries are ramifying and uniformly distributed though not numerous, and dry gullies or flood channels are common.

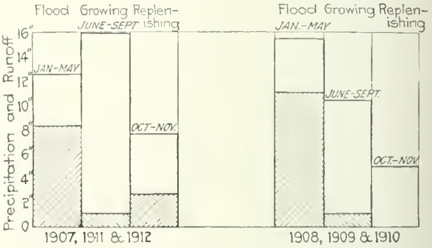
CHEMUNG RIVER RAINFALL, RUNOFF AND EVAPORATION DATA; INCHES IN EACH PERIOD

	Flood Period			Growing Period			Replenishing Period		
	Rainfall	Runoff	Evaporation	Rainfall	Runoff	Evaporation	Rainfall	Runoff	Evaporation
1907 ...	11.27	7.62	3.65	13.40	1.10	12.30	8.70	3.66	5.04
1911 ...	11.88	6.31	5.57	15.24	0.73	14.51	7.09	2.07	5.02
1912 ...	14.61	10.73	3.88	19.14	1.60	17.54	7.39	2.37	5.02
Mean.	12.59	8.22	4.37	15.93	1.14	14.79	7.73	2.70	5.03
1908 ...	16.05	12.17	3.88	10.16	1.06	9.10	4.88	0.24	4.64
1909 ...	13.31	9.15	4.16	10.71	1.41	9.30	4.97	0.23	4.74
1910 ...	16.85	11.68	5.17	10.28	0.85	9.43	5.03	0.40	4.63
Mean.	15.40	11.00	4.40	10.38	1.11	9.27	4.96	0.29	4.67

	Rainfall	Runoff	Evaporation	%	Rainfall	Runoff	Evaporation	%
1907 ...	33.37	12.38	20.99	37	....	....	....	..
1908 ...	....	....	....	..	32.09	13.47	18.62	42
1909 ...	....	....	....	..	29.00	10.79	18.21	37
1910 ...	....	....	....	..	32.16	12.93	19.23	40
1911 ...	34.21	9.11	25.10	27	....	....	....	..
1912 ...	41.14	14.70	26.44	36	....	....	....	..
	36.24	12.06	24.18		31.11	12.40	18.71	

At Chemung, N. Y., a few miles east of Elmira, the drainage basin has an area of 2,440 sq.mi.

The rainfall for the basin has been determined by averaging the records of well-distributed stations. In three of the six years recorded, 1907, 1911 and 1912, the greater part of the precipitation occurred during the growing season, while in the other years, 1908, 1909 and 1910, it occurred in the flood period. In the first-mentioned years the average rainfall was 36.24 in. and the runoff only 12.08 in. In the other three years the average rainfall was only 31.11 in., over 5 in. less than in 1907, 1911 and 1912, and yet the runoff was slightly greater, amounting to 12.40. In the years in which the greater part of the precipitation occurred during the flood period there was a greater annual runoff, for at this time the ground was in either a saturated or a frozen condition. During the growing and replenishing season the rainfall was less than normal and as a result it was practically all needed for vegetation and to replenish the groundwater supply, so that the runoff was very light. It should also be noted that the amount of the evaporation increased steadily from 1908 through 1911. This was due to the fact that each year the precipitation during the replenishing period was insufficient to saturate the ground and more of the precipitation which fell in the flood period of the following year was needed to replenish the groundwater supply. In the years in which the greater part of the precipitation occurred in the growing season a much larger amount of rainfall was used in vegetation, thereby decreasing the total runoff. The effect of the distribution of rainfall upon the amount of the annual runoff on the Chemung River is remarkable. It well illustrates the fallacy of such statements as "The runoff will be a certain percentage of the rainfall."



MEAN RAINFALL AND RUNOFF ON THE CHEMUNG RIVER BY SEASONAL PERIODS

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*Consulting Engineer, Rochester, N. Y.

It is also evident from an examination of the table ınd diagram that the distribution of the precipitation has a marked effect on the amount of storage capacity ıecessary to maintain a certain stream flow throughout :he year. In the case of the Chemung River, there was ı greater runoff during the years in which the rainfall ›ccurred largely in the flood period and at the same time he rainfall was so distributed in the other three years hat the dry-weather flow was much greater. In all of he years in which the rainfall was heaviest in the flood ›eriod the runoff was extremely low not only in the ;rowing period but also through the replenishing period, overing a period of seven months.

While it is not often the case as with the Chemung River that three dry years occur consecutively, still there re many streams for which the gagings for several years ıay show a high runoff during the latter part of the ear and then there will be a year during which the ıinfall is so distributed that the dry season lasts not nly three or four months but for seven months, re-uiring a considerable revision of calculations of storage.

In the study of the relation between rainfall and run-ff it is sometimes the case that the records of stream ow though only a few years in length have been kept uring a year in which the rainfall was the least that ·curred over a long period of years. From the above ıta it is evident that it does not necessarily follow that ıis year of least rainfall was the year of least total runoff ıring the period for which the rainfall records were ·pt. There may be a year for which the total precipita-on was greater but in which the precipitation was so stributed that the total runoff would be less than in .e year of least rainfall.

⁂

Sewage Works and Outfall for Lakewood, Ohio

A 7,500,000-gal. sewage-treatment plant consisting of r screens, grit chambers containing adjustable vanes rming double bottoms, Imhoff tanks (see views here-th), sludge beds and liquid-chlorine disinfection ap-ratus is being built for Lakewood, Ohio, to take the ıce of plain sedimentation tanks and cinder contact ds built in 1900.

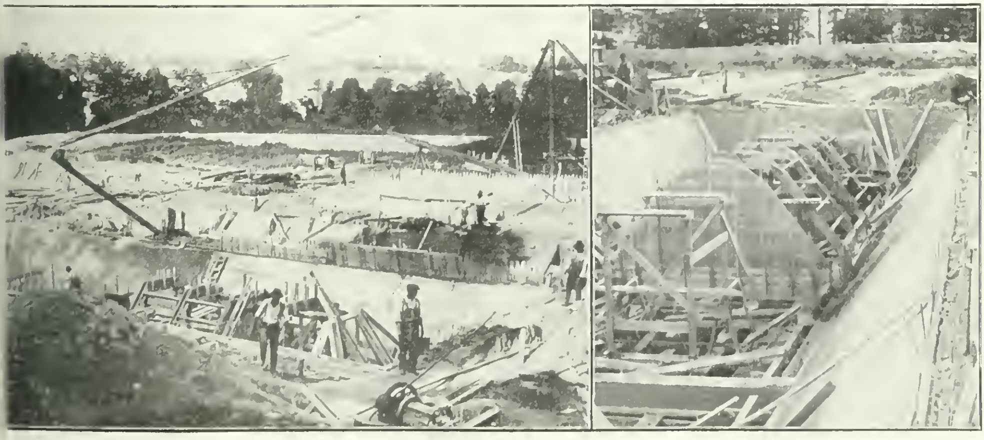
The old sedimentation tanks will be utilized to take the excess flow over and above 7,500,000 gal. a day, owing to admission of storm water into the sanitary sewers at times of heavy rainfall. From these tanks the excess flow will be pumped back into the new plant, at the entrance to the grit chambers, when the sewage flow is normal. A house will be built over the screen and grit chambers, which will contain a small incinerator for burning the screenings. The contractors for the sewage works are Lowensohn & Ule, of Cleveland. The contract price is $78,325, not including the chlorine apparatus and incinerator, contracts for which have not yet been let.

The effluent will be discharged through an outfall sewer extending 5,930 ft. to and then 1,500 ft. into Lake Erie, where the discharge will be through multiple outlets. The contract for the outfall to the lake has been let to Hoag & Dall, of Cleveland, for about $100,000. The lake section, which is estimated to cost $30,000 to $40,000, will probably not be let before next year.

For its first 2,280 ft. the land portion of the outfall sewer is of 36-in. reinforced concrete, which acts as an inverted siphon under low pressure. The sewer then extends for 3,000 ft. in tunnel, lined with vitrified segmental block to give an egg-shaped cross-section equal to a 54-in. circular sewer. Then comes 650 ft. more of 36-in. reinforced-concrete pipe, terminating at the lake shore.

The reinforced-concrete pipe is made in a near-by yard and is being laid under a guarantee for water-tightness—all by the Lock Joint Pipe Co., of New York City.

It has not yet been decided whether the 1,500 ft. of submerged outfall will be of steel, cast iron or reinforced concrete. Alternative bids will be received on all these materials. In any event the first 1,100 ft. will have a diameter of 36 in.; and the outer 400 ft., which will be perforated with 4-in. holes, will be reduced in size progressively. If the material chosen is steel, the diameter will be decreased from 36 to 24 in. gradually; but if cast iron or reinforced concrete is used, then the first 200 ft. will be 30 in. and the last 200 ft. 24 in. in diameter. The holes for the multiple outlets will be located so as to give an upward discharge from either side of the pipe at angles of 45°. The lake end of the



CONSTRUCTION VIEWS OF IMHOFF TANK AT LAKEWOOD, OHIO outlet will be provided with a specially designed flap valve.

The treatment works and outfall sewer were designed in the office of R. Winthrop Pratt, consulting engineer, Cleveland. Construction is in charge of E. A. Fisher, city engineer of Lakewood, with R. L. Squier as resident engineer.

⁂

Tunnel-Concreting Methods

By L. G. Warren*

In concreting the 12-in. shell of the 9-ft. shore tunnel of the new water intake, Milwaukee, Wis., using hand shoveling into forms exclusively, the fastest speed of work attained was placing a section 12 ft. long in 5 hr. The average speed for 12-ft. sections was 5.90 hr., and the average speed for 8-ft. sections 5.64 hr.

The tunnel shell within neat line has about 1¼ cu.yd. of concrete per lineal foot, and there is about 20% excess concrete on the average, owing to excavation beyond the neat line. The mixture is 1:2:4, the stone ranging from ⅛ to 1½ in.

All mixing is done on the surface. A 9-cu.ft. mixer at one of the two shafts and a ½-yd. mixer at the other shaft furnish the concrete. Both mixers are driven by electric motors, after gasoline and steam engines were tried and abandoned; the motors have given satisfactory service. In the hopper of the ½-yd. mixer a partition was placed dividing the hopper into two compartments, for sand and stone respectively, of the exact capacity required for the batch. This minor device has proved to be a great time saver for the contractor and a comfort to the city inspectors.

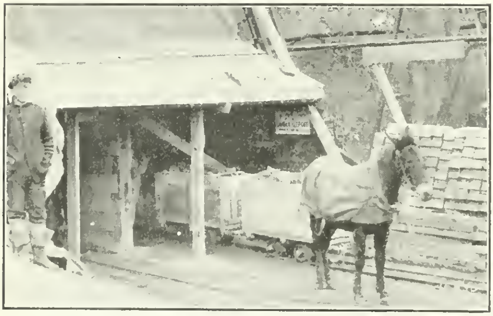


FIG. 1. WOODEN MUCK CAR CARRYING CONCRETE INTO TUNNEL

Concrete is handled from the mixer to the heading in the regular tunnel cars used for carrying the excavation spoil. These are wooden ½-yd. cars (Fig. 1). Due to the rough handling which muck cars get, constant vigilance must be exercised to maintain them water-tight or grout-tight, if they are to be satisfactory for carrying concrete. At the forms, slick plates 30 in. wide by 12 ft. long, of ¼-in. steel, are used for receiving the concrete dumped from the cars. The shovelers work from these plates, when the forms up to the arch key plates are being filled. When this height has been reached, a platform is erected inside the forms. Concrete is then shoveled from the slick plates to the platform, from which two men shovel it upon the arch plates. These two men also act as tampers, using wooden tampers to pack the arch concrete.

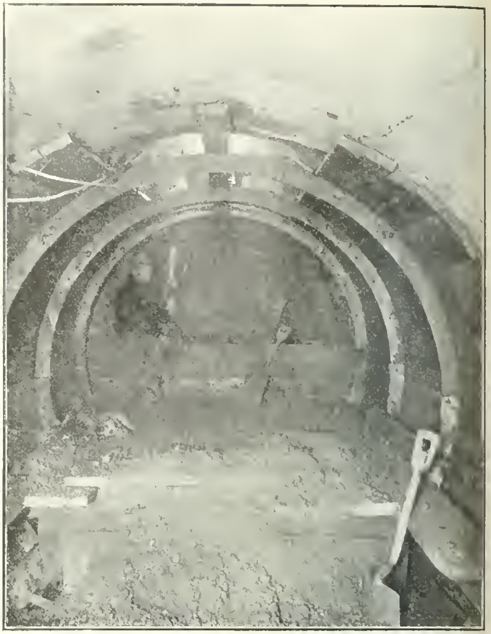


FIG. 2. WOODEN FORM FOR CONCRETING TUNNEL SHELL, AND SHOVELING PLATFORM

Both the Jackson steel segmental forms and plain wooden forms have been used. The wood forms consist of 2⅝-in. stave lagging on rings of 4x3x⅜-in. angle spaced about 3 ft. (see view, Fig. 2). They are built up as the filling proceeds, the installation of a section being one continuous operation, to secure monolithic construction. Junctions between successive sections, longitudinal of the tunnel, are secured by tongue-and-groove construction of the abutting ends of sections, close attention being given to ramming the fresh concrete into the groove of the exposed face of the preceding section. The groove is formed by a wooden piece 6 in. deep, 4 in. wide at the front and 3 in. wide at the back, nailed to the end bulkhead of the form in 3-ft. sections. The wedge shape makes the removal of these pieces easy and enables them to be used many times. The face of the preceding section of completed concrete is coated with a neat grout before the concrete is placed in any section. The mining crews act as concrete men for placing lining as soon as the excavation of a section is completed.

Measuring the time of individual operations involved in mixing for this concreting, the following figures were obtained: Shoveling 2 cu.ft. of sand from pile into measuring wheelbarrows, 35 sec.; the same for 4 cu.ft. of stone, 57 sec.; dumping cement, stone and sand into mixer, 21 sec.; mixing 22 revolutions, 100 sec.; dumping from mixer, 22 sec.; a total of 3.91 min. of the time of four men. The average time required in setting up angle ribs and temporary floor of the wooden forms was 40 min.

It has been found that care must be observed to provide a vent for the compressed air in porous ground, in order to prevent rupture of the green concrete in the arch under the action of compressed air. especially when ir loss is present above the arch previous to placing the oncrete. Two fresh arches in the tunnel were cracked through this action when the headings were closed by ight bulkheads; in both cases there had been heavy air oss over the arch prior to placing concrete. The bulkeads acted as corks in a bottle and therefore the comressed-air pressure lifted the fresh concrete and cracked t. The cracks were closed by grouting. Following this xperience an air vent was placed in every face bulkhead.

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*Resident Engineer, Shore Tunnel, Milwaukee, Wis.

The tunnel is being built under the direction of George F. Staal, City Engineer, by the O'Brien & Jackson Contruction Co.

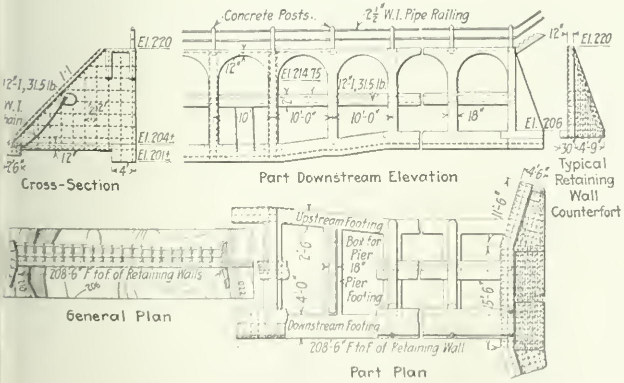
Reinforced-Concrete Drift Catcher at Erie, Penn.

By Theodore E. Seelye*

The flood of Aug. 3, 1915, which did such a large mount of damage in the valley of Mill Creek in Erie. Penn., was much aggravated by the great quantities of rift brought down from the watershed above the city. he creek passed through the city in an open channel, hich was carried under the street crossings through rge culverts. During the course of the flood, these culerts for the most part became entirely clogged with rift, which caused practically all of the water to flow er the street intersections and thereby increased to a nsiderable degree the height of the flood water.

While the major portion of this drift had its origin in e city and consisted of the wreckage of buildings and tthouses, the outlying district was nevertheless a large ntributor, the floating material consisting mostly of upoted trees, stumps, chicken houses, etc.

The proposed improvement of the creek now under ay contemplates the construction of a large reinforcedncrete tube through the city to carry the entire flood ow of the creek. There will therefore be no drift origating within the city limits, and while the velocity rough the tube will be so high and the design of the trance such that there will be practically no chance for lodgment of floating débris, it was considered wise as a precautionary measure to erect a structure to intercept the larger pieces coming in from the country.



DETAILS OF STRUCTURE TO CATCH DRIFT IN ERIE FLOOD-PROTECTION WORKS

For this purpose, the drift catcher illustrated herewith was devised. This might be described most simply as a hollow reinforced-concrete dam with the deck slabs omitted. The site chosen for the work lies in Glenwood Park, about three-quarters of a mile south of the city limits. This park, with the creek running through it from end to end, is the property of the city. An excellent site was available, permitting the construction of a long, low structure of the type indicated above, with a comparatively high bank on each end so that a maximum of water area was obtainable without the danger of backing the water up to a great height in case of clogging.

The drift catcher will be 208 ft. long between abutments, and will be about 16 ft. high, with a walkway across the top surmounted by an ornamental railing. The walkway is supported by arches between the buttresses, which are 10 ft. c. to c., to add stiffness. A heavy beam of oval section connects the buttresses near their upstream edges at about half the height of the structure and serves to suspend heavy chains which are fastened again to the foundation. These chains are planned to retain the smaller débris coming at the beginning of a flood. The entire structure rests upon a foundation of rock and is designed with a view to offering a pleasing architectural addition to the park.

The construction will be performed by contract under the supervision of Farley Gannett, Consulting Engineer, Harrisburg, Penn. Faulkner G. Lynch is City Engineer. The contractor performing the work is A. G. Diefendorf, of Erie.

Making the Most of Federal-Aid Road Appropriations

By D. A. Thomas*

With a view to using the money apportioned to Michigan during the next five years under the Federal-Aid Road Act, State Highway Commissioner Frank F. Rogers has formulated a plan that will permit the completion of the state's trunk-line road system through the poorest counties. It remains for the legislature to enact the necessary legislation.

Nearly all the trunk lines have gaps in them where they run through the poorer counties. This is particularly true of the East Michigan Pike and the West Michigan Pike, which skirt respectively the east and west borders of the lower peninsula and form a part of the Dixie Highway. Under the present state-highway laws it would be quite impossible to fill the gaps for many years to come, as the poorer counties and townships cannot stand the financial strain. It is in such locations that it is proposed to use the Federal aid. The Federal-Aid Road Act apportions to Michigan during the next five years $2,186,756. This money can be secured only by meeting it dollar for dollar, thus insuring the spending of $4,376,512 on Federal-Aid roads during the period.

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*Of the firm of Farley Gannett, Consulting Engineer, Harsburg, Penn.

*Michigan State Highway Department, Lansing, Mich.

In order to arrive at an equitable distribution of the cost among the Government, state and counties a unit known as the valuation per trunk-line mile has been developed by dividing the assessed valuation of any county by the trunk-line mileage within its borders. The values for this unit vary through a wide range of from $25,233 to $16,320,156.

Counties with an assessed valuation per trunk-line mile of less than $100,000, of which there are 19, are classed together; those from $100,000 to $200,000 are placed in a second class, and so on up to those of $500,000 or more, of which there are 27.

A schedule is proposed which would require the counties of the first class (the poorer counties) to pay 25% and the state 25%, while the Federal aid will make up the remaining 50%. In each succeeding class the counties' share would be increased by 5% and the state's decreased 5% until those richer counties in the last class would be required to pay the full 50%.

Such a distribution as is outlined above will impose no great hardships upon the poorer counties. The state will also be called upon to contribute less toward the construction of the roads than under the present reward system, which provides for the payment of state rewards of from $500 to $3,400 per mi. on trunk-line roads constructed according to the specifications of the State Highway Department.

Since the cost of the Federal-Aid roads will be less to the state in most cases, it is expected that the legislature will increase the reward on the more expensive types of roads, which will materially aid the richer counties to build the class of roads commensurate with their traffic. Thus the best interests of the whole state will be served.

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More on Bolted and Lagscrewed Joints in Timber

By H. D. Dewell*

In discussing the tests of bolted and lagscrewed timber joints in the articles "New Tests of Bolted Joints in Timber Framing" and "Lagscrewed Timber Joints," *Engineering News*, July 20 and 27, 1916, there were certain omissions and errors. It is believed also that the reasons for certain of the deductions made and the conclusions drawn may not have been clear.

Theory of Action of Bolted Joints

On page 112, in stating the different formulas for bolt bending, the total load on the joint is P and not $2P$. This error will be obvious to one reading in detail.

Referring to Fig. 4, page 114, the side note to the figure should read "P = Total load on joint = $2(P_2 - P_1)$. In the definition of terms, following, d = the diameter of the bolt and not the width of timber and splice pads, as there stated.

In Table 1, item 7 gives the values corresponding to a slip of $\frac{1}{32}$ in. or 0.03125 in., and not 0.025 in., as there stated in the footnote.

In the same table, item 9 should not appear. The author recommends as working values the figures given in item 8, which are those computed according to the theory discussed in the text.

The theory of bolt action advanced rests upon the assumption that, beyond a certain minimum value of l (width of side timbers or one-half the width of center timber), the strength of the joint is independent of the length of bolt and that such a value for t in the sketch may be found that the moment in the bolt will just equal the flexural strength of the bolt. This assumption, in principle, is similar to that of Prof. H. R. Thayer, as discussed in his "Structural Design," Vol. 1, the difference being in the assumed distribution of load on the bolt, the resulting moment and the capacity of the joint.

The maximum moment on the bolt in the sketch will occur at a point of zero shear. There are five such points, two each side of the center line of joint, at a point x (not marked in the sketch) which is distant ½ b or a either side of the contact faces of the timbers, and one at the center of joint. In the total length of bolt there are four points having equal maximum bending moments.

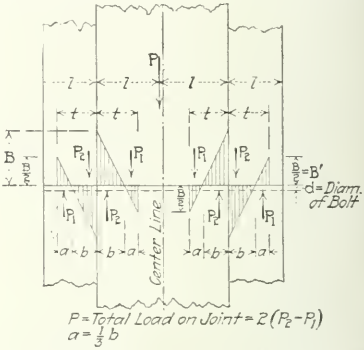

FIG. 1. PRESSURE DISTRIBUTION IN BOLTED TIMBER JOINT

Distribution as deduced from tests and used for calculations. Diagram should replace Fig. 4, p. 114, July 20, 1916

The following equations lead to the expression for the maximum moment for the conditions of the sketch. Let the bending moment be computed for the point x, distant ½ b to the left of the left contact face of timbers:

$$M = P_1\left(\frac{t}{3} + \frac{2t}{9} - \frac{t}{9}\right) = \frac{4P_1 t}{9} \tag{1}$$

$$P_1 = \frac{1}{2}\left(\frac{B}{2} \times \frac{t}{3}\right) d = \frac{Btd}{12} \tag{2}$$

$$M = \frac{4}{9} \times \frac{Btd}{12} \times t = \frac{1}{27} dBt^2 = \frac{2}{27} Pt^2 \tag{3}$$

The resisting moment of the bolt is $\frac{\pi d^3 S}{32}$. Equating the bending moment to the resisting moment, there results

$$\frac{1}{27} dBt^2 = \frac{\pi d^3 S}{32} \tag{4}$$

Solving for t,

$$t^2 = \frac{27\pi d^3 S}{32 Bd} \tag{5}$$

and

$$t = d\left(\frac{27\pi S}{32 B}\right)^{\frac{1}{2}} \tag{6}$$

A value of t may thus be found for each diameter of bolt, working values for the bearing stress B and the bolt bending stress S having once been established.

$$P = 2(P_2 - P_1) = 2(4P_1 - P_1) = 6P_1$$
$$= \frac{6Btd}{12} = \frac{1}{2} Btd \tag{7}$$

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*Civil Engineer, 58 Sutter St., San Francisco, Calif.

For joints in which the distance l is less than t, it is eld that the bending moment on the bolt varies between ıe limits $M = {}^{2}/_{27}\ Pt$ and $M = 1/3\ Pl$, and the safe load n the joint varies correspondingly between the limits ' $= 1/2\ Btd$ and $P = Bld$. At the latter limit, the ressure diagram is triangular in shape, the unit pressure eing zero at the outer edge of the plice pad and a maximum of B at ıe face of the center timber. All f the above discussion tacitly asımes that the ratio of the diameter f the bolt to the thickness of side mber is such that the flexural strength the bolt is reached with the triıgular pressure diagram. With a int in which the diameter of the bolt relatively large as compared with ıe thickness of splice pads, the presre diagram may be trapezoidal in ape, with the largest pressure always the inner face of the splice pad. he final limit in this direction, or e maximum load that the joint can ke, will be when the pressure diaam becomes rectangular in shape. other words, there will then exist uniform pressure along the length bolt, the bending moment and the tal load being represented by $M =$ Pl, and $P = 2\ Bld$ respectively. ıe whole argumentation may be sumarized by the statement that the thev proposed holds that the bending ment on the bolt varies between the limits $M = {}^{2}/_{27}\ Pl$ d $M = 1/2\ Pl$, and the capacity of the joint varies ween $P = 1/2\ Btd$ and $P = 2\ Bld$, the relation between bending moment and the total load always being such ıt the safe flexural strength of the bolt is reached, less the diameter of the bolt is so great that a uniform ssure distribution of bearing along its length does not ess it in flexure to its safe capacity; and, with the t reservation, the pressure distribution on the bolt is h that the maximum unit stress in bearing for the tim is reached at the contact faces of the joint.

Vorking values for bolted joints with varying thickses of timbers are best found by means of plotted ves, similar to those of the accompanying figure, which istrates the method of finding the safe capacities of j nts where the relative sizes of bolt diameters and thick s of timbers determine the limits of bending moments a l total loads as lying between $M = {}^{2}/_{27}\ Pl$ and $M =$ 1 Pl, and $P = \frac{Bld}{2}$ and $P = Bld$.

EXAMPLE OF USE OF CURVES

Given: ⅞-in. bolt, l = 3 in.

Method:

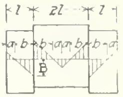
Resisting moment of ⅞-in. bolt at 16,000 lb. per sq.in. = 1,050 lb. per in.

Since curves are for 1-in. bolt, equivalent moment for ⅞-in. bolt $= \frac{1,050}{0.875} = 1,200$ lb. per sq.in.

$M = Cl^2 = 1,200$ lb. per sq.in., and $C = \frac{1,200}{9}$ lb. per sq.in. $= 133.3$.

From curves, when $C = 133.3$, $K = 810$ lb.

Then $P = 810$ lb. × 3 in. × 0.875 = 2,130 lb.



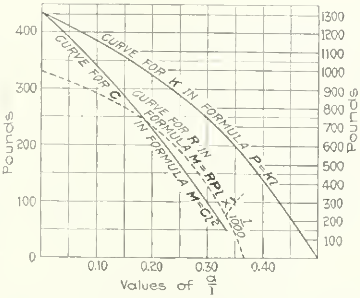


FIG. 2. VARIATION OF STRENGTH OF 1-IN. BOLT WITH THICKNESS OF TIMBER

ASSUMPTIONS

1. Maximum pressure on ends of timber = 1,300 lb. per sq.in. on diametral section of bolt = B.
2. Diameter of bolt = 1 in.
3. Range of curves— $a = 0$ to $a = \frac{1}{3}l$.
4. $M = \frac{1}{3}Pl$ to $M = \frac{2}{27}Pl$.

where

M = Maximum bending moment on bolt, and

P = Total load on joint.

5. For all values of $\frac{a}{l} < 0.33\frac{1}{3}$, the strength of joint depends on bending of bolt.
6. Pressure distribution on bolt is always triangular, with varying values of $\frac{a}{l}$.

Table of Values

$\frac{a}{l}$	R	C	K
0	0.333	433	1,300
$\frac{1}{8}$	0.256	266	1,010
$\frac{1}{4}$	0.188	163	866
$\frac{1}{3}$	0.074	48.2	650

LAGSCREWED JOINTS

n the presentation of the results of the tests on lagwed timber joints there was an unfortunate error de in the values recommended for working strengths o lagscrewed joints where steel plates are fastened to t ıber. Thus, Table 1, page 163, July 27, 1916, should modified as shown in Table 1 herewith.

TABLE 1. STRENGTH IN POUNDS, OF LAGSCREWS FASTENING STEEL PLATES TO TIMBER

	¾x4½-In. Lag	⅞x5½-in Lag
Kidder	2,100	2,800
Thayer	1,125	1,575
Tests*	1,200	1,200
Tests†	1,450	1,450

* One-half the values for limiting deflection of $\frac{1}{16}$ in † Values for deflection of $\frac{1}{32}$ in.

sing the limiting deflection of $\frac{1}{16}$ in. as in the case of t bolted joint, with a factor of 2 for working loads, it een that the safe working resistance of a ⅞-in. lagw in such a joint is 1,200 lb., and the corresponding resistance of a ¾-in. lag may be taken at 1,030 lb., based on the ratio of their diameters.

The recommended working values for lagscrews, based on one-half the strengths shown by the tests at a deflection of $\frac{1}{16}$ in., are expressed in tabular form:

TABLE 2. RECOMMENDED WORKING VALUES FOR LAGSCREWS

	Pounds per Screw
Metal plate lagged to timber, ¾x4½-in. lagscrew	1,030
Metal plate lagged to timber, ⅞x5-in. lagscrew	1,200
Timber planking lagged to timber, ¾x4½-in. lagscrew	900
Timber planking lagged to timber, ⅞x5-in. lagscrew	1,050

For detail information regarding the action of the various joints under load, the following table of results is submitted. This table should have appeared in the July 27 article.

TABLE 3. TESTS ON LAGSCREWED JOINTS

Summary of Results

Joint Letter or Number	Number and Size of Lags	Thickness of Side Pieces	Thickness of Center Piece	Load at Apparent Yield Point, Lb	Load at Slip of $\frac{1}{16}$ In., Lb.	Final Load, Lb.	Final Slip, In
7	Three ¾ in.	½-in. steel pl.		6,500	7,700	20,000	0.92
8	Three ¾ in.	½-in. steel pl.		5,500	6,700	19,700	0.75
9	Three ¾ in.	½-in. steel pl.		5,000	6,700	30,000	1.11
17	Three ¾-in.	½-in. steel pl.		8,000	7,500	30,000	1.15
A	Six ¾ in.	2 in.	8 in.	26,000	12,500	49,100	1.40
B*	Six ¾ in.	2 in.	8 in.	20,000	14,100	31,000	1.61
C	Six ¾ in.	1½ in.	8 in.	20,000	12,400	34,000	1.49
D	Six ¾ in.	2 in.	8 in.	25,000	10,700	44,100	1.69
E*	Six ¾ in.	2 in.	8 in.	20,000	10,400	33,000	1.79
F	Six ¾ in.	1½ in.	8 in.	23,000	12,000	33,100	1.11
G	Six ¾ in.	2 in.	8 in	22,000	13,800	44,700	1.44
H	Six ¾ in.	1½ in.	8 in	17,000	9,400	28,885	1.50
I*	Six ¾ in.	1½ in.	8 in.	11,500	8,500	20,000	0.53†
J*	Six ¾ in.	2 in.	8 in		10,500	14,000	0.13†

* Indicates that lagscrews had bearing across the grain of the center timber In joint J, the load was removed at 14,000 lb., when the joint came back immediately to a deflection of 0.10 in. Its final recovery was not noted The final loads do not necessarily indicate the ultimate strength of the joints. † Load removed

Notes from Field and Office

Railway chief engineer discusses night work—Railway methods applied to highway-bridge erection—Earth fill six miles long contains 1,700,000 yd.—Pile tests in Chicago—An odd street intersection—Contractors' cost records—Garden-hose finish for concrete pavements—Water lifts sand to filters

Cost of Night and Day Work

By Hunter McDonald*

In connection with the relative cost and efficiency of night work and day work, as discussed in *Engineering News*, Aug. 17, it has been my experience that the ordinary grading contractor uses every means and argument in his power to avoid doing night work when called upon to do so by proper authority. One of his principal objections is that it requires a very good organization to handle a double shift. Furthermore, the ordinary contractor is not equipped with lighting apparatus, which is absolutely essential to handle night work successfully.

My experience, based on railway construction purely, has also been that while the contractor has proceeded to put on a night shift when required, he has not made the proper effort to get the best results. Owing no doubt to his desire not to incur the additional plant expenses, the work has been poorly lighted, and the consequent wrecks to dump trains have materially cut down the output. Contractors also claim that night work cuts down the efficiency of the day force, on account of loss of time in making repairs to tracks or equipment damaged by the night force.

Under the best conditions of which I have knowledge, I would say that the night shift has had an output of about 85% of the day shift, but the average is considerably lower, probably around 66%. Of course, the season of the year cuts considerable figure. My experience has led me to believe that it is best to insist upon the work being sufficiently covered with plant to enable the contractor to finish within his time limit without the necessity of doing night work, and to insist on night work only as the last possible resort when the work has been delayed for other reasons over which no one has control.

In tunnel work I have found that the night shift makes practically the same progress as the day shift.

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*Chief Engineer, Nashville, Chattanooga & St. Louis Ry., Nashville, Tenn.

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Erecting Highway Bridges Under Traffic; Michigan

By C. V. Dewart*

In addition to consultation, preparing plans and general supervision of all highway-bridge work, the Michigan State Highway Department is called upon to plan, build, maintain and pay for bridges of over 30-ft. span on the state trunk-line roads, which constitute a 5,000-mi.

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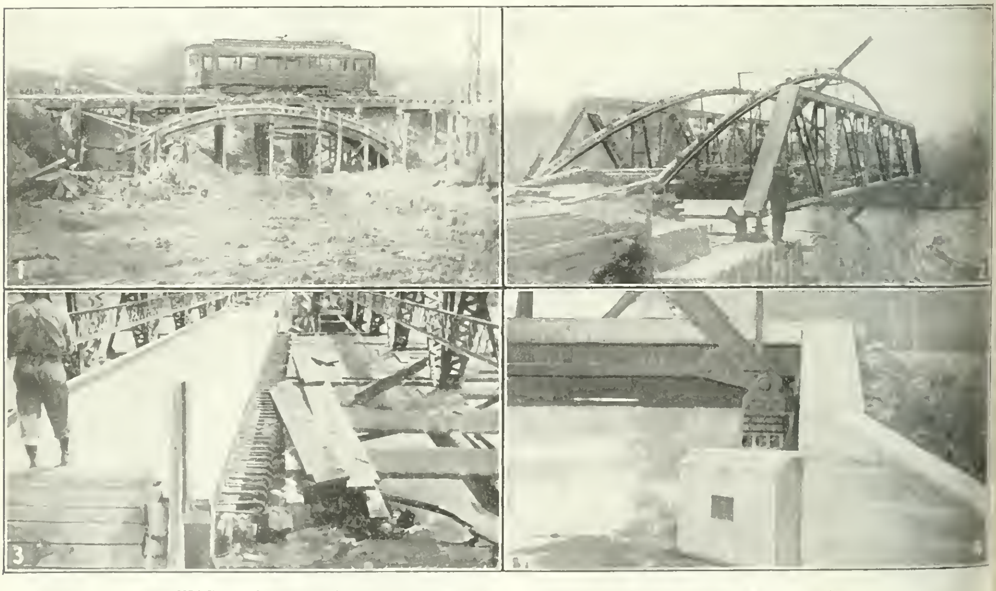
*Bridge Engineer, Michigan State Highway Department, Lansing, Mich.



FIGS. 1 TO 4. ERECTING HIGHWAY BRIDGES UNDER TRAFFIC IN MICHIGAN
Fig. 1—Concrete arch erected under traffic. Fig. 2—Steel trusses of new bridge erected outside old bridge. Fig. 3—Concrete floor of new bridge laid half at a time. Fig. 4—Bridge abutment properly designed

ystem connecting all of the principal cities of the state. uring the last three years the state has built (or is uilding) 80 bridges ranging in cost from $2,000 to 40,000.

The maintenance of traffic on railroad bridges while nder reconstruction is general, but until a few years ago he maintenance of traffic on highway bridges under the ame conditions was unusual. The trunk-line bridges e have built, with few exceptions, are on main traveled oads, and in many cases, such as the Whitefish River ridge near the town of Rapid River, the bridge under onstruction is the only connecting link for miles around. dd to this the greatly increased automobile and through affic, also the fact that when the state does the work he local inhabitants expect more than if they were doing themselves, and there is reason enough to justify our olicy of maintaining travel on all trunk-line bridges. he exceptions to this rule are few.

Maintenance of traffic during construction of an arch an be done by pouring one-half of the arch ring at one me and then turning traffic to the completed half, as lustrated in Fig. 1. This is becoming fairly common the construction of large bridges. When time is too ort to allow proper setting of the arch ring, this method ay still be followed by boxing around the supports of he old bridge, where they pass through the arch ring. he full width of the arch ring may be poured at one me, and as soon as it has set sufficiently to carry the ad the old bridge supports may be cut off on the line the extrados, shifted to the arch ring, the holes in e ring poured and the backfill made.

For concrete arches and small-span bridges, however, ere is comparatively little difficulty encountered. Gen-ally traffic may be maintained in these cases by grading wn the approaches to a short temporary wooden span one side of the proposed bridge site.

Long-span steel bridges present an entirely different roblem. Our pony-truss designs, which are standard r spans from 70 to 100 ft. inclusive, have the trusses aced about 3 ft. farther apart than the ordinary old-yle trusses and may be erected complete with the new usses outside of the old and the new floor system under-eath the old.

The trusses in this case may be erected by three dis-nct methods: (1) By building falsework under each nel point and proceeding in the usual manner: (2) the construction of temporary supports for the trusses, hich are erected one at a time in a horizontal position ongside of the old bridge and then swung into a ver-cal position (the same set of supports is then used on e opposite side of the bridge); (3) by the use of angers supported from the top chord of the old bridge e new trusses are erected in their final position without e use of falsework of any kind below, as shown in ig. 2.

In the second and third cases the floor-beams and lat-al sway bracing are swung into place from below. Next l plank and stringers of the old bridge are removed om one-half of the roadway only and stringers for the ew bridge placed on this side, maintaining travel on e opposite side of the bridge. Then the old floor sys-m is replaced, traffic restored to this side, the old floor moved on the opposite side and the second half of the oor system completed in the same manner as described r the first half.

As soon as the new trusses are completely riveted, the old bridge may be removed complete or blocked up at the floor-beams and removed piecemeal. The former method is much preferable, however, when there is some place where the old bridge can be used to advantage. It may be relocated on some near-by road of lesser importance crossing the same river, without knocking it down and then reërecting. All this may be done with very little if any interruption to traffic, provided forethought is used in the arrangement of floor planking.

With the old bridge removed and the plank of the old bridge relaid on the new floor joists, it is a simple operation to remove the plank on one half of the roadway at a time, pour the concrete floor on this half, then turn traffic to the completed half of the concrete floor and pour the concrete of the second half. A standard concrete floor with a vertical construction joint along the center line of the road is shown in Fig. 3.

We find that the second and third methods, or some modification of the two, have resulted or would have resulted in a very material reduction in cost of erection for nearly all cases, and in some cases we have found that the third method of erection has cost less with traffic maintained than the first method without traffic.

It is often necessary to erect the new trusses below their final elevation in order that the new floor-beams may be placed without interference to the old floor system. Our standard steel bridges up to 80-ft. span with plate expansion supports have a minimum depth of casting of 6 in., and for spans of 80 ft. and over a minimum depth of casting of 12 in. under the fixed end, or at the expansion end 6 in. under the rollers and 6 in. of geared segmental rollers. By the omission of castings and rollers at the start, from 6 to 12 in. may be gained for erection purposes. Stringers framed into the floor-beams constitute another advantage in this case; the top flange of the floor-beams of the new bridge may be erected in the same plane as the bottom flange of the floor-beams of the old bridge without interference.

All this generally provides plenty of room to complete the erection of the new bridge without jacking up the old bridge and thereby making a very objectionable hump in the roadway during the entire time of erection. The elevation of the old floor is not changed until the new bridge is completely erected. It is then only a matter of a few days to remove the old bridge, relay the wooden floor and jack the new bridge up to its final elevation. It is of primary importance to design the bridge seats in such a manner as to provide plenty of room for the jacks (see Fig. 4).

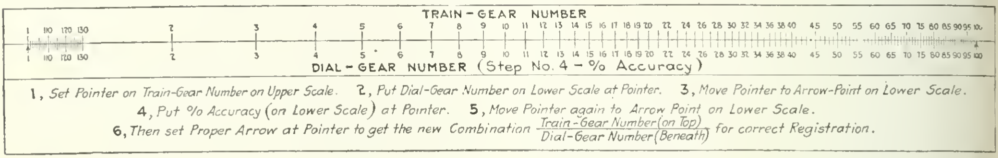
Too much cannot be said against the usual practice of boxing in or "pocketing" an end pedestal. How much has been preached against this practice, and yet how very few of the abutment seats that have been built recently are of the proper design! The cost is no more; the fault lies either in ignorance or in the total disregard of the requirements of an abutment. "Pocketing" a bridge seat accumulates dirt and corrosion, interferes with erection and maintenance and is altogether wrong from an æsthetic point of view.

With a little care in designing and staking out a bridge, the abutments and piers may be built up complete without in any way interfering with the old bridge or its foundations. This is certainly worth while whenever it can be done.

Slide Rule for Re-Gearing Water Meters

The accompanying sketch shows an improvised slide rule devised by F. L. Bock, Assistant Engineer, Distribution Section, St. Louis Water-Works, for the use of nontechnical employees in computing any combination of change gears in re-gearing water meters to register accurately. There are three pieces to the rule, the central one sliding between the outer two. The logarithmic graduations on the top and middle piece are seen to be those of an ordinary slide rule. The bottom piece contains only directions for use.

The proper gears are found after a test in which the per cent. accuracy and the number of teeth on both old gears are known. These data are applied as directed on the six steps given on the rule. The "pointer" referred to corresponds to the hair-line on the rider of an ordinary slide rule. This device has been found very convenient in the Meter Branch of the St. Louis Water Division, Department of Public Utilities.



1, Set Pointer on Train-Gear Number on Upper Scale. 2, Put Dial-Gear Number on Lower Scale at Pointer. 3, Move Pointer to Arrow-Point on Lower Scale.

4, Put % Accuracy (on Lower Scale) at Pointer. 5, Move Pointer again to Arrow Point on Lower Scale.

6, Then set Proper Arrow at Pointer to get the new Combination $\frac{\text{Train-Gear Number (on Top)}}{\text{Dial-Gear Number (Beneath)}}$ *for correct Registration.*

SLIDE RULE FOR RE-GEARING WATER METERS

⁂

Long Fill Built from Borrow

The heaviest earthwork on the new line of the Vandalia R.R. between Indianapolis and Frankfort, Ind., is on the first six miles north from the connection with the present line at Ben Davis (outside of Indianapolis). As the line is intended for high-speed traffic, all grade crossings are avoided; and as the country is flat this necessitates a high fill for about six miles, interrupted only by bridges.

The average height of fill is 26 ft., and the total quantity will be about 1,700,000 cu.yd. for the present single-track fill. The width at subgrade for single track is 24 ft. (36 ft. on future double track), but in construction a width of 32 ft. is given, to allow for the washing and sloughing of new slopes. The shrinkage averages 4%, and the top of the fill is kept about 1.5 ft. above grade line.

The material for this fill is obtained from a borrow pit about 1½ mi. from the railway, where 70 acres of land were purchased, including a hill. The material in the hill is earth, clay and gravel, the last occurring in pockets so that it cannot be utilized for ballast. Below the normal ground line is clay. Numerous springs were cut in the hill, and the water made this clay stratum so soft that the steam shovels could not cut very deep below the ground level. As all the material available will be needed for the fill, it is planned to lay tile drains across adjacent property at the east end so as to drain the borrow-pit site into a neighboring stream. When this is done, an additional cut will be made over the entire site. A surface drain in the bottom of the cut now discharges into a farm drainage system.

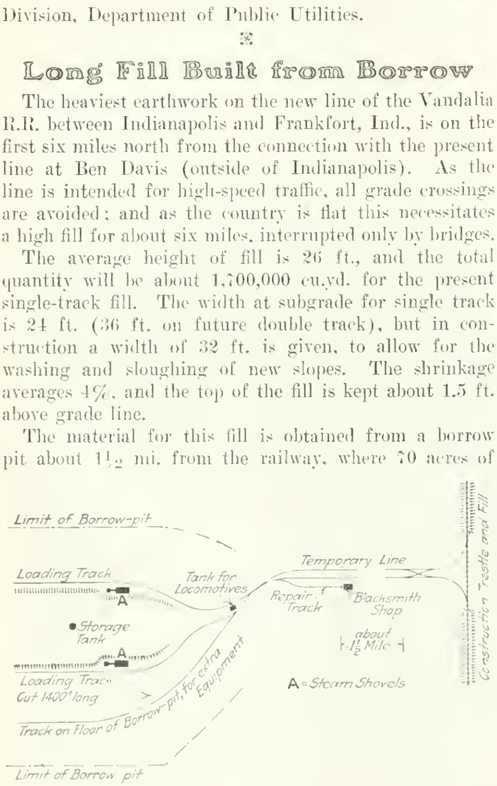


FIG. 1. BORROW PIT AND TRACKS FOR A BIG FILL ON INDIANAPOLIS & FRANKFORT R.R.

The excavation is being done by two 70-ton steam shovels working on opposite sides of the hill, as shown in Fig. 1. One of these has a 2½-yd. and the other a 2-yd. bucket. The track is kept laid close up behind the shovel, so that as soon as it has finished a cut it can be run back and set in place for the next cut. This track then becomes the new loading track, the former loading track being gradually taken up and relaid behind the shovel as the machine advances. The steam-shovel cuts are about 1,400 ft. long, with a maximum depth of 40 ft. Water is pumped from a creek to a tank on top of the hill, from which gravity pipes are led to the shovels and to a tank for the locomotives. Coal for the shovels is delivered by the dump-cars.

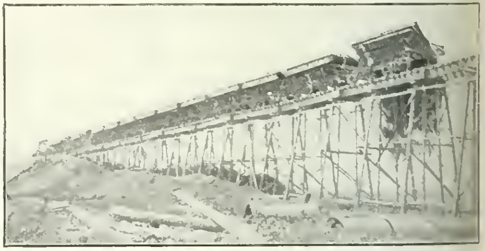


FIG. 2. BUILDING 26-FT. FILL FROM TRESTLE

A temporary trestle is used for making the fill, this being diverted around bridge sites so that the trains can dump at any desired points. These trestles have four-pile bents (with outside batter piles) with log caps, diagonal bracing and three lines of girts. The bents are spaced 14 ft. c. to c. The stringers are pairs of 10x16-in. timbers 28 ft. long. These are much larger than the stringers commonly used on temporary trestles, and they are recovered from the fill, only the piles and caps being left in place. Fig. 2 shows a train dumping from the trestle. After the fill reaches the top of the trestle, it is widened by means of a Jordan spreader, which throws over the side of the fill the material dumped from the cars.

The borrow pit is reached by a double-track temporary spur about 1½ mi. long, so that the trains from the two steam shovels can be handled independently. The tracks are connected at both ends of the line, as shown in Fig. 1, and the spur is connected with the line on the temporary trestle by means of a Y, so that filling an be done in either direction.

The material is handled by standard-gage equipment, vith six-wheel 55-ton locomotives hauling 12- and 15-car rains of 12-yd. side-dump cars. The cars are dumped y hand, the contractors considering this preferable to ir dumping. The steam shovel loads them in such a vay that one or two men can dump a car readily, as oon as the side chains are removed. About four trains re operated, but extra locomotives and cars are kept n hand so that additional trains can be put on when ecessary. With the longer hauls, a loaded train can be un out, dumped and returned while the empty train is eing loaded at the pit. With four trains a progress of bout 6,500 cu.yd. per day is made. The yardage is etermined by borrow-pit measurements, cross-sections eing taken every 30 days.

A force of about 120 men is employed on this earth-ork, including those on the dump, in the trains and at he borrow pit, and also the trestle men. They work a 0-hour day. As work has been delayed by scarcity of bor, a 10-hour night shift will be put on, the borrow it and shovels being equipped for electric lighting, and etylene lights being used on the dump. There is about ½ mi. of construction track, including the spur to the orrow pit. The rails (with frogs and switches) are pplied by the railway company, while the contractor pplies the ties, spikes and bolts.

The contractors are Dunn & McCarthy, of Chicago. he work is under the direction of F. T. Hatch, Chief ngineer of the Vandalia R.R.; H. T. Whitney is Engi-er in Charge, and A. F. Dye is Resident Engineer on e six-mile residency that includes the heavy fill.

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Making Pile Tests for the New Chicago Railway Station

Pile tests at the new freighthouse of the Pennsylvania ines at Chicago showed practically no settlement under 40-ton load after the third day and a maximum total ttlement of 0.067 in. after 11 days. For each test three -ft. piles were driven till their heads were 1 ft. below ty datum (water level in the river), an oak follower ing used to put them down to the required depth. e test pile proper was driven first and then one pile each side, the center-to-center spacing not exceeding ice the greatest diameter of the test pile. After the ving was completed, a pit 10x10 ft. was excavated l sheeted. On the test pile was a cap 12x12 in., 2 ft. long, secured by a drift bolt, and upon this were four timbers of the same size in two courses.

TABLE OF TESTS OF FOUNDATION PILES

test pile No. 1....	North pile	0.316 in.	South pile	0.316 in.
test pile No. 2....	West pile	0.098 in.	East pile	0.073 in.
test pile No. 3....	West pile	0.078 in.	East pile	0.109 in.

	Test Pile No. 1, In.	Test Pile No. 2, In.	Test Pile No. 3, In.
ttlement with 40 tons........	0.023	0.056	0.027
rst day after loading.........	0.000	0.000	0.006
cond day	0.007	0.000	0.006
ird day	0.001	0.011	0.000
urth day	0.001	0.000	0.000
fth day	0.000	0.000	0.001
th day	0.002	0.000	0.000
venth to eleventh day.......	No further settlement		
tal settlement	0.034	0.067	0.040
t for last blow..............	0.353	0.226	0.085
	Ft.	Ft.	Ft.
ximum circumference	3.88	3.65	3.54
nimum circumference	2.56	2.55	2.67

The upper timbers carried a loading platform 8x8 ft. of 3-in. plank. Upon this was piled about 40 tons of pig iron, an opening being left in the middle to permit placing the level rod on the head of the drift bolt. Measurements were made daily. The maximum results at the end of 11 days are shown in the accompanying table. The first three lines show the final set (under the last blow) of the six piles adjacent to the test piles. The remainder of the table relates to the test piles themselves.

The construction is under the direction of Robert Trimble, Chief Engineer of Maintenance-of-Way, Pennsylvania Lines. The Fitzsimons & Connell Co., of Chicago, had the contract for the piledriving.

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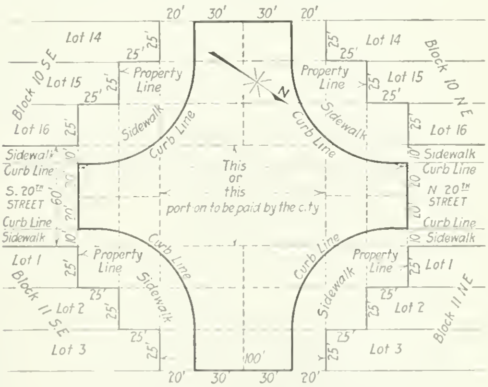
Street-Intersection Problem

The accompanying sketch illustrates an interesting (and very likely unusual) problem in paving-cost assessment which has arisen in Middleboro, Ky., a city of about 7,500 population. The ordinance authorizes the improvement of Cumberland Ave. and intersecting streets, "at the cost of the abutting lots and parcels of land." A controversy arose as to what constituted the area of the very unusual street intersection at Cumberland Ave. and 20th St., which the city is to pay for. F. S. Lee, civil engineer of Middleboro, believes that Cumberland Ave., at its intersection with 20th St., runs back with the offset property lines, as shown in the sketch, to the frontage property lines of lots 16 and 1. Cumberland Ave. is 100 ft. wide between property lines except for the two lots at the corners of the intersection, as shown, where there are two offsets of 25 ft. each, on each side of the avenue, making it 200 ft. wide at the 20th St. intersection. The width of the avenue is determined by the position and distance apart of the property lines irrespective of whether they are continuous straight lines, offsets or any other shaped lines. Another contention is that the intersection of Cumberland Ave. and 20th St. cannot be over 100 ft. wide, but that lots 14 and 15 and 2 and 3, on their respective sides of the street and avenue intersection have a frontage of 25 ft. on the side street. The practice of other cities in similar problems and the opinions of other city engineers would be welcome.

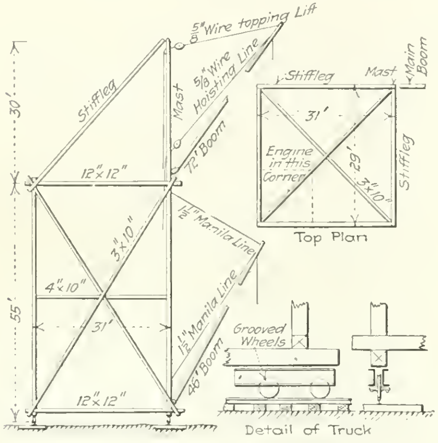


STREET INTERSECTION IN MIDDLEBORO, KY.

Tower Derricks for Erecting Steel Frames

The erection of the steel frame for the five-story freight station of the Pennsylvania Lines at Chicago was done by means of two traveling tower derricks of timber construction. The tower was 29x31 ft., 55 ft. high from the rails to the base of the 30-ft. mast. This mast was placed at one corner and was held by two stiff-legs. The boom was 12x14-in., 72 ft. long, trussed by four ⅝-in. cables, and carried a ⅝-in. wire hoisting line. The hoisting capacity was 7 tons, and the maximum lift, or vertical reach, was 124 ft. above the rails.

The tower was built of 12x12-in. posts (48 ft. high), top caps and bottom sills, with intermediate horizonal struts 4x10 in. Each side had diagonal bracing of 3x10-in. planks extending between the top and bottom corners, and similar horizontal diagonal bracing was placed at the top. The bottom was decked, and it carried (in the corner opposite the mast) a 30-hp. double-drum hoisting engine (cylinders 8x10 in.) and a vertical boiler. Under each corner was a two-wheel truck (tandem) with grooved wheels 14 in. in diameter. The gage was 31 ft. c. to c. of rails, each rail being laid on ordinary wood ties.



TOWER DERRICK USED IN STEEL ERECTION

For handling the 12-ton girders used over the driveways on the second floor of the building a 14x16-in. boom 46 ft. long was stepped at the base of the post carrying the main boom. This was rigged with 1½-in. manila rope, using a 9-part line for the hoisting and a 7-part line for the topping lift. Few girders were handled each day, so no change was made in the hoisting plant; but the manila line was led to the niggerhead of the engine.

The 17,000 tons of steel was erected in this way in about seven months, averaging 150 tons per working day, by the Kelly-Atkinson Construction Co., of Chicago.

*

Time Saved in Ditch Design by Depth-Flow Diagrams

By Lewis M. Hammond*

In designing the distribution system of a large irrigation project it was found that it would be necessary to solve Kutter's formula a very large number of times. This is somewhat of a task, even with the best of the numerous curves and diagrams that have been devised. The main canals and laterals of this distribution system were carefully located on "grade contours," and had a uniform slope, generally about 0.001, but the small ditches, of from 3 to 18 sec.-ft. capacity, followed section lines or roads, and had every conceivable slope, from 0.00025 to 0.20.

To begin with, the two general types of ditches shown in Fig. 1 were decided upon. It was also decided to use an irrigating head of 3, 5, or 6 sec.-ft., and to use for *n* the values 0.013 for concrete-lined ditches and 0.0225 for unlined earth ditches.

Curves were then prepared showing actual water depth for various slopes, for various bottom widths, and for capacities of 3, 5, 6, 10, 12, 15 and 18 sec.-ft. A preliminary study of the various profiles gave the number of different bottom widths and the range of slopes that would have to be considered for each capacity. All the curves for any one capacity were plotted on one sheet. It took about two days to prepare the curves, and they have saved that amount of time many times over since then, for with these curves a ditch section could be designed at a single glance, without computing *A*, *r*, or *v* from any of the numerous tables or diagrams which have been prepared for that purpose.

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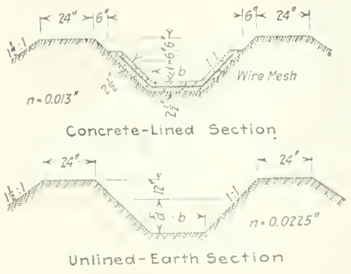
*Assistant Engineer, United States Reclamation Service, Provo, Utah.



Concrete-Lined Section

Unlined-Earth Section

FIG. 1. SHOWING VALUES USED IN FIG. 2.

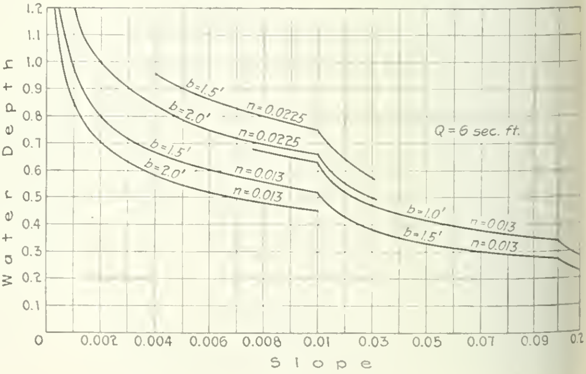
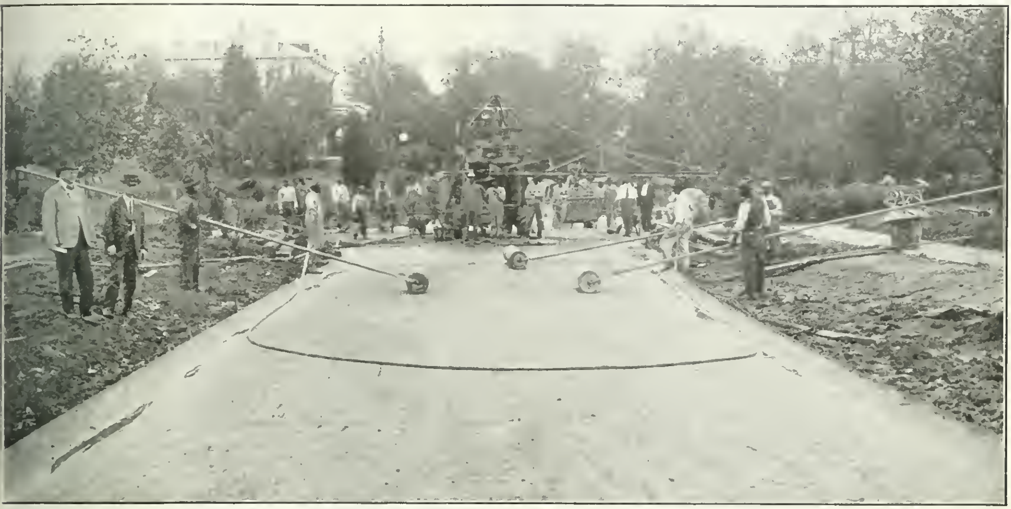


FIG. 2. SAMPLE CURVE USED IN DESIGNING DITCHES

Garden-Hose Finish for Concrete Pavements

Peculiar methods of finishing a concrete pavement surface are becoming as numerous as the varieties of a certain brand of pickles. The most recent one comes from the South and is said to have originated in Macon, Ga., where J. J. Gaillard is the city engineer.



FINISHING A CONCRETE PAVEMENT IN MYERS PARK, CHARLOTTE, N. C.

The illustration shows 70,000 sq.yd. of pavement under onstruction in Myers Park, a residential suburb of Charotte, N. C. The contractor is W. C. Campbell, of Charotte, who employed the following methods:

The concrete is formed to the shape of the finished roadway by means of wooden rollers 12 in. in diameter nd 4 to 8 ft. in length. These are provided with ong handles and are operated from either side of the road. Transverse joints are made at intervals of 30 ft. The joints are made with two thicknesses of twoly tar roofing paper, so placed that they come to within ¼ in. of the surface, forming blind or concealed joints.

The surface finishing is done with an ordinary garden ose, made of rubber. This is dragged over the surface y two laborers from the concrete gang. The work is one at such times as the mixer is being moved ahead. No other finishing is given the surface.

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Water Lifts Sand to Filters from Railway Cars

By William Gore*

About 6,000 cu.yd. of filter sand is required in the ew Ransome drifting-sand mechanical filtration plant at Toronto, described in *Engineering News* of Sept. 21, 1916, p. 566. This sand is prepared at a local pit on he mainland and transported by railway cars to the site, eing carried on scows for part of the distance. The ifting of the sand from the railway cars into the filters is done by water carriage, a method now commonly adopted in slow sand filtration practice. A point of interest in this case is the use of the comparatively low-pressure water-supply provided by the filter washback system. This pressure at the level of floor of the railway car is from 25 to 35 lb. per sq.in. As the actual lift is 12 ft. and the distance of delivery is up to 150 ft., it is evident that a special type of lifter is required.

The experience with the trailing-orifice type of lifter in the sand washers adopted in the drifting-sand filter showed that sand could be lifted with pressures much

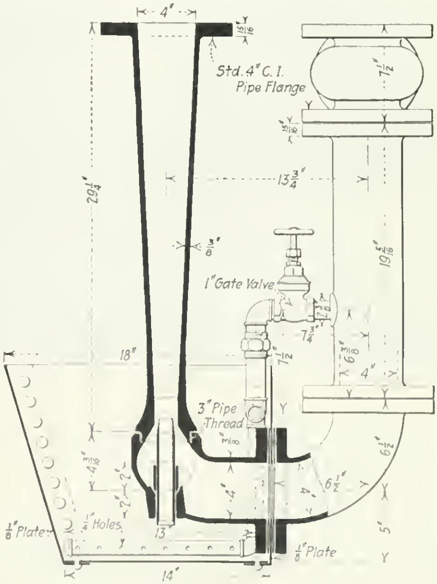

FIG. 1. DETAIL OF PORTABLE SAND LIFTER

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*Consulting Engineer, John ver Mehr Engineering Co., 151 imcoe St., Toronto, Ont.

less than usually adopted, and a modification of this type of lifter has been adopted. A section through the lifter is shown in Fig. 1, and views of it in use are given in Figs. 2 and 3. The hopper arrangement into which the sand is fed by hand and the water jets for forming a sand slurry are much the same as in Mr. Hazen's well-known design, but the water jet is vertical and continuous except for the 1-in. pipe that penetrates the throat along its axis and conveys the sand slurry from the bottom of the hopper to the center of the jet of water. The arrangement forms a kind of U-tube, the water being brought down one leg and the sand and water passing up the other leg. The bend at the bottom forms a convenient place to attach the hopper and to pass the sand into the water.

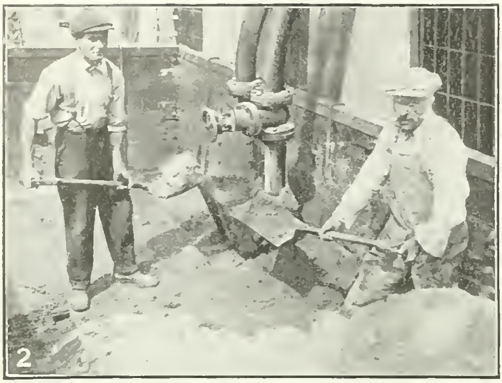


FIG. 2. SHOVELING SAND INTO HOPPER OF LIFT

The object of the trailing orifice is to avoid, as much as possible, scour at the throat. In practice a very considerable vacuum is maintained at the throat; and although theory indicates that the trailing orifice gives a less effective suction than a right-angled connection, this is not noticeable.

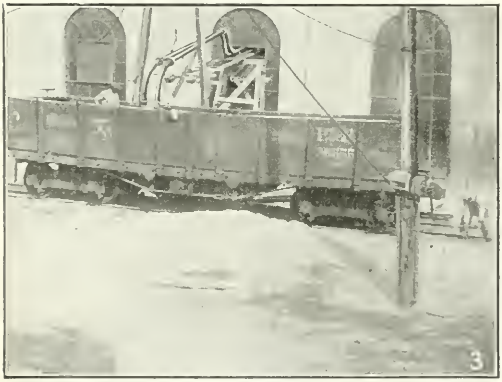


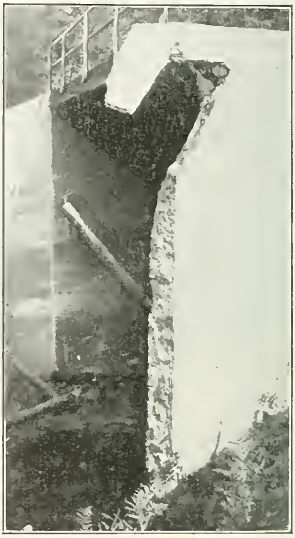
FIG. 3. HOW LIFT IS SUPPORTED FROM ABOVE

It is found that the amount of water required is 12,500 Imp. gal. per hr. for a delivery of from 7 to 8 cu.yd. of sand per hour. There is therefore about 10% sand in the discharge. It was found necessary to rebush the throat of the lifter with a short length of 1½-in. pipe after about each 600 cu.yd. delivery. The scour observe appears to be due to eddy action commencing where tl jet passes over the sharp edge of the sand-supply pip

In respect to scour, the experience with the lift throat differs from that of the sand-washers, where tl sand pipe is ¾ in. in diameter only and the disturban therefore much less; besides the velocities are al several times less.

NOTES

Backfill Wrecks Plain Concrete Abutment—The abutme shown in the accompanying view failed for reasons that a obvious to any engineer. It was built by some Michig township road commissioners without engineering advice assistance. The brid that the abutmer were designed to car is of 20-ft. span w a 16-ft. roadway. T height of bridge s above the water su face is 22 ft., and t height above top footing probably least 25 ft. With t relatively great hei the abutments w plain concrete with reinforcement and w not over 18 in. thi The bridge spans river in a deep gu which necessitated approach to the bri over a high fill. this section no ot material was availa for filling than sa and with such mate the backfilling done. The result that before the fill complete the fine s retained by the al ment exerted su pressure as to ca one wing wall to broken off, as sho A crack was also duced across the en face of the abutm which so affected strength that timbers were placed between the two abutm to prevent the collapse of the entire structure. The stan plans issued by the Michigan State Highway Department such bridges do not permit of unreinforced-concrete a ments of a greater height than 10 ft.—D. A. Thomas, Michi State Highway Department, Lansing, Mich.



MICHIGAN TOWNSHIP BRIDGE ABUTMENT WHICH FAILED

Motor Trucks Used 1 Gal. of Gasoline per 11 mi. on a mi. trip from the White factory in Cleveland to the No Grinding Co., Worcester, Mass. The trucks, which were ton, were stopped only for replenishing the gasoline and supply and for meals for the drivers. The trip was ard for the latter, but the army bodies of the trucks were fi with hay, so that the drivers took turns at sleeping driving.

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The Problem of Designing Flag Poles has been scien cally attacked by the Bureau of Yards and Docks of the Un States Navy, which recently requested the Washington N Yard to make tests on standard flags to determine stresses produced with different wind velocities. Two of flags were used, one a No. 7, 3x5½ ft., the other a N 2½x4¼ ft. The flags were tried in wind velocities of f 20 to 60 mi. per hr. and the results show that the total h zontal resistance of a flag, exposed to a steady current of can be approximately represented by the formula $R = CA$ where R = the resistance in pounds, A = area in sq.ft., velocity of wind in mi. per hr., $C = 0.00030$. The value decreases slightly with the size of the flag; that is, resistance per square foot of area decreases slightly with increase of size.

Editorials

Prizes Offered for Best Articles on Engineering Subjects

Cash prizes to the amount of $300 are offered by *Engineering News* for the best articles contributed on the four subjects stated below. For the best article submitted on each subject a first prize of $50 will be awarded, and for the article next in merit a second prize of $25. For other articles not receiving a prize, but deemed sufficiently meritorious for publication in *Engineering News*, a payment of $10 will be made. In comparing the different articles for the award of a prize, the controlling feature will be the value and interest of the information presented and the amount of information condensed within the limits of space named under each subject. No one need hesitate to take part in the competition because of distrust of his literary ability. In judging the articles, literary finish will be a very minor feature compared with the technical value of the information which is presented.

In case the two best articles submitted are found to be of substantially equal merit, the sum of the first and second prizes will be divided equally between the two authors.

All articles submitted in this prize competition must reach the office of *Engineering News* on or before Dec. 10, 1916. No article received after that date can be considered. The examination and award of prizes will be made by the editors of *Engineering News*, and the names of those receiving the prizes will be announced, if possible, in the issue of Thursday, Dec. 21. The submission of drawings and photographs with an article, to add to its interest and value, is encouraged, and the drawings may be presented in any convenient form.

Articles submitted in the competition should be addressed to the Editor of *Engineering News*, and the package should be marked on the outside, "For Entry in Prize Competition." Anyone is free to take part in the competition, but it should be clearly stated in the article whether the author himself is directly connected with the work that he describes or what the source of his information may be. This is in conformity to the well-known principle that every article published as professional data for engineers should show clearly the source from which it is obtained, so that the reader may know to what extent he may rely upon it as authoritative.

The four different topics on which papers are desired are printed below, with a suggestive explanation in each case of the field that the subject may cover. This explanation is not meant, however, to limit competitors in their treatment of the general subject.

1. *Rebuilding with Permanent Surface an Old Macadam Roadway*—There are in the United States many thousands of miles of roads and streets on which a water-bound macadam roadway has been built, often on a solid telford foundation. With the rapid increase in automobile traffic of the last five years particularly, the maintenance of these macadam surfaces has become a very serious burden. Various methods of treatment by penetration with asphalt oils, tar, etc., and covering with carpet coats have been used in the attempt to keep these roadways in fair condition. The expense of these methods of maintenance, however, and the unsatisfactory results secured have led to a general demand for the rebuilding of such roads, where traffic is heavy, with some form of permanent surface. In connection with this rebuilding, there is generally need for widening the old roadway, since with the high speeds of automobile traffic a greater width is generally deemed necessary for safety than was called for in the days of horse-drawn traffic.

The problem that is presented to a very large number of engineers, therefore, is whether in constructing a permanent paving of concrete, asphalt or other material the old macadam material, including the telford foundation, should be entirely removed or whether the new road should be built on top of the old as a foundation; how the subgrade should be treated; difficulties presented by the different crown of the old road and the new; whether material removed should be used on the shoulders of the road or carted away; and withal how to do the whole work within such moderate limits of cost per mile that the amount of money available may be made to cover a large mileage of streets. Length, 700 to 1,000 words.

2. *Operating Methods in a Drill-Sharpening Shop*—One of the most important factors in the economical operation of many contract jobs is the manner in which the drill-sharpening shop is run. Manipulation of the steel by the blacksmith, kind of steel to be used with different kinds of rock, experience with different brands of alloy steel and their heat-treatment are among the things that an engineer needs to know in order to secure the best results from his rock-drilling outfit. Length, 500 to 800 words.

3. *Dry Mixing of Concrete Materials at a Central Plant*—One of the newer developments in concrete work carried on in a large scale is the mixing of the stone or gravel, sand and cement at some central plant and transportation of the dry mixture to the place where it is to be used. Results of experience with this system are desired with an account of the advantages found, the difficulties experienced, detailed cost figures, etc. Length, 700 to 1,000 words.

4. *Adapting the Motor Truck to Its Work*—The rapid increase in the use of the commercial motor vehicle during the past year and a half is a matter of common knowledge. The high price of feed and of horses will continue to stimulate the use of motor haulage. The great variation, however, in the economic results reported indicates that selection of a motor truck suited to the work it has to do will make a large difference in the operating costs per ton-mile. Every user and prospective user of a motor truck is interested to know what features in design and equipment are found to be sources of trouble and what conduce to efficient and economical performance. Length, 700 to 1,000 words.

National Engineering Societies and Their Local Sections

Local sections of each of the great national engineering societies have been organized in the principal cities throughout the country. Many of these local sections have become strong organizations, holding regular and well-attended meetings, so that those belonging to the sections frequently testify that they are getting a more valuable return from their society membership through the local section to which they belong than in any other way.

A question that is coming up in rather acute form is the extent to which the national society, through its governing board, should control these local sections. In the American Society of Civil Engineers, the organization of the local sections has been a purely voluntary matter on the part of the members resident in a given locality. Nothing in the society's constitution authorizes the organization of such local sections, and they are in fact not even mentioned in the society's last Year Book. Apparently, therefore, each of these local organizations of the Civil Engineers is free to do exactly as it pleases and to manage its own affairs without any interference whatever from the society headquarters in New York.

In the American Society of Mechanical Engineers, on the other hand, the organization of the local sections was expressly authorized by a constitutional amendment that gave the society's Council entire control over the affairs of the local section. A substantial reason for this control is that part of the expenses of the local sections are paid from the general treasury of the society.

In most of the cities where these local sections of national societies have been organized, there has been also a movement toward the federation of all the engineering and scientific organizations in the city. Sometimes, as at Philadelphia, this federation is chiefly for social purposes, to combine in the enjoyment of club facilities, etc. In a number of cities, however, the general demand that the engineering profession shall exert an influence in public matters has resulted in the creation of committees or boards on which all the engineering organizations in the city are represented. This board is given authority to deal with public questions that may come up on which the opinion of the engineering profession may well be expressed.

The local associations of members of the American Society of Civil Engineers are free to take part in such movements. They have no authority to act for or represent their national society, of course; but because they have no official standing in the national society they are not accountable to it. The sections of the American Society of Mechanical Engineers, on the other hand, are by their charters subject to the authority of that society's governing board. The question whether that board shall permit its local sections to join other organizations in connection with public work is under active discussion.

There is, of course, no objection raised by anyone to these local sections uniting with other organizations to hold meetings, excursions, etc. The doubt arises when the proposition is made that these local sections shall take part in some public matter. In St. Paul, for example, the Minnesota Joint Engineering Board has been organized to represent three sections of the national societies, three local associations and the Engineering School of the University of Minnesota. Among the committees that are to carry on the work of this board are Committees on Public Affairs, Federal Legislation, State Legislation and Municipal Legislation.

A somewhat similar organization in the South is the Affiliated Technical Societies of Atlanta, made up of representatives from the local sections of five national societies and a representative of the Engineering Association of the South. This association, which has been in existence for three years, is apparently about to undertake similar work to that proposed by the Minnesota Joint Engineering Board. A recent circular issued by the Affiliated Technical Societies of Atlanta says:

> Like many others, you must have experienced a desire for a wider participation of engineers in nontechnical affairs, both local and national. The trend of the times is to force a greater civic responsibility on members of societies and upon professional engineers.

These two organizations are without doubt typical of a general movement in the engineering profession toward having its organizations exert an influence in public affairs. This movement is likely to take shape more rapidly in the local organizations than in the national societies.

The argument made by those who hold that the national society should strictly control its local sections and prevent them from taking action on public questions relating to legislation, etc., is, briefly, that no group of members should have the power to commit the society as a whole on any question on which the members of the society might hold radically different opinions. To take a concrete example: It might be that a local section in one city might take strong ground in favor of the enactment of laws to require the examination and licensing of engineers. A local section in another city might take an exactly contrary stand. It is urged that such conflicting opinions expressed by the sections would weaken the prestige of the national society.

Before accepting this view of the situation, it is well to inquire whether the acts of a local section, on matters of public interest, would be understood to represent the sentiment of the entire national society. Suppose, for example, that the San Francisco Association of Members of the American Society of Civil Engineers were to adopt a resolution favoring the passage of the national flood-control bill that was actively pushed at the recent session of Congress. No one would suppose that such action committed the entire society to the support of that bill. It is difficult to believe that the reputation and prestige of the national societies of Mechanical Engineers or Mining Engineers or Electrical Engineers would suffer because of the action that a local section might take on public questions coming before it.

If this is a correct view of the case, then the best policy for the national societies to adopt toward their local sections is the policy of noninterference. And this is a commonsense policy. It is not likely that a dozen engineers meeting once a month in New York City can wisely dictate what another group of engineers in a city a thousand miles away shall do or shall not do with reference to some local question.

The officers of the national societies ought to understand, too, that it is still an open question whether their local sections are to be permanent bodies. There is no denying that in the local field it is the general organizations that are strong and influential and not the sections of the national societies. The most important development of the past dozen years in engineering-society work has been the rapid growth in power and influence of such local societies as the Engineers' Club of Philadelphia, the Cleveland Engineering Society, the Western Society of Engineers and the Boston Society of Civil Engineers.

The prevailing sentiment in the profession is strongly in favor of the get-together movement, in which engineers of all branches of the profession join in a strong local organization. If the governing boards of the national societies adopt a policy of helpful coöperation toward their local sections, giving them financial aid from the national treasury and useful counsel in the conduct of their affairs, the sections may be an important aid in making the society's work nation-wide. If, however, a society adopts a repressive policy and attempts to dictate from headquarters what a section may or may not do, the probabilities are that the local sections in that society will soon cease to exist.

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Steam Turbine at Sea Replaces the Reciprocating Engine

The remarkable success of the steam turbine in replacing the reciprocating steam engine is well known to engineers. For the propulsion of vessels, however, the reciprocating engine has held its own. Installations of steam turbines at sea have generally been confined to high-speed passenger and naval vessels. The difficulty in driving the screw propeller of an ordinary vessel by a steam turbine mounted directly upon the shaft is that the rotative speed at which the propeller is most efficient is very much lower than the rotative speed best adapted to the steam turbine. Even in the fast vessels driven by steam turbines a great deal has to be sacrificed. The turbines have to be especially designed to enable them to give good results at a moderate rotative speed and the screw propellers are made of finer pitch than would otherwise be desired to enable them to be run at a speed suitable for the turbines.

During the last years of active work of the late George Westinghouse, the engineering development in which he took the greatest interest was the Westinghouse-Macalpine system of speed-reduction gearing by which a high speed steam turbine drives a propeller shaft at low speed. With this combination it is possible to build a steam turbine which will be economical in the use of steam and can be built at moderate cost and the propeller speed is kept down to a rate suitable for such slow vessels as tramp steamers. The English steam turbine inventor, Parsons, also designed a system of speed-reducing gearing for use on ships, which has been applied to some extent, but it does not have the floating frame feature which was a characteristic of the Westinghouse-Macalpine system.

It is of interest to learn that the sanguine hopes of Mr. Westinghouse for this system of vessel propulsion are now being realized. The Westinghouse Machine Co. has recently received orders for equipping with its steam turbines and double-reduction gearing 44 merchant vessels now under contract in shipyards on the Atlantic and Pacific coasts, while contracts for 16 additional vessels are in immediate prospect. These figures do not include the orders for this class of equipment for United States naval vessels or for foreign governments. There is reason to believe that this development may mean the eventual replacing of the reciprocating engine by the steam turbine on shipboard.

Letters to the Editor

What Are Road-Maintenance Costs in New York?

Sir—The actual costs of road maintenance on New York State's bituminous highways have never been clearly stated. We have had, it is true, some extravagant guesses on the part of a former governor of the state, and annually there is given out a summary that combines all asphaltic and bituminous roads and gives a lump-sum statement as to what they have cost. But as to particular roads and the way in which the money spent on them is accounted for, no facts have up to this time been obtainable. For these reasons the figures presented herewith are of exceptional interest.

It appears that under the system followed in New York the cost of maintenance is distributed under the following headings: Improvements, Resurfacing, Engineering and Inspection, Ordinary repairs to road surfaces (which is divided to show the cost of labor and material separately), Cleaning macadam, Trimming shoulders and cleaning tops, Oil (which is divided into the cost of oil, sweeping, applying and covering and material for coverings), Guard rail, Concrete, Tools and Plant, Patrol, Extraordinary repairs and miscellaneous.

In the figures herewith, showing the cost of maintenance per mile per year on 24 roads, the items charged to engineering and inspection have been eliminated in arriving at the figure showing the cost per mile per year. One reason for excluding the charges for engineering and inspection is that the latter items do not cover labor and materials actually required to keep the road surface in repair. A further reason is that there appears to be no relation between the cost of engineering and inspection and the amount of money laid out for repair and materials. For example, road No. 616, built in 1910, has never been resurfaced, and yet we find that the charge against this road for engineering and inspection amounts to $620.35. In the case of road No. 686, where only $32 was spent for resurfacing, $631.39 was charged up for engineering and inspection. On the other hand, the records show a number of cases where large sums were spent for resurfacing and little or nothing for engineering and inspection.

Study of the New York maintenance sheets would indicate that the engineering and inspection charges were arbitrarily assessed against roads on which the labor and material outlay was negligible. Road No. 350 cost $3,651.92 for resurfacing in 1911. About $2,500 was also spent for oil used on the same road, and yet the engineering and inspection charge is $768, or about the same as is charged against roads on account of which little or nothing was spent for labor and materials; and in the case just referred to the larger part of the engineering and inspection charge—namely, $596.17—appears under date of 1912, or two years before the larger amounts were spent in resurfacing and for labor and materials.

Another example that may be cited is road No. 5047, which cost $2,106 for resurfacing in 1914, but carries an engineering and inspection charge of only $217.83 for the five years it has been under maintenance.

All of the roads on which maintenance costs are here presented were constructed by the penetration method. They were not selected with a view to proving anything for or against this method of construction or the materials used. As a matter of fact, there was no opportunity to select any particular roads, the only figures obtainable for the purpose of this investigation being those here presented.

COST OF MAINTENANCE PER MILE PER YEAR ON 24 NEW YORK ROADS

Maintenance Cost, Less Engineering, on 12 New York Roads Constructed with Residual Asphalt Binder

Number of Road	Miles	Date Accepted	Total Cost, Maintenance and Repair	Maintenance and Repair Less Engineering	Cost per Mile per Year
5047	1.64	1911	$5,732.99	$5,515.16	$671
630	2.24	1910	10,250.58	9,352.48	696
735	7.90	1910	12,908.94	11,444.49	289
769	4.21	1910	7,163.90	6,471.33	307
5076	5.22	1911	5,646.06	5,091.26	244
5086	5.04	1912	11,260.49	9,886.67	654
690	4.25	1910	8,583.80	7,274.87	261
669	5.98	1913	5,896.15	5,575.59	311
654	5.35	1910	8,074.40	7,319.59	228
393	3.61	1910	6,593.50	5,849.75	324
350	7.26	1911	16,335.48	15,567.31	420
796	2.54	1910	21,324.67	19,547.76	705
Average maintenance per mile per year					$426

Maintenance Cost, Less Engineering, on 12 New York Roads Constructed with Fluxed Natural Asphalt Binder

Number of Road	Miles	Date Accepted	Total Cost, Maintenance and Repair	Maintenance and Repair Less Engineering	Cost per Mile per Year
719	5.56	1911	$6,369.37	$5,296.97	$190
5085	4.52	1913	5,068.79	3,971.34	293
5117	6.00	1912	6,328.65	5,999.26	250
415	3.37	1912	4,704.41	4,224.98	313
847	5.74	1912	6,689.44	5,717.34	248
571	2.61	1910	1,328.54	826.87	63
646	4.12	1910	3,724.80	3,104.45	124
650	5.66	1910	13,260.86	11,983.22	353
665	5.16	1912	4,656.48	4,145.07	201
686	8.72	1912	2,845.74	2,214.35	63
5054	2.00	1912	4,357.42	3,608.47	377
877	.97	1913	1,076.54	978.37	336
Average maintenance per mile per year					$234

While it would require a great deal of space to present in detail the distribution of maintenance on each of the roads listed, a few examples suffice to show how the records are kept and of what the totals consist. Typical of the maintenance sheets from which the accompanying table was made up are those relating to roads Nos. 719 and 5047. In these and all other cases the cost of engineering and inspection was subtracted from the total cost of maintenance. The remainder was then divided by the number of miles in the road to obtain the cost of maintenance per mile. This figure was again divided by the number of years the road had been under maintenance to obtain the cost per mile per year.

The two detailed statements here reproduced also serve to illustrate the lack of proportion between the cost of engineering and inspection and the amounts spent for labor and material. Road No. 5047 was resurfaced at a cost of $2,106, and there are other considerable charges for labor and material. Yet the engineering and inspection charge is only $227.83. Road No. 719 has never been resurfaced, is nearly three times as long as road 5047 and shows a much lower cost of maintenance per mile, yet it carries an engineering and inspection charge of $1,072.40.

Daniel T. Pierce,
Executive Assistant, Barber Asphalt Paving Co.
Philadelphia, Penn., Oct. 2, 1916.

Process Wanted for Protecting Drawings from Dampness

Sir—The Board of Water Supply of the City of New York will in a short time hang drawings in underground chambers and it will be necessary to protect these drawings from dampness.

About eight or ten years ago a man called with a process for casting drawings in a transparent solid which apparently was neither celluloid nor collodion, although it looked somewhat like either. We had no use for his scheme at the time but would like very much to try it now, so we would be very glad to hear from any of your readers who have run across this process or a similar one.

The drawings will be in some cases larger than 36x48 in. and should be made rigid enough to hang on a wall.

C. F. Bell,
Assistant Engineer in Charge of Drafting.
Board of Water Supply, Engineering Bureau, Municipal Building, New York City, Oct. 20, 1916.

Lubrication of Engine Cylinders

Sir—I have read with interest the article in *Engineering News* of Oct. 5, on "Oil in Engine Cylinders," in which is quoted the experience with one of our engines at the Rockwell Manufacturing Co.'s plant in Milwaukee.

As to the claim that their cylinder-oil consumption record surpasses all previous records of economic cylinder lubrication, I would say that this is not strictly a fact, as there are many vertical engines operated without any cylinder lubrication whatsoever, particularly marine engines.

The experience at the Rockwell Manufacturing Co.'s plant shows the advantage of the use of poppet valves and of carrying the weight of the piston on outside guides instead of carrying it on the bottom of the cylinder. The poppet valve has no rubbing surfaces and requires no lubrication. If in addition, the piston is turned smaller than the cylinder and supported on a stiff piston rod with a crosshead at either end, then there are no other surfaces to lubricate in the cylinder than the packing rings.

The nature and amount of friction of packing rings on cylinder walls are difficult to observe and determine; therefore there are no reliable data on this point. The friction, however, on a well-designed packing ring is exceedingly small. If it were not, then it would not be possible to run some engines without cylinder lubrication. It is very probable that a film of steam forms between the packing rings and the cylinder wall and aids the lubrication.

The lubrication of a steam cylinder is entirely different from the lubrication of a bearing. In a bearing, arrangements can be provided where the friction is reduced to a minimum. This condition could not be even approached in the lubrication of steam cylinders, and I do not think that the friction of a steam engine can be in any way reduced by increasing the amount of cylinder lubricant.

If the friction of the piston in a steam engine is not kept very low, this fact will manifest itself in wear and in cutting of the cylinder; as long as the amount of lubricant is sufficient to prevent cutting and wear on the cylinder, it is sufficient. In the cylinder of the Rockwell engine there is no sign of wear.

In a good many plants where city water is used for boiler feed and where the exhaust steam from the engine is used for heating purposes a considerable portion of the feed water is used over and over again, and in such cases it is very important to keep down the amount of cylinder lubricant used. BRUNO V. NORDBERG,

Chief Engineer, Nordberg Manufacturing Co.

Milwaukee, Wis., Oct. 5, 1916.

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Dr. Travis and the Imhoff Tank

Sir—I have read with much interest your editorial note on "Dr. Travis and the Septic Tank" and also the description of the "Hydrolytic Sewage Tanks at Luton, England," by J. W. Tomlinson, both in your issue of Aug. 31, 1916. As I have had a good deal to do with the Travis tank, I would appreciate a little space in your paper.

As regards the origin of the Travis tank there is no doubt, and Dr. Travis has always fully acknowledged this, that the excellent work of H. W. Clark for the Massachusetts State Board of Health suggested to Dr. Travis further experimental research into the separation of the solids of sewage from the liquid and their separate treatment afterward, as a result of which he eventually evolved the well-known form of his tank. But the Travis tank is altogether a new constructional form and differs entirely from the two separate tanks used by Mr. Clark.

When Dr. Imhoff, in 1905, was an assistant in the Kön Prüfungs austalt für Wasserversorgung und Abwässer beseitigung in Berlin, he had before him the schemes submitted for approval by the Emschergenossenschaft for Travis tanks in one or two cases, and it was in his official capacity as "assistant judge" in examining into these schemes that he became acquainted with the Travis tank. On Apr. 1, 1906, Dr. Imhoff was appointed engineer to the Emschergenossenschaft, and on Apr. 28, 1906, he lodged the application for his German patent No. 187,723.

This patent, and this is important to notice, does not cover the form of the tank employed by Dr. Imhoff, for that was already patented to Dr. Travis; it only covers the prevention, as far as possible, of all movement in the sludge chamber and the passage back into the sedimentation chambers of the putrefying contents of the sludge chamber. This is clearly expressed in the judgment of the German High Court of Justice, delivered June 17, 1912.

I should like to point out here that it is another fallacy to assume that there is no movement in the sludge chamber. On the contrary, there must be violent motion according to the degree of putrefaction attained in it, and by closing the outlet this violent agitation is not prevented, but is rendered more or less arbitrary in its various currents. It further stands to reason that there must be a continual displacement of the contents of the sludge chamber into the sedimentation chambers, and it is well known that where the sojourn of the sewage in the sedimentation chambers is protracted the effluent from them is more or less septic.

It is only fair to add that down to the end of 1913 there had been erected in Germany 63 Travis tanks. In England, I am told, there are now about ten Travis tanks dealing with something like 6,500,000 Imp. gal. of sewage daily.

There are a number of Travis tanks at work in India. There is also one, if not two, I believe, in South America, but probably the largest Travis tank installation at the present time is at Cairo, Egypt, when daily 11,000,000 Imp. gal. are treated. H. ALFRED ROECHLING.

29 Broadway, Westminster, London, S. W., England,
Oct. 3, 1916.

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Goose Lake Valley Irrigation System, Oregon

Sir—In the article on the "Goose Lake Valley Irrigation System, Oregon," by Kenneth A. Heron, in *Engineering News*, Sept. 14, 1916, there were shown detailed plans of three structures on this system.

The writer designed and had charge of the construction of all these structures and feels that some explanation of their design is proper. When the original designs for these structures were first made, the nearest railroad station was at Likely, Calif., nearly 100 mi. from the location of the proposed structures. Being unable to obtain the quantity of lumber required from local mills, I immediately installed a sawmill. During construction the railroad was extended to Lakeview, Ore., and it was then decided to substitute metal flumes for many of the wood flumes originally planned. As a large portion of the lumber had already been sawed, it became necessary to completely revise the plans for nearly all structures and an attempt was made to utilize, as far as possible, the lumber on hand. A well-proportioned structure was not always possible under these circumstances, and this explains the combination of 6x14-in. and 3x12-in. stringers in the first plan shown, and the 3x12-in. longitudinal braces on the substructures for metal flumes, etc.

The pile trestles shown had already been driven for wooden flumes before metal flumes were decided upon, which necessitated the rather complicated substructure for the metal flumes. At locations where pile trestles had not already been driven for wooden flumes a much simpler and more economical structure was erected for metal flumes.

The lining for the flumes and tunnels shown was cut 2½ in. thick, so that, after seasoning, it came from the planer a strong 2 in. This explains why the dimensions shown are not the ordinary commercial dimensions.

I notice an error in the distance shown between centers of the 4x4-in. carrier beams on the metal-flume substructure. As I recall it, these were spaced about 30 in. apart. The dimension shown (10 ft. 2½ in. c. to c.) refers to the distance between centers of holes bored in the carrier beams to receive the carrier rods that supported the metal flume. G. W. RICE.

Investment Building, Los Angeles, Calif.,
Oct. 17, 1916.

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The Cost of Running Automobiles used by the Operating Department of the City of San Diego, Calif., is given in the monthly report of S. M. Lockwood, Manager. There are 13 automobiles in use by the Operating Department, which during the month of August made an aggregate of 17,010 mi. The total cost of running these machines, for tires, gas, oil and repairs, during the month was 4.2c. per mi.

Brooklyn Adds an Automatic Sewage-Pumping Station

By L. J. Gersoni*

In providing sewerage systems for newly developed territory in the Borough of Brooklyn, New York City, the Bureau of Sewers has designed and built several pumping stations, both hand controlled and automatic. The latest automatic station to be put into service is located at Avenue U and Ocean Parkway. This station was designed to lift the sanitary sewage from a low-lying area of 739 acres into the gravity system for the district. The present estimated population of this drainage area is about 8,000, or 10.83 per acre. The development will most likely be residential, with a population of about 100 per acre in 25 years.

FIG. 1. VENTILATING TOWERS AND ENTRANCE TO PUMPING STATION, AVE. U, BROOKLYN

At present the average flow to the station is 3.5 cu.ft. per sec., and the maximum 3.7. As the sewers are in water-bearing soil, 0.003 cu.ft. per sec. per acre throughout the day was estimated to be the inleakage, based on data for similar conditions elsewhere. This amounted to 2.2 sec.-ft. running to the station. (After the plant went into service it was found that the infiltration was considerably less—due to careful inspection of the work and extreme care in making the joints of the vitrified pipe.)

Station Equipment

It was judged necessary to have a pumping capacity of 16 cu.ft. per sec., the expected ultimate flow, at the head developed, as the storage capacity of the station well is small. Two 12-in. pumps, each to deliver 3,600 gal. per min. against 31-ft. head, were installed. One will handle the flow up to about the year 1930, when a third or spare unit can be installed, insuring two pumps always ready for service.

The station is under the bicycle path of the parkway and consists of a wet-well, into which the sewage flows, and a dry-well, in which are located the pumps, motors, switchboards, etc. Fig. 1 shows the entrance to the station and also the ventilating towers. The only visible portions are made to harmonize with the surroundings. The sewage passes through bar screens (see Fig. 2) having openings 1 in. wide in the clear, installed merely as a protection for the pumps. These screens are hand-raked periodically, and the small amount of resulting screenings is taken away in closed cans. The three pump suctions pass horizontally through the partition wall, entering the wet-well at the floor level. In operation the well is never pumped dry, the pumps being automatically stopped when there is about a foot of water over the tops of the suction pipes.

The pumps are of a vertical-shaft type, with inclosed impellers, built by the Morris Machine Works, of Baldwinsville, N. Y. They are mounted on chairs on the pumproom floor, permitting the suction connections to be made at the bottom. The suction elbows are provided with hand holes and cover plates to give easy access to the interior of the pump. The upper side covers, including the bearings and stuffing-boxes, are easily removable and on removal expose to view the entire impeller. The pump bearings are positively lubricated by force-feed lubricators driven from the vertical shafts. A small connection from the suction line of each pump is carried to the drainage sump in the floor, so that it can be pumped out and the floor kept dry.

The pumps are driven by 50-hp. two-phase 60-cycle 720-r.p.m. synchronous vertical-shaft induction motors with wound rotors, made by the Fairbanks-Morse Co. It was necessary to use wound rotors in order to keep the inrush current at starting within 150% of the full-load current, this being a requirement of the Flatbush Gas Co., which supplies power for operation. The motors are mounted on sub-bases, which contain the thrust bearings for the pumps. The motor thrust bearings are at the top of the motor frames. The motor and pump shafts are joined by pin couplings so that no part of the pump thrust is transmitted to the motor thrust bearings. All

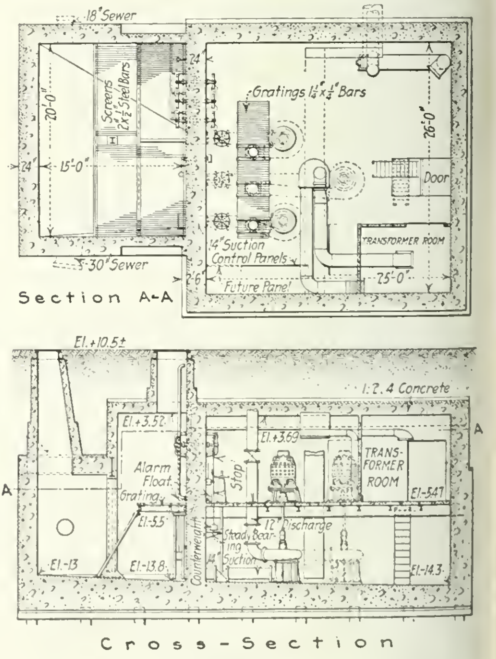

FIG. 2. ELEVATION AND PLAN OF AUTOMATIC PUMPING STATION

motor windings are impregnated with insulating compound by the vacuum process, to make them suitable for operation in damp places. Lubrication of all bearings is entirely automatic, gages being provided to show the height of oil in all wells.

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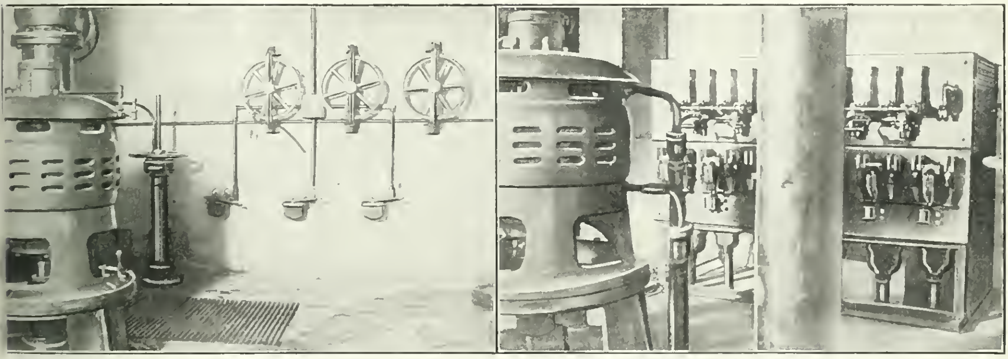
*Mechanical Engineer, Bureau of Sewers, 215 Montague St., Brooklyn, N. Y.

The pump efficiency is above 60% from 2,750 gal. per min. at 34 ft. head to 4,850 at 22.5 ft. head, with a maximum of 68.5% between 3,600 gal. per min. at 31 ft. head and 4,250 gal. per min. at 28 ft. head, the range of capacity and head developed when both pumps are in operation. With only one pump in operation the capacity is approximately 4,500 gal. per min. at 26 ft. head with an efficiency of 67%. The capacity and efficiency vary throughout an operating period of the pumps as there is an increase of 3.5 ft. static head between the time of starting and stopping of a pump.

STATION OPERATION

Power is carried in by an underground circuit at 2,200 volts, and is transformed in the station to 220 volts for power and 220-110 for lighting.

The pumps are started and stopped automatically at predetermined levels of sewage in the wet-well by means of current-limit starters made by the Sundh Electric Co.



FIGS. 3 AND 4. VIEWS IN AVE. U, AUTOMATIC SEWAGE-PUMPING STATION

Fig. 3—Showing motor, float switches, inlet valves, standard and discharge valve. Fig. 4—Showing motor and control switches

he float switches controlling the current to the operating ils of the starters are so set that should one pump fail start or should the flow into the well gain on the pump operation the other motor will start after the level of e sewage has risen 6 in. above the level at which the rst pump should have started. Each starter panel is rovided with a Cutter Co. four-pole inverse-time over-ad circuit-breaker, a magnetically operated primary ntactor, and two magnetically operated secondary ntactors for cutting out resistance from the rotor rcuit. No-voltage release, operated by a coil in each ase, is provided on the starters, so that, should the ltage fail in either phase, the primary and secondary ntactors will be open, and on return of voltage the rter will be in proper position to go through a normal rting cycle.

There is an alarm float switch throwing into circuit r Edison-Lalande cells capable of ringing the alarm bell ntinuously for 24 hr. An interlock on each circuit-eaker is also provided so that the alarm is sounded ould the circuit-breaker open. The alarm bell, mounted in one of the ventilating towers, can thus be sounded either by the alarm float switch closing, if the level of the sewage in the wet-well rises to an abnormal height, or by the opening of any of the circuit-breakers on account of some abnormal sustained overload condition in the operation of the pumps. It is intended in the future to arrange the alarm so that it will be sounded at a central operating station where there will be someone in attendance at all hours. For the present, however, the police have been instructed to notify the Sewer Bureau should the alarm be sounded.

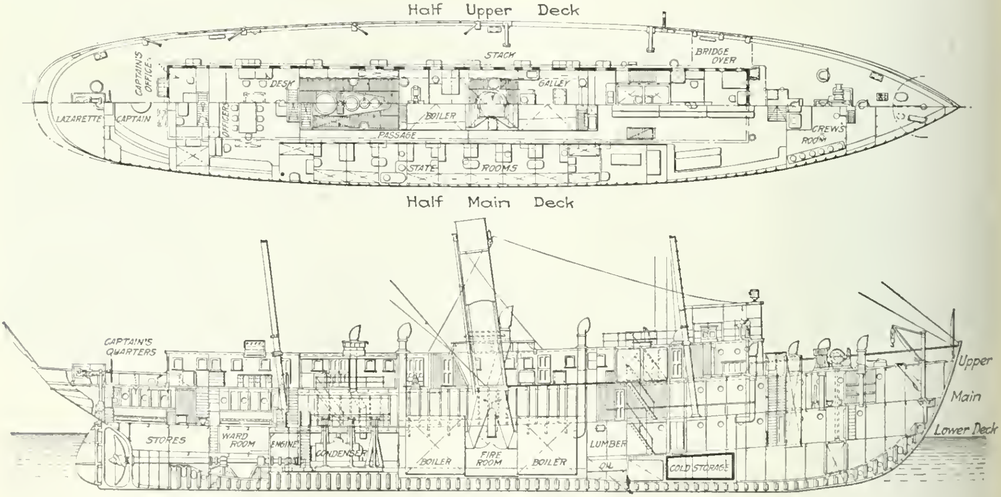
Fig. 4 shows one of the motors and the two present starter panels. All coils on the starter panels are impregnated with insulating compound by the vacuum process.

The mechanism for operating the float switches on the control circuits is unique, being a departure from the usual float-chamber type. Cast-iron sleeves, with a stuffing-box at each end, are set in the partition wall between the wet-well and the dry-well. Bronze shafts, with a bearing bracket at each end, pass through these sleeves and carry two drums, one on each side of the wall. Cast-iron floats with bronze shoes, operating in T-bar guides set in the wet-well, are connected by bronze cables to the drums on the wet-well side of the wall. Similar cables, provided with adjustable stops and fastened to the drums in the dry-well, pass through slotted arms on the float switches and carry the counterweights. As the level of the sewage in the wet-well rises and the floats rise, their cables winding up on the wet-well drums, the counterweights sink, their cables unwinding from the dry-well drums. When the stop, in its downward travel, strikes the slotted arm of the float switch, the switch is closed, thus completing the circuit of the operating coil on the motor starter and automatically starting the pump then connected to this particular float switch. The stopping of the pump is accomplished by another stop on the counterweight cable striking the switch arm and opening the float switch when the float in the wet-well has dropped to a lower predetermined level.

It has been found by the Sewer Bureau that this type of float mechanism is more reliable in operation than the separate float-chamber type as it is entirely accessible and at all times exposed to view. Should the float stick or fail to operate for any reason, it can be very easily and quickly put in operating condition again

Fig. 3 shows one of the motors with its sub-base containing the pump thrust bearing, and the three float-operated switches for controlling the current to the operating coils on the motor starters. Only two float switches—one for each starter—are at present in service. The third will be made operative when the third pump, motor and starter panel are installed. Selector switches on the main switchboard permit any pump and its motor to be controlled by any one of the three float switches. Each starter panel is provided with a normally open, spring-loaded switch to short-circuit the float switch so that the attendant on coming into the station can tell if the pump, motor and starter are in working order without waiting for the float-operated switches to be thrown.

In addition to the integrating power and light meters the main switchboard is provided with a graphic recording voltmeter and a graphic recording ammeter. The former serves as a check on the voltage of the system as maintained by the power company, while the latter shows the operating periods of the pumps and indicates the clogging of a pump by recording a current consumption different from the normal. The switchboard was built by the Sprague Electric Co. All wiring is done with lead-sheathed rubber-covered wire in galvanized steel conduit.



DECK PLANS AND LONGITUDINAL SECTION OF THE UNITED STATES COAST AND GEODETIC SURVEY'S NEW STEAMER "SURVEYOR"

There are two ventilating towers—one for the transformer room and the other for the rest of the dry-well. (In Fig. 1 one tower is shown behind a tree at the left.) For the main-well ventilation, inlet and discharge ducts lead to a ½-hp. motor-driven fan capable of changing the air in 10 min. The inlet and discharge ducts are carried in one tower.

It is found necessary to operate the ventilating system only a few minutes each day, when the attendant calls at the station, in order to keep the air pure and dry and prevent the deposit of moisture on the apparatus.

Since the station was put into service in December, 1915, it has operated to the entire satisfaction of the Sewer Bureau. The attendant visits the station each morning, changes the charts on the recording instruments, sees that all lubricators are properly filled and everything is in good working order, and does the necessary cleaning and incidental work about the station. The entire time of his presence at the station is about one hour per day.

The general contractor for the mechanical and electrical equipment of the station was the Almirall Co., of New York. E. J. Fort is the Chief Engineer of Sewers and G. T. Hammond the Engineer of Design.

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United States Coast Survey Steamer "Surveyor"

The latest addition to the fleet of the United States Coast and Geodetic Survey is the modern steamer "Surveyor," which was launched last July.

The "Surveyor" is a steel vessel of 1,000 tons displacement. Her dimensions are: Length over all, 186 ft.; length on load water-line, 160 ft.; beam, 34 ft.; depth of hold, 21½ ft.; loaded draft, 12 ft. She will be driven by one triplex-expansion engine of 1,000 hp. and is expected to maintain a 12-knot speed. Through the courtesy of the Bureau of Construction and Repair of the Navy Department a model of this vessel was made and tested in the model tank at the Washington navy yard, and data were furnished for the design of her propeller.

The vessel will carry a complement of 11 officers, who conduct the surveys, and 56 enlisted men. She will burn fuel oil exclusively and will have a tank capacity of 230 tons. She will carry 20,000 gal. of fresh water for the boilers and for general ship use and will have sufficient capacity for mess and ships' stores for about six months.

The "Surveyor" is intended for hydrographic surveying on the Pacific Coast of the United States and Alaska. When completed and equipped at New York she will go by way of the Panama Canal to Seattle, Wash., and from there to the coast of western Alaska.

At the close of the working season in Alaska she will be used for similar surveys on the coast of Washington, ton, Oregon and California. It is expected that this will be her general program of operations for several years—the Alaskan coast during the spring, summer and early fall months and the west coast of the United States during the balance of the year.

The "Surveyor" was designed especially for this duty, and her plans are the result of years of experience with vessels indifferently suited for the work. It is believed that she will be found most efficient and that her design, construction and equipment are as nearly perfect for hydrographic surveying as the appropriation (about $200,000) permitted.

Exceptional seaworthiness, with rugged construction, wide beam and sufficient power to make progress against head seas, are the essential characteristics of the vessel, and in designing her these matters were given more weight than speed and trim lines. The maximum carrying capacity for the displacement was considered necessary in order to provide comfortable quarters for a sufficient crew to make the surveys, and to carry fuel, water and supplies in such quantities as to allow her to remain at sea as long as possible.

The vessel has two full decks and below these, forward ınd aft of the boiler and machinery compartments, a hird deck. These will be referred to here as the upper, nain and lower decks. A deckhouse 116x16 ft. extends rom 44 ft. abaft the stern to within 26 ft. of the bulvarks aft. The top of this house forms a boat deck that xtends to the sides of the vessel. Above the deckhouse re the wheelhouse and the navigator's bridge.

On the main deck are the commanding officer's quarters, he officers' messroom and staterooms, the petty officers' taterooms and messrooms, the hospital space, crew's mess nd workrooms and the washrooms and toilet. The crew ave quarters in two forecastles on the lower deck forward. ll quarters are large and well ventilated, and every possible convenience for the comfort of the officers and men as been provided. Below the lower deck forward and n this deck aft are the storerooms, drinking-water tanks nd cold storage. In the deckhouse are the chartroom nd executive officer's office, radio rooms, galley and panies, engineer's office and machine shop, officers drafting om and office and the commanding officer's office.

The main engine is of the vertical, inverted, threelinder, triple-expansion, surface-condensing type, with linders 18, 29 and 47 in. in diameter and 30-in. stroke. he working steam pressure at the high-pressure cylinder ill be 185 lb., driving the engine at 110 r.p.m. The opeller is of cast steel of the built-up type, with four ades. The diameter is 10 ft. 6 in., and the pitch is 13 . 4½ in.

Steam is furnished by two Scotch-type boilers, 11 ft. 9 . in diameter by 11 ft. 11 in. long over all, each fitted ith two Morrison corrugated furnaces of 42-in. inside ameter. The boilers are in a compartment just forward the engine compartment and are placed one forward of e other with the firing space between. The boilers are ted to burn fuel oil, which is carried in tanks on each le and forward of the boiler space.

The vessel will be lighted by electricity from two nerating sets of 10- and 15-kw. capacity respectively. ere will be a refrigerating plant of two tons capacity d a steam laundry sufficient for the officers and crew.

The subject of water-tight compartments was given particular consideration in the design, for the reason that this vessel will have to investigate uncharted and dangerous waters. In addition to the usual collision bulkhead at one-tenth her length, she has transverse water-tight bulkheads from keel to main deck on frames 19, 34, 53 and 66 and from keel to lower deck on frame 74. The entire lower deck, both fore and aft, consists of two water-tight flats; and the double bottom in the boiler and machinery spaces, as well as the several oil tanks, which are formed by the shell plating and longitudinal and transverse bulkheads, divides the lower part of the hull into many water-tight compartments.

The boat equipment of a survey vessel is an important consideration, and this vessel has a liberal allowance of boats suitable for surveying operations. These boats are of navy types. They consist of two special hydrographic-surveying launches, 32 ft. long, equipped with 25-hp. medium-duty gasoline engines; one 30-ft. launch with a 25-hp. gasoline engine; one 30-ft. motor sailing launch equipped with a 10-hp. gasoline engine of the navy type; and two whaleboats 20 and 24 ft. long respectively. While all the launches are adaptable for hydrographic surveying, the two 32-ft. special surveying launches are intended to do most of the work, leaving the 30-ft. launch for general use and the 30-ft. motor sailing launch for boating supplies and landing the equipment of camp parties.

The "Surveyor" will carry the usual equipment of a surveying vessel, including machines for sounding at all depths down to the greatest ocean depths. The lighter machines will be electrically driven, while the deep-sea sounding machine will be operated by a steam engine. The radio equipment, which will be the new type of apparatus designed by the United States Bureau of Standards for Government vessels, will be tested and installed by the radio experts of that bureau.

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Sanitation on Watersheds

Sanitation on the watersheds utilized for the municipal water-supplies of Newark, Jersey City and New York was the subject of an interesting meeting of the New York Section of the American Water-Works Association, on Oct. 18. The methods of sanitary control and the amount of such control necessary in each instance were described by Morris R. Sherrerd, chief engineer of the Street and Water Commissioners of Newark; Charles F. Breitzke, sanitary engineer of the Jersey City Water-Works, and Theodore De L. Coffin, assistant engineer, Department of Water-Supply, Gas and Electricity, New York City, respectively.

The case of Newark is quite unique. As described in *Engineering News*, May 6, 1915, the city has already purchased more than 60% of the watershed and converted it into forest land, as it is intended to do with the remainder. Jersey City has pursued quite the opposite course, for its supply comes from a drainage area on which are a number of small cities and towns and considerable scattered population, and it relies on a maximum amount of sanitary inspection and chlorination to protect its water drinkers. The conditions on the Croton watershed are not dangerous, but much attention is paid to sanitary inspection.

The discussion of these papers developed three points of particular interest: First, the practical impossibility of enforcing laws and regulations upon an indifferent public—which all experience; second, the amount of pollution caused by railway passenger trains and whether or not it can be really controlled; and third, the advisability and effectiveness of owning an entire watershed, as in the case of Newark.

Dr. W. P. Mason, of Troy, N. Y., emphasized the point that very few definite data exist on the amount of pollution from railway trains and of the danger that may arise from it. He thought the danger of pollution could be best removed by having a patrolman, or section hand, go over and sterilize any offal found dropped at critical places. The opinions of Alexander Potter and Edward Wegmann, both consulting engineers, New York City, that the money spent in the purchase of watersheds, as in the case of Newark, would be much better spent in filtration plants, met with some applause. It was claimed that depopulating the watershed worked injustice to many property owners; and while it lessened the danger of contamination of the water-supply, it by no means gave positive insurance against it, as would a filtration plant.

News of the Engineering World

George A. Kyle To Build Chinese Railways

The Siems-Carey Railway and Canal Co., owned jointly by the American International Corporation, New York City, and Siems & Carey, of St. Paul, Minn., has concluded a contract with the Chinese Government to build 1,100 mi. of railway, as noted in *Engineering News*, Oct. 5, p. 673. The engineer chosen to take charge of the location and construction of these lines and to supervise operations when the railways are completed is George A. Kyle, an American railway engineer of large and varied experience.

GEORGE A. KYLE

George Allan Kyle was born in the village of Tobasco, Clermont County, Ohio, Sept. 21, 1857. He attended a district school and then went to a business college in Cincinnati. His technical education in engineering consisted of a short course at Holbrook's College, Lebanon Ohio.

His experience in civil engineering began at 16 years of age, in 1876, as a rodman on railway surveys in Ohio and Iowa. In the course of a few years he was promoted to the position of resident engineer. In 1882 he became locating engineer of the South Dubuque & Northwestern Ry., in Iowa. The following year he was division engineer in charge of location and construction of 30 mi. of the Cincinnati & Eastern Ry., near Portsmouth, Ohio.

For the ten years following 1884 Mr. Kyle experienced the usual lot of a railway-construction engineer. His work and travels extended through nearly all the Western States, from Iowa to Oregon and Washington and from the Dakotas to Nevada and California. The principal railways with which he was connected during this time were the Chicago Great Western, Union Pacific, Northern Pacific and Baltimore & Ohio Southwestern.

In 1895 he went to South Africa in charge of surface improvements, the development of some deep-level mines, the building of several miles of railway and a stamp mill, cyanide plant, etc., for the Summer & Jack Gold Mining Co., Ltd., in the Transvaal. Four years later he returned to the United States and was employed by the Northern Pacific Ry. as division engineer in charge of location and construction until 1901. For a year following he was engineer of maintenance-of-way of the Western division. In 1902 he was made division engineer of the Grand Trunk Pacific Ry. in Canada and started 35 parties on preliminary surveys for 2,000 mi. of line. This position he resigned in 1904 and returned to the Northern Pacific on special work.

During 1905 and 1906 Mr. Kyle was in Alaska as engineer of surveys and consulting engineer on construction of the Alaska Central Ry. The next two years he was assistant chief engineer under E. J. Pearson, of the Chicago, Milwaukee & Puget Sound Ry. Since then he has been chief engineer of the Oregon Trunk Ry. and later vice-president and general manager; from 1911 to date he has maintained an office in Portland, Ore., for private practice.

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Terminal Railway Gets Another 200-Year Franchise

A franchise running for 200 years, passed by the city commissioners and voted by the people of Kansas City, Kan., has been accepted by the nine railroads involved within the time limit, Oct. 4, 1916, and the Kansas City Terminal Railway Co., grantee, is preparing to start actual construction work amounting to five or six million dollars. This is the same company which received a 200-year franchise from Kansas City, Mo. in 1909, modified in 1911, and has since that time spent about forty million dollars in regrading, track and terminal work, new Union Station and a number of new street viaducts and subways.

One of the principal pieces of construction work provided for in the Kansas side franchise is the construction of a double track "high line" which will take the passenger-train traffic up out of the congested yards, freight and switch tracks along the Kaw River. One branch of the high line will start near Fifth and Central St. to serve the Missouri Pacific and Chicago Great Western; the other branch will pick up the Rock Island and the Union Pacific trains near Seventh St. and Berger Ave. The two branches will join about 1,000 ft. northwest of the bridge over the Kaw River, the main stem continuing across the river and terminating near 25th St. and Southwest Blvd. in Kansas City, Mo. This high-line structure will have a length of 13,000 ft., of which 5,000 ft. will be filled between concrete retaining walls and the other 8,000 ft. will be of steel viaduct construction. It will be double-track throughout. The present Kaw River bridge will be removed and a four-track double-deck bridge constructed in its place, the high-line viaduct connecting with the upper deck. Freight and some passenger train traffic will be accommodated over the lower deck as at present. The plans for this strucure have already been prepared by George E. Tebbetts, Bridge Engineer for the Terminal Company, but no official announcement of the award of contract has yet been made. John V. Hanna is chief engineer.

The franchise also provides for the construction of wo union passenger stations, one located at Fifth St. and Central Ave., and the other at Seventh St. and Berger Ave.; each must cost not less than $100,000.

Three new viaducts carrying Fifth, Seventh and Twelfth St. over the Terminal tracks along the north bank of the Kaw River are required to be built. The Terminal Company agrees to pay all of the cost of the viaduct at Fifth St. north of the south line of their right-of-way including an approach at the north end on a 5½% grade. The city will pay one-third of the cost of the viaducts at Seventh and Twelfth St. The Fifth St. viaduct must be completed within two years after the pproval of the plans, the Twelfth St. viaduct within one year, and the Seventh St. viaduct within one year.

Provision is also made for the construction of a viaduct over the Terminal Company's right-of-way at Central Ave. o connect with the new Central Ave. bridge, the company agreeing to pay for all of the portion of the viaduct over its right-of-way if it is constructed for vehicles and pedestrains only, or two-thirds of the cost if used by street cars. The company also agrees to construct, maintain and operate a sub-freight station near 19th St. and Kansas Ave., and one near Adams St. and Kansas Ave.

The franchise provides for undiscriminating switching charges equal to those in force in Kansas City, Mo., and for admitting other railway companies in the future to use of the passenger stations upon reasonable terms.

Effect of Hurricane on Corpus Christi Viaduct

The accompanying two views show the effect of the storm of Aug. 18 around the Corpus Christi viaduct, which was described in *Engineering News*, Mar. 30, 1916, p. 698. The view on the left is looking along the line of the railway trestle, which was practically destroyed. The causeway is seen at the right. Fig. 2 is looking along the line of the causeway approach, which, it will be noticed, is also partly destroyed. The railway viaduct is at the right.

The Corpus Christi Causeway, which connects Nueces and San Patricio Counties, Texas, crosses a neck of water 30 mi. inland from the Gulf of Mexico. It consists of a concrete highway bridge 2,532 ft. long and a fill approach 6,200 ft. long, making a total length of 1.66 mi. The bridge part is a series of 76 reinforced-concrete arches, with the piers resting on timber piles, having a concrete cap extending down to the present bottom.

The fill has a top width of 40 ft. with 1 on 6 side slopes, which approximate the natural beach slopes of the sand spits at each end of the causeway. This entire fill is novel in that it is of oyster shell placed by hydraulic dredging from a shell reef that underlies the entire structure. The slopes are protected by continuous mats of brush faggots built into the toes of the fill and on the exposed side by a heavy apron of riprap.

The experience in the recent storm only duplicates that of a year ago at the Galveston causeway and shows that an overtopping flood has the same effect on a bridge-approach fill as it has on an earth dam; that is, it is practically certain to destroy it. The tide level during the Corpus Christi storm was approximately 2 ft. below the floor of the causeway, but the waves covered the entire structure. Although subjected to the very heaviest waves and the pounding of timbers from the railway trestle, the concrete part was undamaged, not even a spindle in the rail being cracked. The shell fill, however,

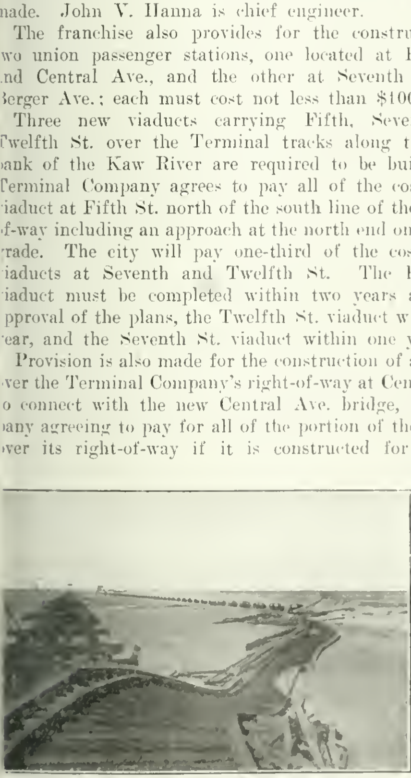


FIG. 1. LOOKING ALONG THE LINE OF RAILWAY TRESTLE AT CORPUS CHRISTI

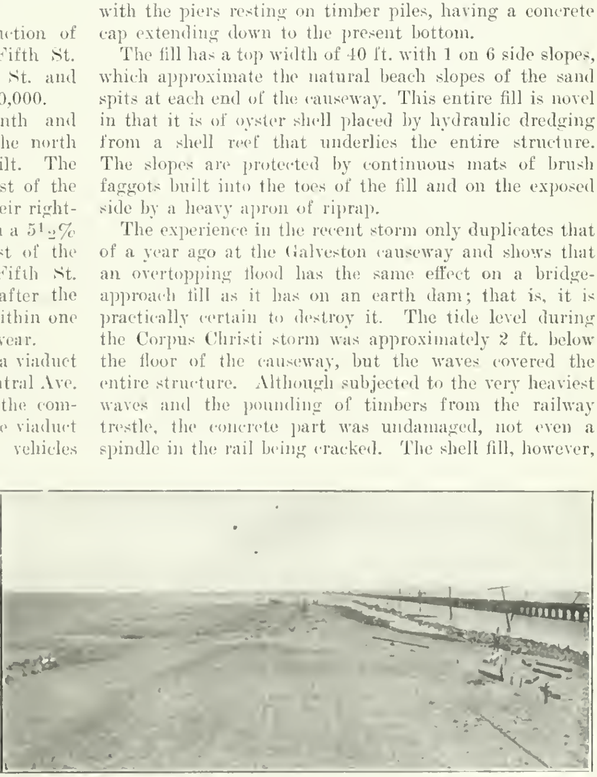


FIG. 2. PARTLY DESTROYED APPROACH FILL TO THE CORPUS CHRISTI CAUSEWAY

was two-thirds destroyed, with a loss of about $30,000. The fill will be rebuilt, because the saving in interest on the concrete construction will pay for the rebuilding in three or four years' time. The rebuilding will be in charge of the engineering firm of Bartlett & Ranney, of San Antonio, which also had charge of the original construction of the bridge.

Bridge and Building Men Meet at New Orleans

The annual convention of the American Railway Bridge and Building Association was held at New Orleans, Oct. 17 to 19, in the Grunewald Hotel. The meeting was called to order by President G. W. Rear, Southern Pacific Co. The report of Secretary C. A. Lichty showed a balance of $1,240 in the treasury. Members attending the convention numbered 148, and 58 new members were admitted into the society.

A number of papers and reports were presented on fuels, paints, floors for shops and roundhouses, modern methods of driving piles, waterproofing roofs of wooden buildings, efficient handling of men, passenger stations, handling concrete, and small coaling stations.

In its report the Committee on Fuels for Internal-Combustion Engines (C. R. Knowles, C. A. Lichty, J. Dupree, J. J. Murphy) states that, weight for weight, oil can be stored in a smaller space than coal, one ton (2,000 lb.) of bituminous steaming coal occupying approximately 40 cu.ft., whereas a ton of oil occupies 35 cu.ft. Considerable attention is given to fuels suitable for heavy-oil engines. The heavy-oil engine is a comparatively recent development and is being used extensively in railway water stations. The most popular engine of this type is the 50-hp. two-cycle.

The Committee on Caring for and Handling Creosoted Timber (E. T. Howson, J. S. Lemond, F. D. Mattos) states that the Louisville & Nashville R.R. was the pioneer in this work and still has in service in teredo-infested waters along the Gulf of Mexico a large number of piles treated in 1876. At the timber-treating plant of this railway at Gautier, Miss., which treats bridge timbers only, a carpenter shop has been installed at which all the timbers are completely framed before they are treated, thus reducing to a minimum the cutting of the timber after treatment. Similarly on the Santa Fe, where large numbers of treated-timber box drains and culverts are used, the timber is framed and sawed to the length desired before being treated. On the Philadelphia & Reading Ry. the chief engineer furnishes the creosoting plant with the details and framing instructions for all timber used on new construction work, and this timber is framed at the creosoting plant before being treated. So far as possible a similar arrangement is carried out for the maintenance-of-way work. Included in this committee report are the Illinois Central rules to be followed in handling creosoted material.

The Committee on Station Buildings for Passenger Service Only (M. A. Long, E. B. Ashby, G. W. Andrews, J. B. Gaut) states that one of the main features to be kept in mind in designing a railroad station is the maintenance cost and recommends the use of brick, stucco or concrete. The better buildings should be roofed with tile or slate, and these materials should be used for slopes of 6 in. per ft. or over. Composition roofs, asbestos shingles and tin are used to a limited extent, but they are not recommended for the better-class structures. One of the principal problems in a station is the floor surface. Wood holds and absorbs the dirt, while varnish is soon scratched and worn off by the cinders carried in by passengers. Where wood is used, it should be either maple or edge-grain pine. Composition floors are used extensively and give a hard, impervious surface; but their wearing qualities are not altogether satisfactory. Floor tile should be vitrified in order to wear satisfactorily.

The report of the Committee on Efficient Methods of Handling Work and Men (F. E. Weise, E. R. Wenner, S. C. Tanner, J. F. Pinson) starts off with the following words of wisdom: "We are sometimes apt to wonder if the words 'efficient' and 'efficiency' have not been overworked, but when we cast about for synonyms we find that they will not do; so we use these words over and over again." This report consists of data on a number of construction operations, with especial regard to bridge building.

On Friday, Oct. 20, an enjoyable excursion was taken by special train to Bogalusa, La., 72 mi. north of New Orleans. A stop was made to inspect the 6-mi. trestle over Lake Pontchartrain, also stopping at Slidell for a trip through the Southern Creosoting Works. At Bogalusa an inspection was made of the Southern Lumber Co.'s sawmill.

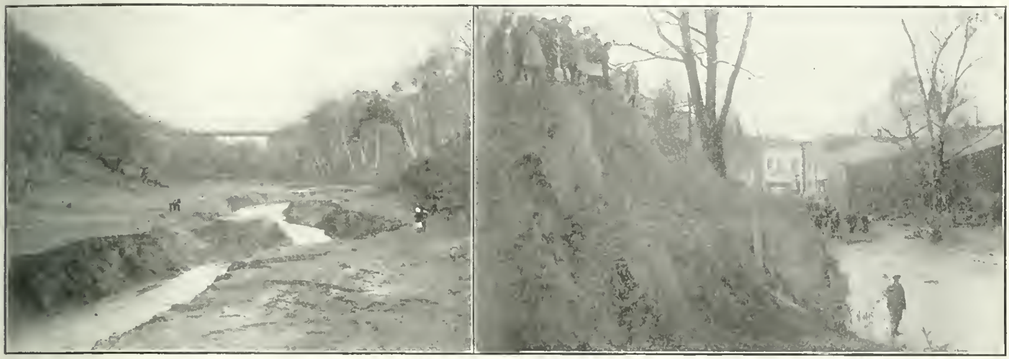
The following officers were elected for the ensuing year: President, C. E. Smith (T. & P.), St. Louis; vice-presidents, E. C. Ashby (L. V.), New York City; S. C. Tanner (B. & O.), Baltimore; Lee Jutton (C. & N. W.), Madison, Wis.; F. E. Weise (C. M. & St. P.), Chicago; secretary-treasurer, C. A. Lichty (C. & N. W.), Chicago.

Strong Talk About Utilities

Privately owned public utilities and the relations of the National Electric Light Association and engineering professors thereto were the subjects of a strong talk by Morris L. Cooke, Director The Utilities Bureau, Philadelphia, Penn., in an address on "The City and Its Utilities" before the League of Kansas Municipalities last week. Mr. Cooke called attention to a new method by which utility properties were being sapped, naming the engineering profession as the means. In one case he said a firm of engineers in the East were being paid 2.7% of the gross receipts for management and 10% additional on the design and construction of all new work. He scored the National Electric Light Association as the essence of invisible government, claiming that a bare 100 men controlled the entire policy of its 14,000 members and stated that it was perilous to thwart the purposes of the Association. He foresaw a virulent storm brewing in the utility field. He called particular attention to the "social significance" of deans and professors in our engineering colleges appearing on the side of private corporations as rate experts and recommended that they be compelled to file as a public document a complete record of any such employment, giving charges collected, terms of employment, etc. Although our colleges are sound at the core, he said, they need guarding. "In rate cases," he urged, "the private interests side is developed by the capital resources of the entire country and states and municipalities should combine to fight in the same way."

Dam Fails for Third Time at Schenectady

A small earth dam belonging to the Schenectady Milling Co. and located at Veeder's Pond, Schenectady, N. Y., failed at 12:28 a.m., Friday, Oct. 20—flooding the surrounding streets and premises, and causing considerable damage by wrecking barns and flooding cellars. The flood wave was high, but of short duration. All the damage was done within 100 ft. of the break. One horse was quickly swept away from his hay pile, but as quickly stranded in a neighbor's store of celery.



VIEWS OF VEEDER'S POND, SCHENECTADY, AND WASHED-OUT DAM

Two previous failures of earth dams at this spot are known to have occurred—both many years ago. The earlier failures probably were as serious as this last one, but excited no comment, as they happened before the affected areas became built up. All three failures were due to faulty design.

The cross-section of the dam, as exposed by the washout of Oct. 20, shows a bottom width of about 60 ft., a top width of about 10 to 15 ft. and a center height of between 25 and 30 ft. The side slopes are about 1 on 1. The total length of the embankment was about 150 ft. About 80 ft. of top width was washed out.

The dam was built up of loose sand with a double plank cutoff wall near the upstream top angle. These planks extended on the left-hand side of the dam, only to within 6 or 8 ft. from the top, as shown at the left in the accompanying view, and to a lesser height on the right-hand side.

The pond has been gradually filled up with sediment to a depth of 12 to 15 ft. near the dam, leaving only a few feet depth of water to the level of the waste gate. This gate is some 4 or 5 ft. below the top of the embankment. High-water marks on the banks indicate a maximum depth of about 6 or 8 ft. of water in the pond at the time of failure. The normal pond area at waste-gate level is about one acre. The view at the right in the accompanying illustration shows the erosion of the sediment in the pond by the flow in the creek after the break occurred.

The failure was caused indirectly by an intense rainfall early in the evening of Oct. 19. The nearest rain gage, at the R. E. Horton Hydraulic Laboratory, about 6 mi. southwest, indicated a fall of 0.85 in. in about 2 hr., following a lighter fall of 0.26 in., which had thoroughly soaked the area tributary to the stream. Apparently there has been built up in the extension of Schenectady's population an impervious layer over the light sandy soil of this locality. Otherwise such a rain would have been discharged more gradually. The 2.6 sq. mi. of drainage area about the dam site is very sparsely wooded: in the lower reaches the stream has very steep banks, but the upper area is flatter and covered with a light growth of brush.

Apparently the direct cause of failure was the overtopping of the fill by the impounded waters. There was no spillway in the dam, a waste gate on a 6-ft. pipe being the only outlet for the stored water. This gate was closed.

* * *

Barge Transportation on the Mississippi River is to be established by the Aluminum Co. of America. This company has purchased 11 large steel barges from the American Steel and Wire Co., each 200 ft. in length, 36 ft. in width and 10½ ft. draft, built by the American Bridge Co. at Ambridge in 1911. The Aluminum Co. is to use the barges for the transportation of material from mines in Arkansas to its plant at East St. Louis.

Standard Plans for School-Building Construction especially designed to reduce the fire risk, are to be framed by the Committee on School House Standardization of the National Educational Association. The Chairman of the committee is Frank Irving Cooper, Architect, of Boston. The committee desires to obtain for use in its work the standards already adopted for school building construction by states, cities, and trade organizations.

Port Improvements at Girardot, Colombia, in the Magdalena River are soon to be started in accordance with a law enacted in 1913. The President of Colombia has appointed an honorary board which with the assistance of an engineer will supervise the work, the plans having been approved by the Minister of Agriculture and Commerce. Girardot is of particular importance as a shipping point because it is the only port connected by rail with the City of Bogota and moreover connects with the Polima Ry. running to Espinal.

A Prize Offer to Engineering Students is announced by the Chicago Association of Commerce. The prizes offered are $50, $30 and $20 for the best three papers not exceeding 3,000 words on any one of the following subjects: (1) "Engineering and Civic Progress"; (2) "The Engineer of the Future"; (3) "The Business Relation of the Engineer to the Commercial World." The contest is open to graduates of 1915 and 1916, or undergraduates of any recognized American engineering school. The papers are to be judged by F. H. Newell, John W. Alvord and John M. Hayford. Papers offered for the prizes should be mailed to Engineers Subdivision Contest, Chicago Association of Commerce, 10 La Salle St., Chicago, and must be received not later than Nov. 1, 1916.

An Official Straw Vote is to be taken at Pomona, Calif., in order to determine whether the citizens are in favor of a bond issue, amounting to $200,000, for flood protection work. The

City Council will arrange for taking the straw vote by appointing one citizen to stand near each polling place in the city at the general election on Nov. 7. He will ask each voter appearing at the polls whether or not he will vote in support of a bond issue if an election to vote on it is called. It will be necessary to have an official election to ratify the bond issue in case the majority of voters are found to be in favor of it, but it is planned by the straw vote to test the public sentiment in advance, so that in case a majority are adverse to the bond issue, the expense of a special election may be saved.

A Flood Conference in Pennsylvania has been called by Governor Brumbaugh, to be held on Oct. 31, for general discussion of ways and means to control the waters of Pennsylvania. Acting at the request of the Pittsburgh Flood Commission, the Governor has invited the mayors and presidents of councils and of chambers of commerce of Philadelphia, Pittsburgh and Scranton, members of the State Water-Supply Commission, the state commissioners of health, forestry and officials of water-power companies, as well as the president of the Ohio and Lake Erie Ship Canal Board, the Allegheny County Commissioners, the officials of the United States Geological Survey in the State, and General Kingman, of the Corps of Engineers, U. S. Army, to attend.

Calorific Value of Gas, instead of candle-power, has been established as the standard by the Public Service Commission for the Second District, State of New York. All companies making more than 20,000,000 cu.ft. per year of coal, water or mixed gas must show a product averaging 585 B.t.u. per cu.ft. Smaller concerns may adopt the standard but it is not compulsory for them. The change has been made to accord with the development of the gas industry which is toward consumption in bunsen-burner apparatus where the usefulness depends on heat content and not on candlepower of an open flame. The cost of oils introduced into ordinary gas to raise the candlepower has greatly increased as the utility of the enrichment has diminished. The illuminants formerly introduced condensed to a considerable extent in the longer transmission and distribution pipe lines which have become necessary.

Orders for Planting Ocean Islands are wanted by an enterprising and imaginative Oriental if a story published in the Boston newspapers is true. According to this story, a postcard was received at the Boston post office addressed "Stock Exchange or Chamber of Commerce, care of Chief Police Officer." The inscription on the card is as follows:

> Notice. My rights of the oceans, being first claimant thereto, in respect of planting islands on Mid-Atlantic and on other oceans to serve as cities or otherwise to the world by my patent or by other manner, have been proclaimed by Heavenly Spirits throughout the world in June, 1916. Confirmation thereof could be given. Offers are invited. Tan Hong Poh, 57 Hill street, Singapore, S. S., 4th Aug., 1916.

It is reported the postcard bore the stamp "Passed by Censor." What more could one ask regarding the validity of the claim to the right of planting islands in the mid-Atlantic or any other part of any ocean, or the ability of the claimant to execute his designs?

Plans for Converting the Site of the Panama-Pacific Exposition, San Francisco, into a residence park are being drawn by Mark Daniels, landscape engineer, Monadnock Building, San Francisco. To make the project feasible, the owners of a large part of the land have decided to combine their holdings. The general plan, as thus far conceived, provides for laying out a part of the district with radial and circular streets to comprise slightly over half of the area of a circle. Streets tangential to the circular streets of half this semicircular area and making acute angles with the tangents of the other ends of the circular streets, with cross-streets at right angles in each case, would comprise the layout of a triangular area based on the semicircular area. In the outlying districts a few main thoroughfares laid out in such directions as to free the entire district from the usual monotonous checkerboard city plan are proposed. Further property adjustments are necessary before the plan can be completed, and it is expected that the Palace of Fine Arts will be preserved and that the California Building will be utilized for a State Normal School.

Geared Turbines will replace direct-connected turbine units on all ships so equipped in the American Navy. This is being done because the Navy Department is convinced that the higher-speed geared machines are lighter, take up less space, are mechanically superior, reduce the steam consumption—particularly at cruising speeds, and increase the steaming radius. The first two ships to be reëngined are the destroyers "Henley" and "Mayrant." Contracts have been placed with the Westinghouse Machine Co., of East Pittsburgh. The "Henley" was built by the Fore River Shipbuilding Co. in 1912. The main machinery consisted of two direct-connected marine turbines with two compound cruising engines which were connected to the main turbine shafting by means of jaw clutches. The turbines had 14 ahead and two reverse stages. Steam was supplied to the turbines at a pressure of 250 lb. by water-tube boilers for which oil was used as fuel. The new machinery will consist of two complete-expansion geared-turbine units of the impulse-reaction type with Kingsbury thrust bearings, and two geared cruising units. It is to be installed in the same engine-room space and to connect with the existing propeller shafting, and drive the propellers at the same speed as formerly. The two cruising turbines will each have a capacity sufficient to move the ship at a speed of 15 knots. They will be connected to the main turbines by clutches and will be used only up to a speed of 15 knots. After this speed has been attained they will be disconnected and the main turbine alone used. Reduction gears will reduce the turbine speed of 3,000 r.p.m. down to 640 for the propeller shaft. The "Mayrant" was built by the William Cramp & Sons Ship and Engine Building Co. in 1911. The old machinery consisted of two turbines without cruising engines. The turbines were designed to develop 13,000 shaft horsepower at a speed of 650 r.p.m. and with a steam pressure of 250 lb. gage. They had 16 stages ahead and 7 stages astern. Steam was supplied by four water-tube boilers. Oil was used for fuel. The new machinery to be furnished will be essentially the same as that for the "Henley." The main turbines, however, will each have a capacity of 7,000 shaft horsepower at a propeller speed of 629 r.p.m. The speed of the turbines will be 3,000 r.p.m.

PERSONALS

Hollie Ford has been elected County Road Engineer of Greaves County, Kentucky, at a salary of $1,600 per annum.

W. P. Barba, M. Am. Soc. M. E., has resigned as Vice-President of the Midvale Steel Co., after 36 years' connection with the company.

W. H. Crawley, of Abbeville, Ala., has been appointed Superintendent of Roads of Houston County, succeeding the late W. E. McEachern.

W. M. Ackworth, of London, England, has been appointed a member of the Railway Board of Inquiry of Canada, to succeed Sir George Paish, resigned.

M. H. Mooney has been appointed County Engineer of Grundy County, Missouri, to succeed W. E. Ralls, resigned. The county offices are at Trenton, Mo.

H. L. Cumming, has been appointed Chief Engineer of the Guantánamo & Western R.R., with headquarters at Guantánamo, Cuba, succeeding R. A. Lyman.

Harry Bowers, County Road Engineer of Ohio County, West Virginia, has resigned to become General Superintendent of the Ball Engineering Co., of Wheeling, W. Va.

E. Herbert Dunmire, Assoc. M. Am. Soc. C. E., City Engineer of Lawrence, Kan., has been appointed Superintendent of the city water-works also, the two positions having been combined.

Jiro Komiya, Electrical Engineer for the Imperial Japanese Government, is in this country to study recent practice in electric-power transmission and distribution. He is now in the Northwest.

H. W. Dow, for the past 12 years associated with the engineering and sales department of the Nordberg Manufacturing Co., Milwaukee, Wis., has been appointed Sales Manager of the company.

J. M. Giles, Assoc. M. Am. Soc. C. E., Supervising Engineer of the Porto Rico Irrigation Service, has been promoted to be Chief Engineer to succeed J. W. Beardsley, whose resignation was noted in these columns, Sept. 14.

John C. Wheelon, Chief Engineer of the Utah-Idaho Sugar Co., of Garland, Utah, was awarded the Harrison Gray Otis prize cup at the International Irrigation Congress for his paper on "The Agricultural Duty of Water."

Charles Gilman Hyde, Professor of Sanitary Engineering, has been appointed Acting Dean of the College of Civil Engineering, University of California, to temporarily succeed Prof. Charles Derleth, Jr., who is on leave of absence.

Cleveland A. James, Assoc. M. Am. Soc. C. E., recently in charge of the Buffalo terminal construction work for the Lehigh Valley R.R., has resigned to enter private practice as Consulting Engineer, with an office in Buffalo, N. Y.

William B. Voth, recently Chief Engineer of the Syracuse & South Bay Electric Railroad Co., Syracuse, N. Y., has been a ointed Manager of the Ogdensburg (N. Y.) Gas, Power and L ht Co. He is an electrical-engineering graduate of the U versity of Wisconsin.

harles B. Sadler, Assoc. M. Am. Soc. C. E., has resigned a: Engineer in charge of the pitometer survey of the Balti- e (Md.) Water Department. From 1909 to 1915 he was igning Engineer of the storm-water division of the Bal- ore Sewerage Commission.

ouis D. Fouquet, Division Engineer in charge of the Se er Division of the Public Service Commission, First Dis- r., New York, has resigned, and the Sewer Division has abolished. This work is now being handled by the rent Division Engineers of Construction.

harles J. Carroll, M. Am. Soc. C. E., of Towanda, Penn., been appointed Assistant Chief Engineer of the pro- d Chinese Government railways to be constructed by the s-Carey Railway and Canal Co. Mr. Carroll is a graduate f ale University and for several years was with the engi- e ing staff of the National Railways of Mexico.

illiam Mendowcroft, for the past 10 years Assistant Engi- e of the Board of Water-Supply of the City of New York n formerly with the Department of Public Works of the ppine Islands and the Metropolitan Water Board of achusetts, has volunteered for field service with the ican Ambulance Corps in France. He sailed for Paris ct. 14.

lfred Craven, M. Am. Soc. C. E., Chief Engineer of the u c Service Commission, First District, New York, in ge of all rapid-transit construction in New York City, een appointed Consulting Engineer at a salary of $12,000 nnum, effective Nov. 1. His salary as Chief Engineer is 0, said to be the highest salary paid to any public-works eer. The change is made at Mr. Craven's own request.

rl E. Akeley, inventor of the cement gun, has been led a John Scott Legacy Medal and Premium by the of Philadelphia, acting on the recommendation of the klin Institute. The award is made in recognition of a "which has proved to be of great value for water- ng dams, reservoirs, coating structural work, houses, Mr. Akeley is a sculptor, naturalist and explorer, with merican Museum of Natural History, New York City.

thur E. Loder, Division Engineer of the California State vay Commission has resigned his position and has been ated Assistant Chief Engineer of the U. S. Office of Public . He will have charge of the construction of highways e National forest reservations under the one million appropriation recently made by Congress. Mr. Loder ormerly connected with the Land Office and later was for ears Chief Engineer of the Los Angeles County High- Commission.

arles W. Okey, Assoc. M. Am. Soc. C. E., Senior Drainage eer, United States Office of Public Roads and Rural En- ng, has resigned to take charge as Chief Engineer of ainage and development of a tract of land at White- S. C., owned by the Combahee Co., of Charleston, S. C. l be a pumping project similar to those of southern ana. Mr. Okey has been in charge of drainage investi- s for the Government in the southern Louisiana district past seven years.

E. Stevens, M. Am. Soc. C. E., whose appointment as Engineer of the Northern Pacific Ry. was noted in columns Sept. 28, was born at Bluehill, Maine, Mar. 8, He was graduated from the University of Maine in 7 For three years he was with Ralph Modjeski, Consult- ngineer, Chicago, Ill. He entered the employ of the rn Pacific Ry. in 1904 in the bridge department. He ppointed Bridge Engineer in 1907, which position he ntil his present promotion.

n V. N. Dorr, President of the Dorr Cyanide Machinery w York City, has been awarded a John Scott Legacy and Premium by the City of Philadelphia, acting on the nd tion of the Franklin Institute. The award is made gnition of his invention of hydrometallurgical appa "the Dorr classifier, for separating quick-settling or material from slow-settling or slimy material, when re suspended in a liquid, and the Dorr thickener, for ing or dewatering slimy material in suspension."

iel Lawrence Turner, M. Am. Soc. C. E., Deputy Engi- Subway Construction, Public Service Commission, New First District, has been appointed Acting Chief Engi- ffective Nov. 1, to succeed Alfred Craven, appointed ting Engineer, as noted elsewhere. Mr. Turner is a te of Rensselaer Polytechnic Institute, class of 1891, nine years was Instructor in surveying, railway en- ng and hydraulics at Harvard University He has been associated with New York City rapid-transit construction work since the beginning of the subways in 1900 under the Rapid Transit Commission. Upon the establishment of the Public Service Commission in 1907 he was appointed Division Engineer of Stations and Chief of the Bureau of Transit Inspection. Since 1912 he has been Deputy Engineer of Subway Construction. A portrait and biographical sketch were published in "Engineering News", Oct. 8, 1914, in connection with a series of articles on the subway construction. Mr. Turner's salary as Acting Chief Engineer will be $12,500 per annum.

OBITUARY

Lawrence M. Thacher, a civil engineer with the Georgia Railway and Power Co., Atlanta, Ga., died Oct. 15. For several years he was with the engineering staff that extended the Florida East Coast Ry. to Key West. He was born in Yarmouth, Mass., and was graduated from the Massachusetts Institute of Technology in 1886. Most of his engineering experience had been in the South. He was President of the Atlanta section of the Engineering Association of the South.

ENGINEERING SOCIETIES

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.
Oct. 30-Nov. 4. Annual meeting at La Salle Hotel, Chicago. Secy., J. A. Andreucetti, C. J. N. W. Ry., Chicago.

AMERICAN MINING CONGRESS.
Nov. 13. In Chicago, Secy., J. F. Callbreath, Munsey Bldg., Washington, D. C.

AËRO CLUB OF AMERICA.
Nov. 13. Annual meeting in New York City. Secy., Wm. Hawley, 297 Madison Ave., New York City.

NATIONAL COMMERCIAL GAS ASSOCIATION.
Nov. 13-18. Convention in Atlantic City, N. J. Secy., Louis Stotz, 61 Broadway, New York City.

RICHMOND RAILROAD CLUB.
Nov. 13. Annual meeting. Secy., F. O. Robinson.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H. Roth, 1410 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Canadian Society of Civil Engineers has grown in membership to 3,076, according to the year book for 1916. There are 8 honorary members, 693 members, 1,409 associate members, 34 associates, 357 juniors and 575 students.

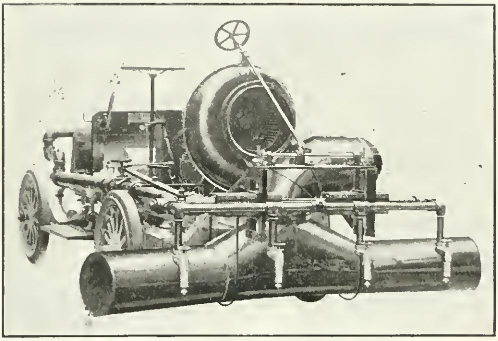
The American Road Builders' Association will hold its annual meeting in New York City on Nov. 3, at the Automobile Club of America, 247 West 51th St. In the evening a dinner will be held in the grillroom of the club, at which short addresses are promised. The attendance at the dinner will not be limited to members; a general invitation is extended to all interested in the good-roads movement.

The Four-State Section of the American Water-Works Association will hold its next meeting in Wilmington, Del., on Nov. 15 Members arriving in the morning should go directly to the Hotel Du Pont, from which they will be taken by automobiles to inspect the new reservoir and filtration plant now under construction. Following this, luncheon will be served at the Du Pont at 1 30 p m., followed by a short business session. The secretary is Charles R. Wood, P. O. Box 363, Philadelphia, Penn.

Appliances and Materials

Macadam Cleaner and Bitumen Spreader

A machine for removing the dirt from the top courses of stone roads and applying hot bitumen in fine sprays has been devised by S. E. Finley, of Atlanta, Ga., and made the basis of a proprietary system of bituminous-macadam road building and repair by a penetration process (known as the "Finley Method"). A motor-truck chassis, as shown in the accompanying view, carries a large blower, chain driven from the transmission shaft and delivering 6,000 cu.ft. of free air at 2 or 3 oz. pressure to a pipe header carried across the rear of the truck. This flue has a wide longitudinal slot just forward of the bottom. Back of the air distributor are four special rotating nozzles that are supplied with the hot binder at 60 lb. per sq.in. pressure. A small air compressor supplies air to the tank truck (used in front of the distributor truck to carry the supply). When this outfit is in service, the dust on and in the road is blown into the air and the bitumen applied before the fine material has had a chance to settle. Any application from the lightest to the heaviest (from less than ⅓ to over 2 gal. per sq.yd.) is claimed possible with uniform distribution.


FINLEY BITUMEN SPREADER

These machines are not sold, but are leased, or work with them is done on contract. It is reported that the cost of application on this basis is about 6c. per gal. Several contracts have been taken at 25c. per sq.yd. of roadway for 1½ gal. of asphalt furnished and applied in two coats.

* * *

New Use of Graphite-Babbitt Bearings

The use of graphite inserts in babbitted bearings has been adopted by the Jeffrey Manufacturing Co., of Columbus, Ohio, for its power-transmission, conveying, elevating, crushing and screening equipment. This is reported to allow reduction in the amount of oil and to give improved service under the severe operating conditions and neglect to which this class of apparatus is subjected.

The graphite cones are pressed in place on a fine copper screen that is inserted in the bearing boxes before the babbitt is poured.

* * *

New Type of Barrel Elevator

The accompanying illustrations show a method of handling oil barrels which has been adopted by the Standard Oil Co. at its works in Milwaukee, Wis. The machine elevates empty barrels from the wash house and delivers them to an inclined skid, on which they roll by gravity a distance of about 100 ft. to the filling room. The special feature of the machine is that it is able to pick up the barrels from a curved chute underneath the foot sprocket.

A diagram of the equipment, showing the elevator in relation to the skids with the barrel arm in the discharging position is given in Fig. 1. Fig. 2 shows the elevator frame with the curved receiving chute at the bottom. The barrel arms are descending.

The barrels are rolled out of the tank at the right-hand side of the picture, Fig. 2, and the arm picks them up one at a time as it sweeps around the bottom of the chute. The barrel arm is attached to two strands of chain belt, which carry it around the head and foot sprockets. The arm is
the automatic discharge type which trips by means of a p
of cams engaging the ends of the curved lever arms that ca
the barrels. These cams are placed on the upcoming side
the elevator just below the opening in the wall throu
which it is desired to discharge the barrels. The chain belt
provided with suitable attachments for the crossbars of
barrel arm, and the whole is mounted on a structural-st

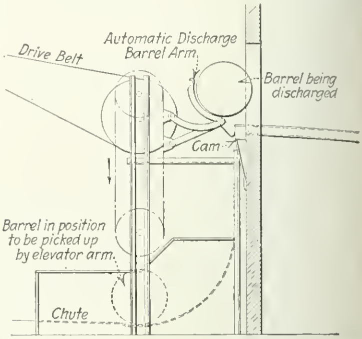

Automatic Discharge Barrel Arm
Drive Belt
Barrel being discharged
Cam
Barrel in position to be picked up by elevator arm
Chute

FIG. 1. BARREL ELEVATOR WITHOUT LOADING P

frame with necessary guides for the chain belt and supp
for the shafting.

One of the advantages claimed for this type of constr
tion over the common design of barrel elevator is that
deep pit is necessary under the foot sprockets, and the eq
ment is particularly adapted to conditions where it wo
not be possible to have any part of the machine extend be
the floor line.

About 1 hp. is required for driving the elevator, and
power is taken from a lineshaft in the building by means
belt coupled on to the elevator countershaft. The capa
of the machine is 120 barrels per hour. It was designed
manufactured by the Chain Belt Co., of Milwaukee, Wis.

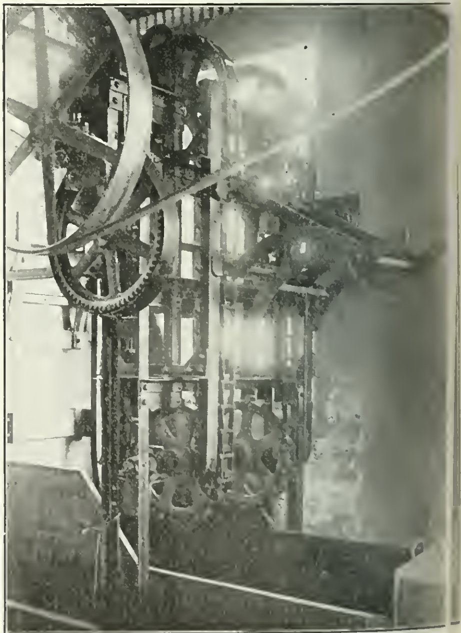


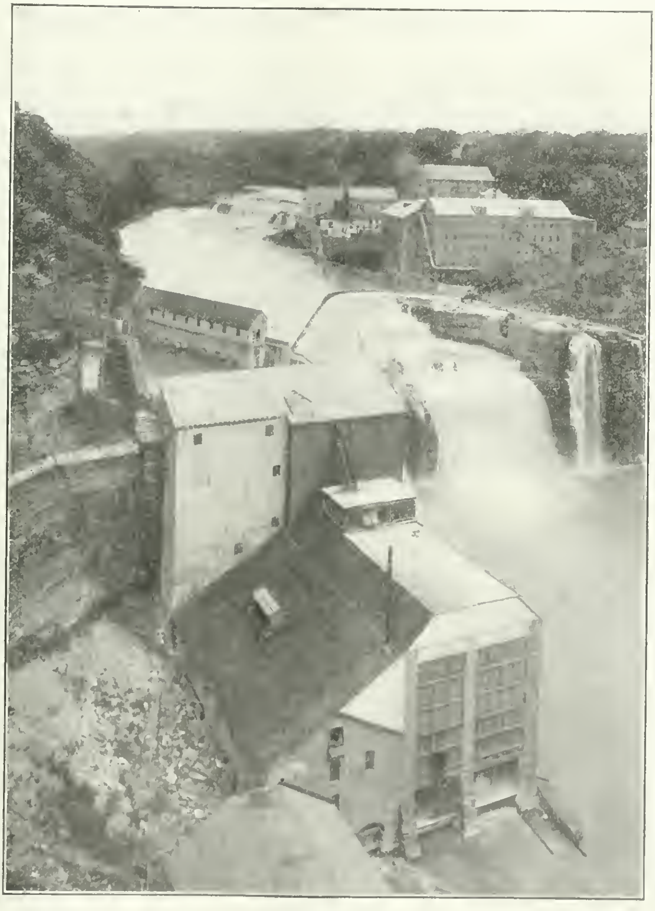
FIG. 2. CHAIN-BELT BARREL ELEVATOR, STAND
OIL CO. PLANT, MILWAUKEE

Engineering News

VOLUME 76 NOVEMBER 2, 1916 NUMBER 18

Developing More Water Power on Genesee at Rochester

A hydro-electric development, novel because made under ınusual topographical conditions and also because it is nade within the residential limits of a large city, is now ınder way by the ?ochester Railway ınd Light Co. at ?ochester, N. Y. The Genesee Riv- r in its flow hrough the city .as four falls to- aling 227 ft. in ead, in addition) 22 ft. of inter- ening rapids. For ome years the ompany has had wo power devel- pments at the vo lower falls, nown as station o. 5 at the low- · falls and sta- on No. 15 at the iddle falls about ,400 ft. upstream. he former sta- on, shown in the reground in Fig. develops 8,800). from the 94-ft. ead by taking the ater from be- nd a low diver- ondam rounding e crest of the lls. The middle lls station, seen the far back- ound of Fig. 1 nd also in Figs. and 7, develops 700 hp. from the -ft. head by tak- g water from hind a gravity tion concrete m 6 ft. high.



LOOKING UP THE GENESEE RIVER FROM DRIVING PARK BRIDGE, ROCHESTER, N. Y.

Old Station No. 5 in foreground; Station No. 5 and site of new dam in far background

The new project consists in supplanting the upper dam a new movable dam 16 ft. high which will elevate the nd 13 ft., and in building a tunnel carrying the water om this pond clear down to the face of the lower cliff, thus providing a low water head of 137 ft. in the new project, a gain of 13 ft., due to the extra head of the new upper pond and to the utilization of 3 ft. of rapids now wasted between the two falls. This increase of head and the increased efficiency of the new turbines increase the available power to about 20,000 hp. In addition the increase of height of the dam makes possible so large a storage behind it that for handling short peak loads the output may be raised to 48,000 hp. The new dam is made up of movable sections, as shown in Fig. 3, because the river is subject to flashy floods. Its maximum recorded flow is 45,000 cu. ft. per sec.; its minimum is 150 cu.ft. per sec., so that auxiliary steam power is required. When the new project is completed the old station No. 15 will be abandoned and the entire power concentrated in new station No. 5, old station No. 5 being removed. The data on the new development can best be appreciated by the following tabulation:

Turbine Installation—Estimated cost, $1,056,000 for present installation of 32,000 hp. Ultimate capacity of plant, 48,000

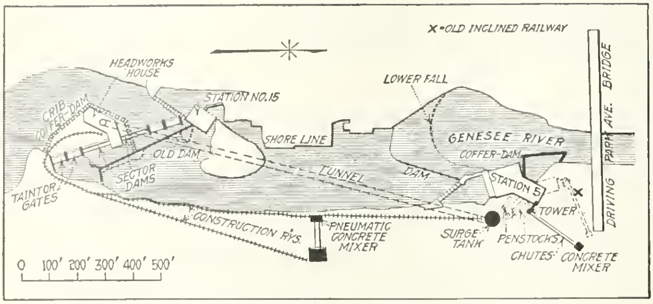


FIG. 2. PLAN OF NEW POWER DEVELOPMENT OF ROCHESTER RAILWAY AND LIGHT CO. ON GENESEE RIVER

hp. Turbines are I. P. Morris Co. vertical Francis type, developing 16,000 hp. at a head of 130 ft. Speed, 180 r.p.m. Weight of one turbine, 272,000 lb. Governors are I. P. Morris Co. double floating-lever governors, water operated. Weight of one governor, 43,000 lb.

Generators are Westinghouse 12,500-kv.-a., three-phase, 60-cycle, 11,500-volt. A combined efficiency of turbine and generator of over 88% is expected. Mounted on each generator is a 250-volt 100-kw. direct-connected exciter. It requires 57,500 cu.ft. of air per min. to cool each generator at full load. The rotating parts of the exciter, generator and turbine and the hydraulic thrust of the turbine are carried by a Kingsbury bearing capable of supporting 100 tons.

Power House—Reinforced-concrete and steel building. Present length, 90 ft. Will be increased to 125 ft. when third unit is installed. Width, 75 ft. Height, 112 ft. above rock. Will serve as a generating and substation and replace old Stations Nos. 5 and 15.

Valves—Flow of water is controlled by Johnson valves contained in the penstock. These valves serve as venturi meters for measuring the flow of water.

Penstocks—Three penstocks are carried out of the rock. One is closed off with a steel bulkhead. These are 13 ft. in diameter and built of ¾-in. plate. They extend about 30 ft. into solid rock.

Tunnel—Horseshoe shape. Area, 317 sq.ft. Capacity, 3,900 cu.ft. per sec., with a velocity of 12.3 ft. per sec.

Dam—Movable steel structure with concrete base and piers. Total length of spillway, 400 ft., made up of four Taintor gates each 50 ft. long and 16 ft. high and two sector gates each 100 ft. long and 16 ft high. Each Taintor gate weighs 40 tons Each Taintor gate hinge weighs 3 tons, two hinges to each gate. Each sector gate weighs 150 tons. Each sector gate hinge weighs 90 tons, being continuous and 100 ft. long.

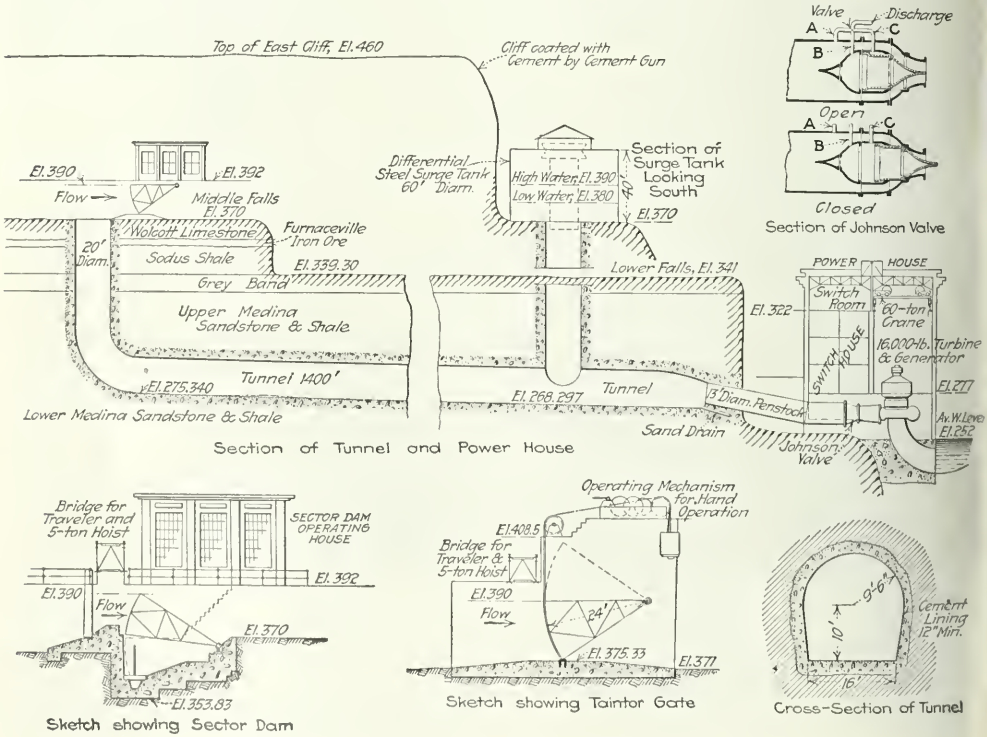
Intake—Located in center of river. Has 16 openings 10 ft. wide by 12 ft. high eight on each side of building; controlled by steel gates operated by traveling electric hoist from above Rubbish kept out by outer curtain wall which extends 4 ft below low water and by steel trash racks inside building.

Pond—Total storage from El. 375.5 to El. 390 equals 23,000,000 cu.ft. of water, which will produce 25,000 kw.-hr. of energy

Surge Tank—A steel-plate differential surge tank 60 ft. in diameter, 48 ft. deep, with riser 18 ft. in diameter, built under R. D. Johnson's patent.

CONSTRUCTION WORK TO BE DONE

The construction elements of the new developmen consist in the erection of a new movable dam at the middle falls, the driving of a shaft in the river at that point and a tunnel 1,400 ft. long to the face of the cliff at the lowe falls, the sinking of a surge tank shaft just above the lowe falls but in the bank to the east of the river and the building of the power plant alongside of old station No. at the lower falls.



Section of Tunnel and Power House

Section of Johnson Valve

Sketch showing Sector Dam

Sketch showing Taintor Gate

Cross-Section of Tunnel

FIG. 3. DETAILS OF NEW HYDRO-ELECTRIC DEVELOPMENT AT ROCHESTER, N. Y.

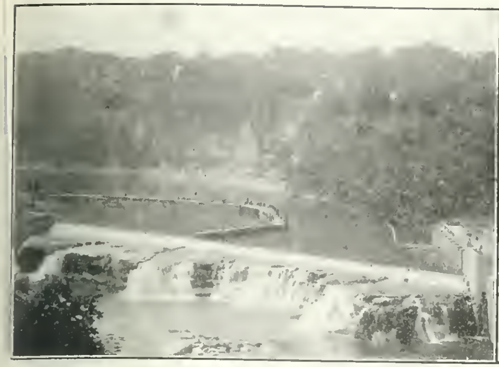


FIG. 4. COFFER-DAM JUST PLACED AT MIDDLE FALLS

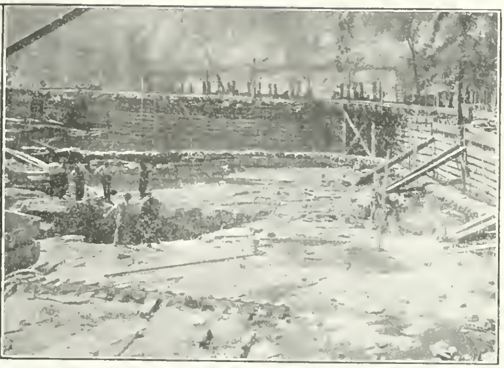
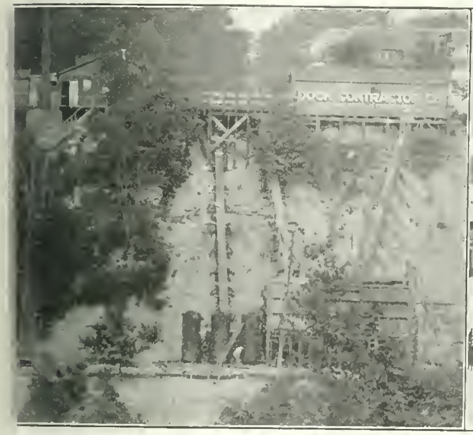


FIG. 5. SINKING INTAKE SHAFT BACK OF COFFER-DAM



IG. 6. CONCRETING PLANT ON EAST CLIFF OF RIVER

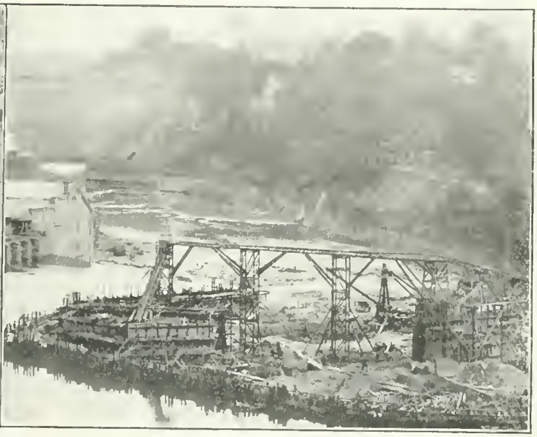


FIG. 7. LOOKING DOWN RIVER FROM MIDDLE FALLS

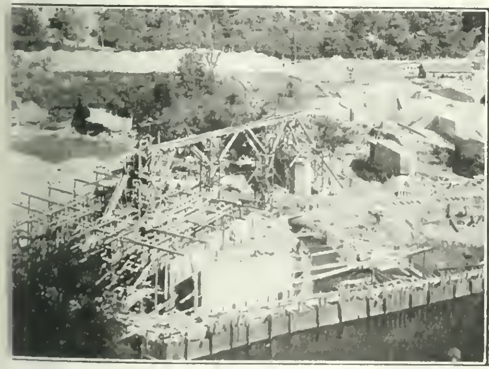


FIG. 8. NEARER VIEW OF CONCRETING TRESTLES

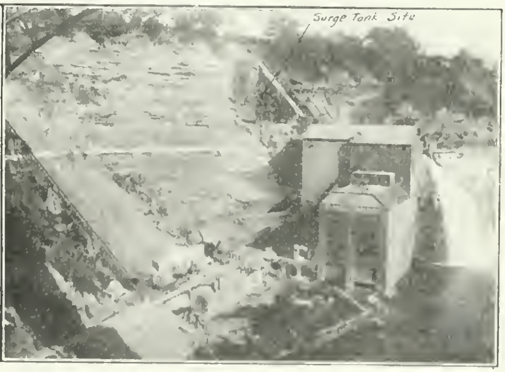


FIG. 9. BEGINNING WORK AT STATION NO. 15

The operations now in progress comprise the construc-
on of the east half of the dam behind a coffer-dam shut-
ıg off that part of the river, the driving of the tunnel
uthward from the surge tank shaft already completed
d the erection of the power station. It is intended to
mplete one-half of the dam in the present season and to complete the tunnel by carrying it through from the north end to the intake shaft to be sunk behind the coffer-dam already in at the middle falls.

The further progress of the work is not decided upon but it is thought that the station will be completed and allowed to take water from the finished half of the dam before throwing old station No. 15 out of service and building the remainder of the dam behind a coffer-dam cutting off the river clear across to the west bank. The scheme of operations depends upon the stage of the river at the time of "cutting in on the line."

Construction operations were somewhat handicapped by the topography, although the height of the top of the gorge permitted the economical use of gravity chutes from the city streets, ending right at the gorge edge, to the work below. It was necessary, however, to do some extensive cutting to locate the construction railway along the east bank of the river.

Coffer-Dam at Middle Falls

The preliminary work at the middle falls was the construction of the coffer-dam. This was built of cribs formed from old freight-car sills—a common timber material in this locality. These cribs, each 10x16 ft. in plan were built on shore, floated out in proper line and sunk by filling with rip-rap. When lined up they were connected by an upper and lower line of old freight-car beams which acted as waling pieces against which to drive wooden sheeting, which took fairly good hold in the thin mud covering to the rock bottom. This dam, shown from the inside in Fig. 5 and also in Figs. 4, 7 and 8, has proved quite tight enough for all practical purposes. With the aid of minor defenses of sand-bag dams and emergency pumps, it has held the maximum 15 ft. head throughout the summer. Behind it have been built the piers for the dam and the head-house structure. The intake shaft was also started, as shown in Fig. 5, with the possibility in mind of working the tunnel from both ends but this idea has since been abandoned.

Material is brought down to the river bed on narrow-gage cars with cable control, the track extending down from the mixing plant at Avenue B to the junction with another line leading to the surge-tank location.

Novel Pneumatic Concreting System Employed

The concreting of the dam and head house is being carried on with a pneumatic mixer and conveyor taking material as chuted down the cliff and shooting it about 1,150 ft. to distribution trestles over the work. The novelty of the scheme lies in the fact that the concrete materials—cement, sand and gravel—are shot dry from the mixer to within 100 ft. of the point of delivery where water is added through a nozzled sleeve. This machine is the invention of Alexander Jensen, 2 Rector St., New York City, and has never before been used on any extensive work. Mr. Jensen claims that the dry materials are carried through the pipe with far less resistance than wet concrete so that much less aid is required for the work.

The concreting plant is shown in Fig. 6. Material is delivered by wagon at the foot of Avenue B (see map Fig. 2) and is dumped down chutes to the storage house over the mixer. It was hoped at the beginning of the work to be able to use the rock taken from the work in the concrete and for that purpose a crusher and screen were installed at the mixer. This rock proved too soft and crumbly for the purpose and that part of the plant has been abandoned, gravel brought in by wagon being used instead. The compressor plant is located on top of the cliff and three storage tanks alongside of the mixer house feed the pipe line at about 85-lb. pressure.

From the mixer an 8-in. flanged wrought-iron pipe-line is carried along the base of the cliff to the site, where it is led to various parts of the work on the trestles shown in the views. The water is added just before the pipe reaches the trestle through a sleeve pierced with nozzles connected to the city water-supply, under about 75-lb. head, 30 lb. of which is due to the drop from the water main on the upper street level. The concrete starts in the pipe under about 85 lb. at pressure but this drops to near 60 lb. at the water entrance and to about 55 lb. at delivery. The work started with a supply of ½ cu.ft. of air to each 1 ft. of pipe line but this has since been increased to ¾ cu.ft. per 1 ft. of line. The water is controlled by a man at the sleeve who adds it according to judgment when he hears the roar and rattle of the charge approaching through the pipe. This judgment is controlled by the appearance of the delivered mix. Each charge is ⅓ cu.yd.

At the delivery end the mixed concrete is dropped into a box where, when necessary, it can be stirred up into a more thorough mix, and is then chuted to proper locations.

A great deal of trouble has been experienced with wear of the pipe not only on the bends which frequently require replacement but even on the straight line. Clogging of the pipe line, with consequent necessary removal of the clogged section, and inadequate mix at the delivery box, has also occurred at times.

At the lower falls the work to be done consists in the construction of the new power house with the connecting penstocks to the tunnel which emerges from the face of the cliff just above the power house. This required the demolition of an old unused building just below the old station, the clearing of the talus which shows clearly in Fig. 1 and the erection of the new station partly on the rock so cleared and partly on rock formerly under water below the old station. For this latter work a small coffer-dam of crib construction similar to that used at the middle falls but built right in place was set up early in the summer and the excavation for the new tail-race by steam shovel sending spoil by cable car down the gorge is now under way back of the coffer.

All material for this part of the work is brought in by an old inclined railway (Fig. 9) leading down from the street level above. This railway, however, is not large enough for the future needs of the station, and a new one 280 ft. long, on an angle of 42½° is to be built with a capacity of 40 tons. The concrete for the station is mixed by a rotary mixer located alongside the top of the incline and is distributed by an Insley chute to wherever required.

Driving the Tunnel

The tunnel, details of which are shown in Figs. 2 and 3, is 1,400 ft. long and of horseshoe section, nearly equivalent to a circle 20 ft. in diameter, that is 317 sq.ft. It has a capacity of 3,900 cu.ft. per sec. with a velocity of 12.3 ft. per sec. It is being driven through Upper Medina sandstone and shale, a formation of sufficient solidity to dispense with timbering except at isolated places where there is considerable scaling. Work is being prosecuted entirely from the surge tank shaft toward the middle falls, though the short section to the north has already been opened and is used for ventilation and to carry out small quantities of rock for plums in the power house concrete. The main spoil, however, is carried back from the face to the shaft where an elevator takes it to cars on the construction railway along the river edge. These cars deposit the spoil along the shore just above the middle falls.

The tunnel is being driven in full-width heading, with a bench of about 13 ft. which is carried along with each shot. Mucking is done with a Thew shovel, electrically driven, which runs on rollers and is of such radius that it can be readily dig into the bench spoil and turn inside the tunnel to deposit the muck in waiting mule-cars on a narrow-gage track. This shovel has a special swivel joint on the bucket so that the bucket will turn sidewise when it hits an immovable piece of rock, thus obviating the danger of blowing a fuse from overload, a common trouble with electric shovels. The bucket is ⅝ cu.yd. capacity.

The tunnel is to be lined with concrete behind Blaw steel forms, but the method of mixing and depositing the concrete has not been decided upon.

The cliff face above the surge-tank shaft and the new station was badly weathered and subject to dangerous rock falls. Preliminary to any work there the whole face was cleaned with a high-power hydraulic jet and subsequently was covered with about ½ in. of cement mortar applied with a cement gun, devised by Alexander Jensen, who also is the inventor of the concreting machine used in the dam. This surfacing of mortar follows closely the irregularities of the rock face and resembles in appearance the saline deposits in a cave, but it seems to consolidate the rock face nd to prevent the small rock falls which might cause rouble after the plant is complete.

Engineers and Contractors

The whole project described herewith is under the direc-ion of James T. Hutchings, General Manager of the Rochester Railway and Light Co. Franklin J. Howes is Chief Engineer of the company and Frederick W. Fisher, Field Engineer. Charles M. Whelan is in charge of the esign of the hydraulic work; the movable dams are under Edgar R. Crofts and the electrical features under Walter . Burch. Norman H. Guinter is Resident Engineer. The entire contract is held by the Dock Contractor Co., of Hoboken, N. J., of which W. V. McMenimen is vice-resident and general manager, and William G. Thomp-on, superintendent.

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Experiments with Submerged Orifices and Tubes

By T. C. Rogers* and T. L. Smith†

The subject of this paper was suggested by a paper · C. B. Stewart, on "The Flow of Water Through Sub-erged Tubes; Results of Experiments at the University Wisconsin," published in *Engineering News*, Jan. 9, 908. In his experiments only one size of orifice was ed, a 4-ft. square, and the entrance conditions and ngth of tube were varied. No experiments were made ith heads of more than 0.4 ft.

In the experiments herein described, three sizes of ifices were used, 6-, 8- and 10-in. squares; and the ngth of tube was varied, but square edges at entrance re used throughout. Heads up to 2.2 ft. were nployed.

Although these two investigations were carried on un-r somewhat different conditions, the results agree very osely and seem to indicate that for submerged square tubes with square edges at entrance there is a definite law, hitherto unknown, regarding the relation between length of tube and coefficient of discharge.

Equipment for Experiments

The experiments were made at the hydraulic laboratory of Cornell University, located in Fall Creek gorge below Beebe Lake, which furnished an abundant gravity supply of fresh water. The water is taken from the lake through a 48-in. pipe and thence delivered to the testing flume through a 10-in. pipe, under about a 40-ft. head. Control is by a 10-in. gate valve. The testing flume is of concrete with walls 4 in. thick. It is 2 ft. wide, 4 ft. deep and 26 ft. long. The details are shown in Fig. 1. The galvanized-iron baffles in the flume near the supply pipe caused the water to approach the orifice without eddies. Surface commotion was reduced by a wooden float, 3 ft. long, placed downstream from the baffles.

The bulkhead containing the orifice and tube was located 10 ft. downstream from the nearest baffle, the arrangement being shown on Fig. 1. The planks of the bulkhead were tongue-and-groove 3 in. wide, 1¾ in. thick and surfaced on the upstream face. The bulkhead was thoroughly calked, and no leakage could be detected.

The orifices, except the sharp edge, for the three different sizes were cut out of a clear white-pine plank 12 in. wide, 2 ft. long and 1¾ in. thick, surfaced on both sides. Care was taken to keep the edges square. The tubes were constructed of clear white-pine boards, ¾ in. thick and surfaced on both sides. After being fitted accurately to their respective orifices, the tubes were held in position by cleats. The long tubes were braced at the top and bottom 1 ft. from the exit.

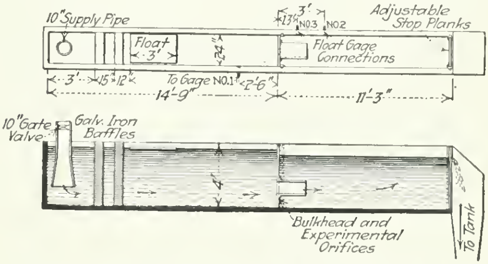

FIG. 1. ARRANGEMENT OF FLUME FOR EXPERIMENTS ON SUBMERGED ORIFICES AND TUBES

The sharp-edge orifices were cut out of No. 26 galvanized-iron plates, 2 ft. square. The edges were made uniform and smooth by finishing them with a fine file.

At the exit end of the testing flume, 11 ft. 3 in. downstream from the orifice, there was constructed a second bulkhead of stop planks. These planks were 3 in. wide and could be removed one at a time, thus facilitating an easy change of head on the downstream end of the flume. After passing over the stop planks the water was led through a galvanized-iron downspout by means of which the flow could be diverted either into the measuring tank or into a waste pipe.

Three float gages were used to determine the height of water in the flume. Gage 1 was situated 2 ft. 6 in. above the bulkhead. Gage 2 was 3 ft. below the bulkhead; and Gage 3 was 1.3 ft. below the bulkhead. The

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*American Telephone and Telegraph Co., New York City.

†Instructor in Civil Engineering, Cornell University, Itha, N. Y.

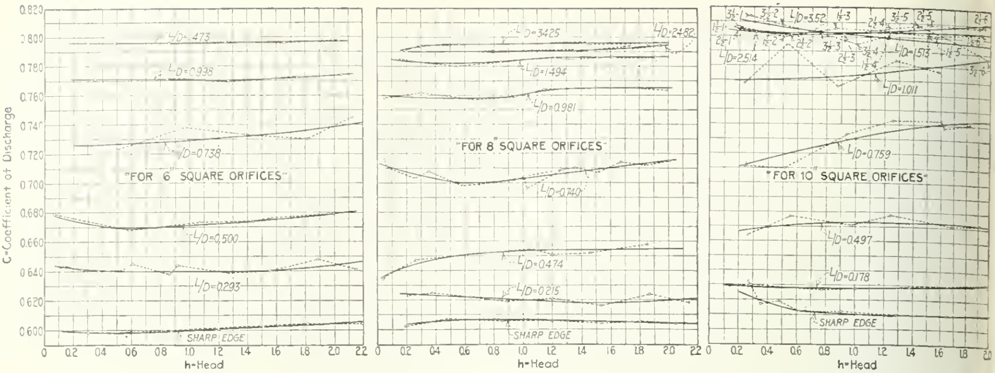


FIG. 2. RESULTS OF EXPERIMENTS WITH SUBMERGED ORIFICES AND TUBES

connections of the gages to the flume were $\frac{3}{4}$ in. in diameter. The gages read to 0.001 ft.

The measuring tank had a capacity of 400 cu.ft. It was constructed of concrete and was provided with a float gage which gave cubic feet directly. The gage read to 0.1 cu.ft.

General Method of Making Observations

The program followed was uniform throughout the experiments. Observer No. 1 adjusted the flow by removing or replacing stop planks and by varying the supply of water. After the water on both sides of the orifice had very nearly reached the desired levels, sufficient time was allowed to elapse for the flow to become steady. No. 1 then signaled to No. 2. No. 2, after a warning signal, diverted the flow into the measuring tank. When the tank was nearly full, No. 2 gave another warning signal and diverted the flow into the waste pipe.

During the filling of the measuring tank all three gages were read. The level of water in the tank was read before and after, a correction applied from a calibration table, and the total quantity determined in this way.

The time was observed in two ways. For runs of less than 2 min. duration, a chronograph, an electric bell and several batteries were connected in series with the diverter so that as the water was diverted into the tank and out of the tank, an electric circuit was made. The completion of the circuit rang the bell sharply and indicated the instant of diversion on the chronograph tape. The chronograph was connected to a seconds pendulum, thus giving a mark on the tape each second. The tape ran at a fairly uniform rate and time was read to 0.01 sec. The bell was used to check the chronograph tim Observer No. 1 noted the time of each ring to the nearest fifth of a second, using a watch with a sweep-secon hand. For runs of more than 2 min., the chronograp was omitted and the time was taken by observer No. 1 He was checked to the nearest second by No. 2.

TABLE 1. ORIFICE-AND-TUBE COEFFICIENTS FOR VARIOUS HEADS

Values taken after averaging curves of Fig. 2

Length of Tube Divided by Side of Square, L/D	Head in Ft. 0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0	Average Coefficient
	6-In Orifice										
Sharp edge	0.599	0.598	0.598	0.598	0.600	0.601	0.601	0.602	0.603	0.604	0.6
0.293	0.642	0.641	0 640	0.640	0.640	0.640	0.640	0.641	0.642	0.644	0.64
0.500	0.675	0.671	0.669	0.670	0.671	0.672	0.674	0.675	0.677	0.679	0.67
0.738	0.726	0 726	0.727	0.728	0.829	0.731	0.732	0.734	0.736	0.738	0.72
0.998	0.771	0.771	0.771	0.771	0.770	0.770	0.771	0.771	0.772	0.774	0.77
1.473	0.796	0.796	0.796	0.796	0.796	0.796	0.796	0.797	0.797	0.797	0.79
	8-In. Orifice										
Sharp edge	0 603	0.605	0.607	0.607	0.607	0.606	0.606	0.605	0.605	0.604	0.60
0.215	0.624	0.623	0.622	0.621	0.620	0.619	0.618	0.618	0.619	0.620	0.62
0.474	0.643	0 648	0.651	0.653	0.653	0.654	0.654	0.654	0.655	0.655	0.65
0.740	0.707	0.703	0.700	0 701	0.703	0.705	0.708	0.710	0.713	0.715	0.70
0.981	0.759	0.758	0.758	0.759	0.760	0.764	0.765	0.765	0.765	0 765	0.76
1.494	0.783	0.782	0.782	0.783	0.784	0.786	0 786	0.786	0.786	0.786	0.78
2.482	0.790	0.790	0.790	0 790	0.790	0 790	0 790	0.791	0.793	0.795	0.79
3.425	0 792	0.795	0.795	0.796	0.796	0.796	0.796	0.796	0 796	0 796	0.79
	10-In. Orifice										
Sharp edge	0.625	0.618	0.613	0.611	0.610	0.610	0.610	0 610	0.610	0.611	0 61
0.178	0.629	0.628	0.628	0.628	0.628	0.629	0.629	0.629	0.630	0 632	0.62
0.497	0.666	0.669	0.671	0.672	0.673	0.673	0 673	0.673	0.672	0.671	0 67
0.759	0.711	0.716	0.721	0.726	0.731	0.735	0.738	0.741	0 743	0 744	0 7
1.011	0.770	0.770	0.771	0.772	0.774	0.776	0 778	0.781	0.784	0.787	0 77
1.513	0.805	0.803	0.803	0.803	0.803	0.803	0 803	0.803	0.804	0 804	0.80
2.514	0.804	0.802	0.802	0.801	0.802	0.804	0 805	0.807	0.809	0.811	0.80
3.520	0.811	0.808	0.805	0.803	0.801	0.800	0.799	0.798	0.796	0.797	0.80

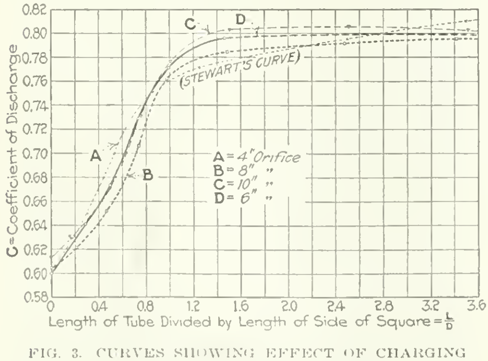


FIG. 3. CURVES SHOWING EFFECT OF CHARGING LENGTH OF ORIFICE TABLES

From experiments by Rogers and Smith and C. B. Stewart

Conclusions

Curves were plotted between discharge coefficient an head for each length of tube (Fig. 2) and also betwe average discharge coefficient and length of tube (Fig. 3 the latter being expressed as the ratio of tube length L to the side of the square orifice D.

The curves plotted showing variation of discharge coefficient with head indicate that in most cases ther is a slight increase in coefficient with higher head

This increase is not pronounced, however, except in one or two curves, and in some cases there seems to be a decrease in the coefficient with higher heads. At any rate there is no definite form that will fit all the curves. Some are nearly straight horizontal lines while others rise rapidly, or dip in the middle. Most of the observations give good lines, but in some cases (and this is more apt to be so with $L/D = 0.50$, 0.75 and 1.00) the points seem to be scattered about the diagrams irregularly.

From the head-coefficient curves, Table 1 was prepared, giving coefficients for every 0.2 ft. up to 2 ft. The average of these was used in plotting the curves between L/D and discharge coefficient C.

All the curves between L/D and C seem to have the ame general form, the coefficient rising rapidly with an ncreased length of tube $L/D = 1.5$, after which ere seems to be very little increase. The greatest discrepancy between any two of the curves is between the - and 8-in. orifices at $L/D = 0.75$. The discrepancy ere is only 3%. These curves, together with C. B. tewart's curve of the same nature for orifices 4 ft. quare, are shown in Fig. 3.

TABLE 2. ORIFICE-AND-TUBE COEFFICIENTS FOR VARIOUS LENGTHS OF PIPE

ength of Tube Divided by Side of Square, L/D	Rogers and Smith Heads 0.2 to 2 Ft.				C B. Stewart, 4 Ft. Sq.	Average of Four Sizes of Orifice
	6 In. Sq.	8 In. Sq.	10 In. Sq.	Average		
Sharp edge	0.600	0.605	0.613	0.606	0.604	0.605
0.25	0.635	0.625	0.637	0.632	0.640	0.634
0.50	0.673	0.657	0.672	0.667	0.692	0.674
0.75	0.732	0.710	0.730	0.724	0.739	0.728
1.00	0.771	0.764	0 775	0.770	0.760	0.767
1.50	0.796	0.784	0.803	0.794	0.777	0.790
2.50	0.799	0.791	0.805	0.798	0.795	0.797
3.50	0.799	0.795	0 802	0.799	0.810	0.802

Table 2 was prepared, showing the coefficients for all ur orifices for $L/D = 0, 0.25, 0.50, 0.75. 1.00, 1.50$ 50 and 3.50. Average coefficients were taken using ly the orifices experimented on in the present inves-gation. The greatest discrepancy between an individ-l observation and the averages (with one exception) 3.8%. Another set of averages was taken, including r. Stewart's coefficients. The greatest discrepancy om these averages for a curve is 3.2% (Stewart's curve), d for an individual observation 4.1%.

The general conclusion may be drawn from these ex-riments that annexing a tube to a submerged square ifice will greatly increase its flow under a given head, til the length of tube is equal to about 1½ times the le of the square. A longer tube will not decrease the w, unless the friction is large, but it will not mate-lly increase it.

Another interesting fact brought out is that for free charge into the air the coefficient does not vary, but mains at about 0.610, whatever the tube length. This lue is about ⅔% greater than the submerged sharp-ge coefficient and corresponds to the submerged coeffi-nt for $L/D = 0.05$. From this it follows that, given square orifice with a tube attached and a fixed head water upstream, a greater quantity may be made to w through the orifice by submerging the downstream le than will flow if the orifice discharges into the air. is fact was verified by experimentation.

These experiments formed part of the work on an dergraduate thesis at Cornell University. The writers sire to acknowledge the aid of Prof. E. W. Schoder suggestions as to the scope and conduct of the work.

Resurfacing Macadam Roads with Small Brick Cubes

Some years ago J. Y. McClintock, County Engineer of Monroe County, N. Y., devised a new type of road in which 2-in. cubes of concrete laid on a sand or stone bed formed the wearing surface. The first experimental road was described in *Engineering News*, Mar. 3, 1910.

Some of these stretches of road have been in service for five or six years, but they have not proved entirely successful, mainly, it is thought, because of the lack of strength or toughness in the concrete itself. The individual blocks have broken or become edge worn, so that it has been necessary to replace them or to cover with an asphalt or tar coating.

About the same time, however, experiments were made with similar small cubes made of clay, and these have worn much more satisfactorily, so much so in fact that Mr. McClintock is favorably inclined to use them extensively in resurfacing worn macadam roads. This season he has covered an experimental stretch with apparent success, although the test of time has not yet been applied.

The blocks used are 2¼-in. cubes of vitrified clay, made by the Corry Brick and Tile Co., of Corry, Penn., and supplied at Rochester for $2.50 per 1,000. Each block weighs about 1 lb. In resurfacing the road the old worn top is brought up to a smooth crown with sand and then rolled. On this surface the cubes are placed by hand, covered with a light coating of sand and the whole rolled to make the finished road. So far no joint binder has been used.

In placing the cubes they are first laid out on a pallet—work that can be done by a boy. The filled pallet is then put down on the rolled surface and slid from under the cubes, leaving them in place except for simple tapping with a hammer. For stretches already put down, the resurfacing costs about $8,000 a mile for a 12-ft. width of road.

The advantages claimed for the method are its cheapness, the ease with which local labor can be used, which is an important consideration in county work, and the readiness with which repairs can be made. If blocks wear down or break, they can be replaced by picking out and setting others in place. It is claimed that the road has a desirable resiliency also. It resembles in surface an ordinary brick road.

In Monroe County, experiments were also made with local clay, which cannot be vitrified, and some sections of road with 2-in. cubes of this material were tried. It was found, however, that they were not tough enough to stand up under traffic. The 2¼-in. vitrified cubes are being used for the pavement of the new county bridge across the Genesee River at Charlotte.

⁂

Conservation of Stream Flow, the Pennsylvania State Water-Supply Commission says in its annual report, is needed in some sections of Pennsylvania to supply the public requirements for water for domestic and industrial uses, as well as to safeguard against floods. Already in some cases, as on the Beaver River, industrial development is checked because of limited water-supply. The commission advises that, judging by experience of the Miami Conservancy District in Ohio, complete investigation of river regulation would cost about $15 per sq.mi. of drainage area. At this rate, the cost of a complete hydraulic survey of Pennsylvania, developing the possibilities for flood control, water-supply and water power would cost about $800,000. If the survey is carried on without interruption, it would be completed in five years. For lack of such comprehensive hydrographic knowledge, unfortunate investments are frequently made

Drawbridge-Type Locomotive Turntable 100 Ft. Long

SYNOPSIS—This table is fixed rigidly by end-rail supports when in position and does not tilt as engines run on and off the table. It is designed to turn very long Mallet locomotives.

In the design of new 100-ft. turntables for the Atchison, Topeka & Santa Fe Ry. special study was given to the problem of eliminating the pounding action that ordinarily occurs when engines are run on and off the table. The first of these tables is shown in Fig. 1, installed at Albuquerque, N. M.

Locomotive turntables when unloaded normally swing with the ends free and unsupported, and a source of trouble and expense with long tables is the pounding at the ends as the engine wheels cross the gap and the table tilts under the load. As one end of the table is apt to be higher than the fixed or radial tracks (especially in old tables), the longitudinal blows from engines running on at this end are destructive to the center and its anchorage. On the Atchison System the experience has been that, with turntables of ordinary construction in pits 75 to 90 ft. in diameter, the annual cost for repairs to end wheels and center is from $400 to $500. With longer tables and the very heavy engines carried, the drop and pound at the ends would be much more serious.

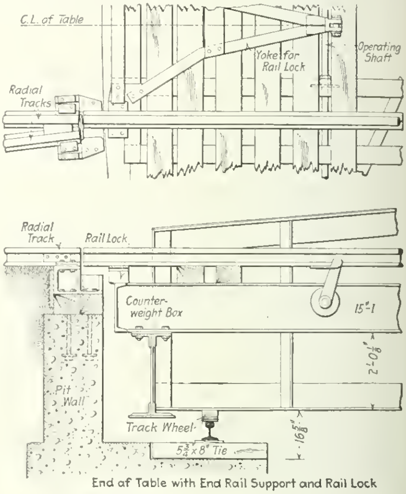
The new 100-ft. turntable is designed like a swing-bridge, with the rail ends projecting over the circle wall and having a bearing on the wall when the table is ready to receive an engine. This construction is shown in Fig. 2. In this way there is no open gap between the fixed rail and the table rail, and no tilting of the table, the rails being held rigidly at the same level. The end-rail supports also render an end lock unnecessary, as they can be applied only when the table is in proper relation to the radial track, and when thus applied the table cannot be shifted from its position.

The table is operated by a tractor running on the pit rail and driven by a 20-hp. electric motor. The tractor is hitched to one end of the table, which swings on a center bearing; but at the motor end there is a counterweight on the end floor-beam so that when the table is empty the carrying wheels at this end are always down on the pit rail and the table rails are always level with the fixed rails. In other words, the empty table is always tilted, with its motor end down, as in Fig. 2.

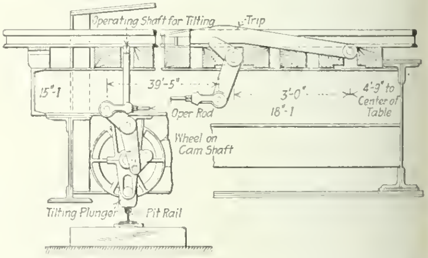
FIG. 1. DRAWBRIDGE-TYPE TURNTABLE WITH END-RAIL SUPPORTS

The rules provide that the table must always b turned so that locomotives run upon it at the moto (low) end. They can be run off at either end, the weight of the engine bringing the high end down to th level of the fixed radial tracks, so that the rail locks a this end can be operated.

On the circular wall of the pit the ends of the rail of the radial tracks are supported by heavy cast-stee blocks bolted to timber sills on the masonry. Thes



End of Table with End Rail Support and Rail Lock



Detail of End Tilting Mechanism and Release Trip

FIG. 2. END OF 100-FT. DRAWBRIDGE-TYPE TURNTABL

blocks extend beyond the rail ends, and the table rai project over the blocks. Shoes or wedges are fitted b neath the ends of the table rails, Fig. 3, and when t table is in position and centered these shoes are driv forward (sliding on the base of the rails) so as to be upon the inclined seats of the blocks upon the cir wall. This makes a rigid connection. If the engine to run off at the opposite end, it is moved into such po tion as to lower that end, and the locks are then operat as above.

The centering or end-lock device consists of a shaped yoke placed between the rails (Fig. 4). The ra shoes are attached to its ends and suspended from t track rails. The apex of the yoke is connected to rm on a transverse shaft operated by a hand lever out- ide the girder, so that by turning the shaft the yoke (with the end shoes or wedges under the rails) is shifted o and fro.

In the first table of this type, mechanism was fitted o allow engines to run on at either end. For this pur- se a tilting device (shown in Fig. 2) was placed at motor end. A camshaft operated a vertical plunger, ich when lowered would take a bearing on the circle l and raise this end of the table so as to lower the posite end correspondingly and enable the rail shoes be driven. In order to prevent breakage of the tilting ice due to the weight of the engine, a tripper was d to release the load. The tripper consisted of a ck lever operated by the first wheel of the locomotive ering the table and crossing the center, thus shifting camshaft so as to pull up the plunger and leave the tor end of the table unsupported.

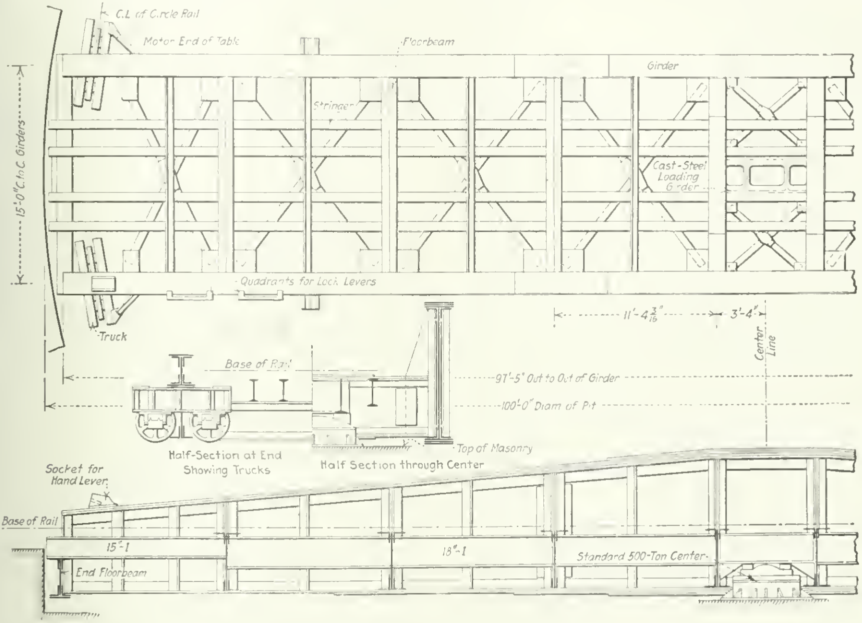


FIG. 3. TURNTABLE 100 FT. LONG, WITH END-RAIL SUPPORTS; ATCHISON, TOPEKA & SANTA FE RY.

The tilting and tripping devices were applied to the t table only and were used for only a short time. ile the operation was effective and satisfactory, it found that the additional cost and complication could saved by requiring the table to be turned so that its tor end always receives the load. This arrangement s not cause any appreciable delay in the service.

The table illustrated is installed at Albuquerque, N. in a pit 100 ft. in diameter. It is of the through e, with steel plate girders, floor-beams and stringers. table itself weighs a little over 90 tons. With the t-steel blocks to support the ends of the table rails the fixed rails of 16 radial tracks, the weight com- e of the table at Albuquerque is about 109 tons. The d-load is 1,800 lb. per ft., (1,300 lb. for steel and lb. for track). Construction is shown in Fig. 3. main girders are 97 ft. 5 in. long over all, with a depth of 7 ft. 6¼ in. at the center and 4 ft. 6¼ in. at the ends. They are spaced 15 ft. c. to c. They have ½-in. webs, with flange angles 8x8x¾ in., and top and bottom cover plates. There are stiffeners on both sides, and inside gusset plate connections with the floor-beams.

Framed between the girders and resting on their bottom chords are ten transverse plate girders. The two at the middle are 10-in. loading girders 6 ft. 8 in. apart. Six of the others are 12-in. floor-beams. The two end floor-beams are only 25 in. deep, so that they can be placed under the stringers. There are four lines of stringers, these being 18-in. I-beams, except that in the end panels 15 in. I-beams are used. Diagonal bottom lateral bracing is fitted in each panel.

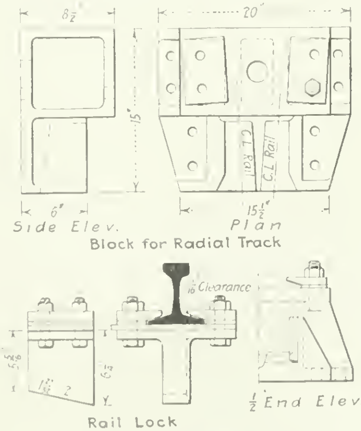


FIG. 4. DETAILS OF END BLOCKS AND RAIL LOCKS

The depth of floor was insufficient for loading girders of plate-girder construction (between the two floor-beams at the center), and in their place there is a cast-steel loading frame fitted between the floor-beams. This frame is about 6½x4 ft., and 3 ft. 1 in. deep, secured by 1-in. rivets.

The table has the railway company's standard center designed for a swinging load of 500 tons. The load is carried by 20 rollers of hardened steel, riding on nickel-steel tracks in the fixed base and revolving head. At each corner of the table is a truck having a frame of a pair of 15-in. I-beams. Upon the I-beams is a seat carrying the end of the girder, and beneath them are the bearings for a pair of 27-in. wheels having their 5-in. treads coned $\frac{3}{32}$ in. in 12 in.

The deck consists of 6x8-in. ties laid across the stringers, with their ends resting on shelf angles on the girder webs. They are secured to these angles and the outside stringers by hook bolts. The tees are spaced 12 to 14 in. c. to c. and have two rows of filler blocks between them to prevent any creeping. Side strips along the ends of the ties, fitted between the stiffeners, hold the ties in place. The track is laid with 90-lb. rails, outside of which are guard timbers 6x8 in., boxed out for the ties and bolted to them. Timbers 6x6 in. protect the end-rail operating yoke, and over the center is a plank cover with ring bolts for handling. On the floor-beams are blocks 2x12 in., 30 in. long, one under each rail.

The radial tracks (46 at Albuquerque) have full-length 90-lb. rails abutting on the pit wall. Their ends are sawed square to the table track, and the clearance between the fixed and table rails must not exceed ¾ in. Cast-steel angle blocks are bolted between the ends of the radial rails.

The circle track in the pit has a radius of 47 ft. 2½ in. to center of rail. It has a 90-lb. rail, carried by creosoted ties 5¾x8 in., 3 ft. long, placed radially. These are spaced 12 in. c. to c. at the main approach tracks and 18 in. c. to c. elsewhere. On each tie the rail is seated on a pair of wedge tie-plates, which provide for adjustment of level.

The pit is 5 to 6½ ft. deep (beneath rail level) and is paved with 5 in. of concrete. The circle wall is of concrete 18 in. thick, with a footing 6 ft. wide to carry the circle track. Below this is a concrete base. On top of the wall are two circular lines of timbers, secured by anchor bolts and carrying the rail blocks. A concrete pedestal supports the center, and a 6-in. pipe extends under the pit and up through this pedestal to carry the wiring for power. In the floor of the pit are four concrete pedestals or jack blocks. With the table swung over these, jacks can be placed under the girders to raise the table for inspection.

The table at Albuquerque is designed specially for handling Mallet engines of the 2-6-6-0 class, weighing 293 tons and having a total wheelbase of about 90 ft. for engine and tender. In these engines the distance from the center of the forward wheel to the center of gravity is 46 ft., or 39 ft. with tender empty, so that the engine can be approximately centered and balanced on the table. A four-wheel switching engine used in the yard has about 63,000 lb. on one axle and 15,000 lb. on the other. This engine and a passenger engine of the 4-6-2 class are commonly turned together on the table. Although this load cannot be centered, the lack of balance has not been found to interfere with the ready operation of the table. It can be turned through a full circle in 1½ min. This table was built by the American Bridge Co.

The new type of turntable described above, with its end-rail supports, tilting device and other special features, was designed by A. F. Robinson, Bridge Engineer of the Atchison, Topeka & Sante Fe Railway System.

⁂

More Details of Sioux City Concrete Paving Practice

By T. H. Johnson*

In answer to many queries which have arisen in regard to the why and wherefore of our methods of constructing concrete pavements in Sioux City, Iowa, described in *Engineering News*, July 27, 1916, the following has been prepared.

Why not use a strike-board? I would not consider abandoning our method of finishing with heavy floats in order to use a strike-board, and I think the heavy floating would develop the unequal densities of the strike-board surface, just as rolling develops the soft spots in the foundation; and we would have to depend on the floating for the final surface anyway.

There are most excellent reasons why we do not use a templet or strike-board. Our streets are nearly all hill-side streets, with the grade on one side frequently from 2 to 4 ft. higher than on the other side. Three-quarters of all the streets so far paved had previously been provided with combined curb and gutter. The form of the gutters and the widely varying heights on opposite sides of the street have made it impossible to use any regularity in crowning the pavement. Our crowns in extreme cases vary in a single block from nothing to 18 in. Our workmen soon learn to form a good street surface without the use of a strike-board, and we have continued to get along without it even where conditions would have permitted its use.

However, I think that there are legitimate objections to the use of a strike-board. Where a mix is used as dry as is being insisted on by most theorists, the use of a strike-board would tend to pull the coarse aggregate away from its mortar bond on one side, and so weaken the concrete. It would certainly increase the density in front of and lessen it behind the particles of coarse aggregate, destroying the uniformity of the structure.

In using the strike-board there is not a uniformly distributed quantity of concrete carried along in front. Parts of the surface the strike-board scarcely touches, passing over without disturbing the concrete. On other parts the quantity of concrete in front will be considerable, and the strike-board will show a tendency to ride or will act in part as a tamper. Again the result is unequal density. The workman in removing the surplus concrete from in front of the strike-board still further aggravates this condition.

The usual directions for using a strike-board when approaching a joint are to move it forward and work it away from the joint. Working the strike-board away from the joint on both sides is especially harmful. It is wrong in principle and should never be practiced.

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*City Engineer, Sioux City, Iowa.

In general any method of laying concrete pavement that omits a possible means of uniformly increasing its density, is wrong. How much more then is a method that tends to decrease the density?

The following analysis of Sioux City paving practice has been prepared to show in as brief a form as possible the why and the wherefore of each detail of practice:

AN ANALYSIS OF SIOUX CITY'S PAVING PRACTICE, SHOWING ADVANTAGES THAT ACCRUE OVER AND ABOVE THOSE OF STANDARD PRACTICE

- Floating with heavy floats before applying dry mixture
  - Aligns flattest surfaces of coarse aggregate with finished surface of pavement
  - Compresses concrete, forcing water out through the surface
    - Increases density and strength of concrete
    - Brings cement toward surface
      - Increases strength and resistance to abrasion
    - Permits a wetter mix
      - Makes concrete easier to place
      - Makes structure more uniform
      - Makes concrete denser and stronger
      - Saves tamping
- pplication of rich dry mixture
  - Extracts surplus water
    - Avoids use of bridge in finishing
    - Hastens time of finishing
    - Makes concrete denser, therefore stronger
    - Increases richness and strength toward top where it is needed
  - Neutralizes laitance
  - Reinforces surface, making it strong and wear-resisting
  - Gives additional mortar to finish surface without disturbing coarse aggregate
  - Renders possible a very wet mix
    - Greater ease in placing
    - Finishing without a bridge
    - Greater uniformity in structure of slab
    - Avoids injurious absorption by the base and evaporation from the surface
- loating after placing dry mix nd until set- ing begins
  - Increases density
    - Makes concrete stronger
    - Makes concrete less absorptive
      - More sanitary
      - Lessens expansion and contraction, reducing tendency to crack
  - Gives rough surface without brooming
  - Retards setting of surface concrete
    - Preventing shrinkage cracks
    - Increasing strength
- nishing joint vith "edger"
  - Gives thick, round corner not easily broken
  - Gives dense, hard troweled finish which is strong and wear-resisting
  - Avoids the use of protection plates

I would like to add a few observations regarding the eneral outcry against a wet mix for concrete pavements. he argument against a wet mix is based on the results laboratory tests, showing that a flowing consistency not so good as one that requires light tamping. These sts also show that a slightly drier consistency is not good as one requiring just light tamping.

If these tests prove anything, they prove that a thin- r consistency than the ideal laboratory one should be sed in a pavement, because in a pavement the con- cte is spread in a comparatively thin layer, one surface which is in contact with fresh earth, in an ideal con- tion to absorb moisture unless wetter than the con- te—which it never is—while the other surface is ex- sed to the drying effect of the atmosphere.

⁂

Street Dirt and Cleaning Not Measurably Unhealthful

Another Banquo's ghost that has been wont to frequent e banquets of medical health officers has been laid low ter two years of careful investigation by the Committee Street Cleaning of the Sanitary Section of the merican Public Health Association. The results of this vestigation were presented at the recent Cincinnati con- ntion of the Association by Samuel Whinery, Chairman the Committee, in the form of a somewhat lengthy port signed also by the other committee members; mely, George H. Norton, Buffalo, John T. Fetherston, w York City, C. M. Talbert, St. Louis, and Richard Fox, Chicago. The conclusions of the report have the more force because they are based not only on a dy of matter previously in print but also on the responses to a questionnaire. Such of these responses as were available for use were, it is true, limited to a baker's dozen, but they have much weight because they come from such men as John T. Fetherston, Commissioner of Street Cleaning, New York; Dr. Haven Emerson, Commissioner of Health, New York City; Dr. Charles V. Chapin, Superintendent of Health, Providence, R. I., and Frederick L. Hoffman, Statistician, Prudential Insurance Co., Newark, N. J.

The conclusions of the committee are summarized in the report as follows:

> In view of all the facts disclosed, and notwithstanding the testimony and opinion that street dirt is not, on the whole, a serious menace to the public health, there is abundant reason for believing that street dust is a deleterious element in urban life, and that it is the principal source of danger to the public health from dirty streets and street cleaning operations.
>
> If this be so, great attention should be given to preventing its formation, and to its prompt and effectual removal from city streets.
>
> Summarizing the results of our investigation the following conclusions seem warranted:
>
> 1. That street cleaning and work connected therewith, as an occupation, is but little if any more unhealthful than the average of other laboring occupations.
> 2. If street cleaners, who are constantly engaged upon the streets, and therefore intensively subjected to the effects of street dirt in all its forms, are not injuriously affected thereby, no great danger to the public health from street dirt and street cleaning operations is to be apprehended.
> 3. That such danger therefrom as may exist is almost wholly attributable to street dust.
> 4. The dumps and land-fills composed of street waste (unmixed with garbage) are not notably detrimental to the public health.
> 5. While disease germs doubtless exist in street dirt and dust there is, at present, no positive evidence available that such germs are responsible for specific diseases, though the possibility and even probability of contagion thereby should be assumed.
>
> It should be noted that we are, in this report, dealing with the sanitary aspects, alone, of street cleaning. There are abundant reasons for keeping city streets clean regardless of the public health.
>
> In conclusion the committee again calls attention to the paucity of actual statistics and accurate scientific investigation in this field. The possible importance of the subject as a factor in the public health entitles it to more careful study.
>
> The number of employees in the street cleaning departments of our cities is sufficient to warrant their segregation into a separate class of industrial workers, and it is urgently recommended that street cleaning departments, public-health departments and the hospitals shall provide and maintain an adequate system of observations and records that shall enable us to arrive at reliable, definite conclusions as to the true sanitary aspects of street dirt and street cleaning.

It is well worth noting that figures for the six years, 1909 to 1914, for an average of 5,501 employees in the Street Cleaning Department of New York City, show a death rate of 14.8 per thousand compared with a death rate of 15 for all males between the ages of 20-69 in the whole of New York City.

⁂

The Life of Railway Rolling Stock on some of the older railways of New England appears to be pretty long. A report has just been made to the Public Service Commission of Massachusetts on the passenger service of the New York, New Haven & Hartford R.R. The report, presented by George W. Bishop, Chief of the Inspection Department of the Commission, shows that the company has about 252 locomotives engaged in local passenger-train service in Massachusetts which are from 13 to 36 years old. Of these, 168 are too small to give good service under the conditions imposed upon them, and engine failures with them are frequent. The company operates about a thousand wooden cars in local passenger-train service in Massachusetts. About half of these are in good condition, and half of the remaining number need to be repaired to give good service. The remaining 250 have been in service from 29 to 40 years and are in generally poor condition. Recently the company retired 25 of these cars, and it has assured the Inspection Department that 169 more will soon be taken out of passenger-train service.

Traffic-Census Methods and Some Results; St. Louis

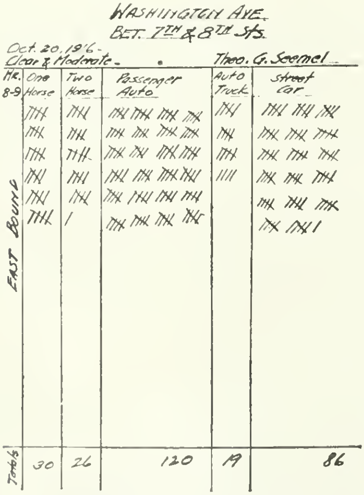
By William Holden*

SYNOPSIS—Methods of taking an extended traffic census, tabulating and platting data and some of the changes in traffic conditions that were shown; also some statistics of standing vehicles and the regulation of traffic by ordinance.

The City of St. Louis has recently completed an elaborate traffic census with the following objects in view: (1) Regulation of traffic by ordinance; (2) provision of suitable pavement; (3) making more direct connections and eliminating obstructing jogs in the street system; (4) widening existing roadways and opening up new thoroughfares where necessary.

The taking of an annual traffic census was started by the Street Department in October, 1913. In that year counts were made on the most important streets in the downtown section. Observers were stationed at intersections, and counts were made of vehicles only, separating them into four classes—one-horse, two-horse, passenger automobile and motor trucks. The department was chiefly interested in determining the volume of traffic of various classes, and no attempt was made to determine tonnage.

Each year the territory covered by the traffic census was extended until in 1915 it included not only the entire downtown district, but covered the main traveled arteries leading to the residential districts and the principal cross-streets. The census of 1914 and of 1915 included street cars. In 1915, observations were made at 173 points for the regular day census and at 14 points for the night-traffic census between the hours of 6 and 10 p.m. In 1913, 1914 and 1915, counts of the number of standing vehicles in the downtown districts were also made for the purpose of determining the amount of available roadway and also the curb space occupied, which would serve as a basis for proper regulation of parked vehicles.



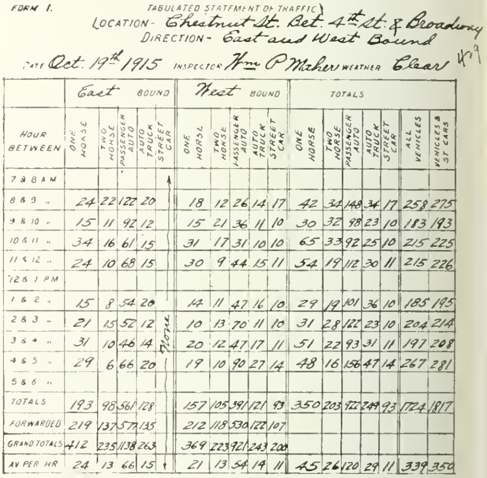
WASHINGTON AVE.
BET. 7TH & 8TH STS.

Oct. 20, 1916 -
Clear & Moderate -
Theo. G. Seemel

Hr. 8-9	One Horse	Two Horse	Passenger Auto	Auto Truck	Street Car
East Bound					
Totals	30	26	120	19	86

FIG. 1. FIELD SHEET FOR TABULATING TRAFFIC CENSUS (HALF SIZE)

In 1913 and 1914 the observers were stationed at the street intersections, two men being used for each. The observers were located on corners diagonally opposite each other. Each man counted traffic moving in the direction which passed on his side of the street. On a few of the extra-busy intersections it was necessary to use four men, each man taking traffic in one direction only.



FORM 1.
TABULATED STATEMENT OF TRAFFIC
LOCATION - Chestnut St. Bet. 4th St. & Broadway
DIRECTION - East and West Bound
DATE Oct. 19th 1915 INSPECTOR Wm P Maher WEATHER Clear

	East Bound					West Bound					Totals						
Hour Between	One Horse	Two Horse	Passenger Auto	Auto Truck	Street Car	One Horse	Two Horse	Passenger Auto	Auto Truck	Street Car	One Horse	Two Horse	Passenger Auto	Auto Truck	Street Car	All Vehicles	Vehicles & St Cars
7 & 8 A M																	
8 & 9 "	24	22	122	20		18	12	26	14	17	42	34	148	34	17	258	275
9 & 10 "	15	11	92	12		15	21	36	11	10	30	32	98	23	10	183	193
10 & 11 "	34	16	61	15		31	17	31	10	10	65	33	92	25	10	215	225
11 & 12 "	24	10	68	15		30	9	44	15	11	54	19	112	30	11	215	226
12 & 1 P M																	
1 & 2 "	15	8	54	20		14	11	47	16	10	29	19	101	36	10	185	195
2 & 3 "	21	15	52	12	None	10	13	70	11	10	31	28	122	23	10	204	214
3 & 4 "	31	10	46	14		20	12	47	17	11	51	22	93	31	11	197	208
4 & 5 "	29	6	66	20		19	10	90	27	14	48	16	156	47	14	267	281
5 & 6 "																	
Totals	193	98	561	128		157	105	391	121	93	350	203	922	249	93	1724	1817
Forwarded	219	137	577	135		212	118	530	122	107							
Grand Totals	412	235	1138	263		369	223	921	243	200							
Av per Hr	24	13	66	15		21	13	54	14	11	45	26	120	29	11	339	350

FIG. 2. FORM 1, FOR TABULATING HOURLY TRAFFIC

In 1915 another method was adopted, which is now generally used, of stationing the observers in the middle of the block. Each man counts only the traffic on his street, which is moving straight past him. This eliminates the possibility of confusion due to vehicles turning the corner and being counted twice or not at all. By this method the traffic in any block on any street is counted direct. Likewise by taking the proper direction from the records of the observers in each of the four adjoining blocks, the traffic coming to any intersection can be arrived at. On two or three streets where traffic was exceptionally heavy it was necessary to place two men to the block, each man counting traffic bound in one direction only. In 1913 and 1914, counts were made for two days at each point.

In the first two years the count extended from 8 a.m. to 5 p.m., omitting the noon hour. In 1915 by a shift in the two days' count, the observations covered from 8 a.m. to 6 p.m., not including the noon hour. The 1915 census was taken during the last two weeks of October, not including Sundays. The weather was clear and the atmosphere moderate for the entire period.

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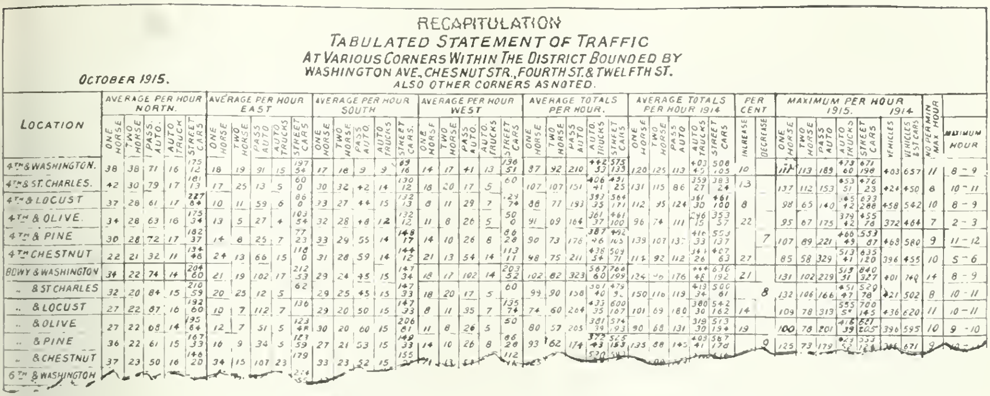
*Engineer, Department of Streets and Sewers, St. Louis, Mo.



RECAPITULATION
TABULATED STATEMENT OF TRAFFIC
AT VARIOUS CORNERS WITHIN THE DISTRICT BOUNDED BY
WASHINGTON AVE., CHESNUT STR., FOURTH ST. & TWELFTH ST.
ALSO OTHER CORNERS AS NOTED.

OCTOBER 1915.

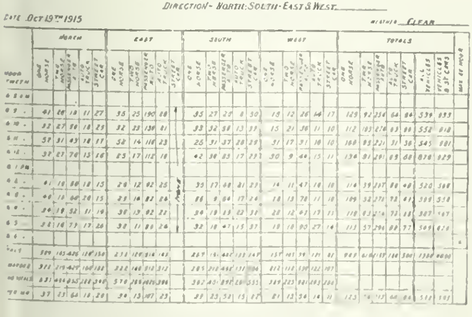
LOCATION	AVERAGE PER HOUR NORTH.					AVERAGE PER HOUR EAST					AVERAGE PER HOUR SOUTH					AVERAGE PER HOUR WEST					AVERAGE TOTALS PER HOUR.					AVERAGE TOTALS PER HOUR 1914					PER CENT		MAXIMUM PER HOUR 1915.					1914		NO PER MIN MAX HOUR	MAXIMUM HOUR
	ONE HORSE	TWO HORSE	PASS. AUTO.	AUTO TRUCK	STREET CARS	ONE HORSE	TWO HORSE	PASS AUTO	AUTO TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS AUTO.	AUTO TRUCKS	STREET CARS.	ONE HORSE	TWO HORSE	PASS AUTO.	AUTO. TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS AUTO	AUTO. TRUCKS	STREET CARS	ONE HORSE	TWO HORSE	PASS AUTO	AUTO TRUCKS	STREET CARS	INCREASE	DECREASE	ONE HORSE	TWO HORSE	PASS AUTO	AUTO TRUCKS	STREET CARS	VEHICLES	VEHICLES & ST CARS		
4TH & WASHINGTON.	38	38	71	16	175 12	18	19	91	15	197 54	17	18	9	9	69 16	14	17	41	13	136 51	87	92	210	442 53	575 139	120	125	113	403 45	508 105	10		117	113	189	473 60	671 198	403	657	11	8 - 9
4TH & ST. CHARLES.	42	30	79	17	181 13	17	25	13	5	60 0	30	32	42	14	130 12	18	20	17	5	60	107	107	151	406 41	431 25	131	115	86	359 27	383 24	13		137	112	153	453 51	476 23	424	450	8	10 - 11
4TH & LOCUST	37	28	61	17	227 84	10	11	59	6	86 0	33	27	44	15	132 13	8	11	29	7	129 74	88	77	193	393 35	564 171	112	95	124	361 30	461 100	8		98	65	140	[illegible] 42	633 288	458	542	10	8 - 9
4TH & OLIVE.	34	28	63	16	175 34	13	5	27	4	103 54	32	28	48	12	132 12	11	8	26	5	50 0	91	69	164	361 37	461 100	96	74	111	296 15	353 57	22		95	67	175	379 42	455 76	372	464	7	2 - 3
4TH & PINE	30	28	72	17	182 37	14	8	25	7	77 23	33	29	55	14	148 17	14	10	26	8	86 28	90	73	178	387 46	492 105	139	107	137	416 33	553 137		7	107	89	221	466 49	553 87	463	580	9	11 - 12
4TH CHESTNUT	22	21	32	11	134 48	24	13	66	15	118 0	31	28	59	14	144 12	21	13	54	14	113 11	98	75	211	438 54	509 71	114	92	112	344 26	407 63	27		85	58	329	513 41	635 120	396	455	10	5 - 6
BDWY & WASHINGTON	34	22	74	14	204 60	21	19	102	17	212 53	29	24	45	15	147 34	18	17	102	14	203 52	102	82	323	567 60	766 199	124	[illegible]	176	444 48	636 192	21		131	102	229	519 31	840 327	401	740	14	8 - 9
" & ST CHARLES	32	20	84	15	210 59	20	25	12	5	62	29	25	45	15	147 33	18	20	17	5	60	99	90	158	381 40	479 92	150	116	119	419 34	500 61		8	132	106	166	451 47	529 78	421	502	8	10 - 11
" & LOCUST	27	22	87	16	192 60	10	7	112	7	136	29	20	50	15	147 33	8	11	35	7	135 74	74	60	264	433 35	600 167	101	69	180	380 30	542 162	14		109	78	313	555 55	700 145	436	620	11	10 - 11
" & OLIVE	27	22	68	14	195 64	12	7	51	5	123 48	30	20	60	15	206 81	11	8	26	5	50	80	57	205	381 39	574 193	90	68	131	319 30	513 194	19		100	78	201	416 39	627 205	396	595	10	9 - 10
" & PINE	36	22	61	15	167 33	16	9	34	5	123 59	27	21	53	15	149 33	14	10	26	8	86 28	93	62	174	372 43	525 153	135	88	145	403 41	567 178		9	125	73	179	[illegible]	[illegible]	[illegible]	671	9	
" & CHESTNUT	37	23	50	16	146 20	34	15	107	23	179	33	23	52	15	155					112				520																	
6TH & WASHINGTON										274 55																															

FIG. 3. SUMMARY SHEET OF ST. LOUIS, MO., TRAFFIC CENSUS

The men used in making the 1915 count were for the nost part average inspectors from the Street and Sewer Divisions, together with a few additional inspectors borowed from other departments. About one-half of these nen had had some experience in previous counts. An asistant supervised the count, collected daily reports, made ssignments of new locations and later handled the clerical orce in tabulating and compiling the data under the eneral direction of the engineer-in-charge.

The forms used were made as simple as possible. The eld sheet, Fig. 1, shows in headings the location of the bserver, direction of traffic observed, date, weather, inpector's name, and hour recorded on the particular heet. Generally one sheet was used for each hour. A ehicle drawn by two or more horses, as Fig. 1 shows, as counted as a two-horse vehicle. It was found that ie best observers were able to take care of all traffic ound in one direction even on the busiest street, which mounted to a maximum of about 870 vehicles per hour.

At the end of each day the men were required to total ie columns for each hour on field sheets and enter these n Form 1 (Fig. 2). The field sheets were attached to orm 1 and sent to the office the following morning. As ion as the work of the inspector in totaling and transrring the data from field sheet to Form 1 was checked, ie field sheets were dispensed with. From Form 1 the affic on each street in both directions was reduced to an erage per hour.



TABULATED STATEMENT OF TRAFFIC.
LOCATION- BROADWAY AND CHESTNUT ST. INTERSECTION
DIRECTION- NORTH: SOUTH- EAST & WEST.
DATE OCT 19TH 1915
WEATHER CLEAR

NORTH
EAST
SOUTH
WEST
TOTALS

FIG. 4. FORM 2, FOR TABULATING TRAFFIC AT INTERSECTIONS

From recorded directions by the observers in the four adjoining blocks only the traffic coming toward the intersection is entered on Form 2 (Fig. 4). This gives at the bottom the average per hour in each direction and the total of all four directions. In the column of hourly totals at the right are given combined totals for each hour. By taking the average for the two days for each hourly total, is determined which hour in the average day shows the maximum traffic. The total of vehicles and street cars was considered in arriving at the maximum hour.

From Form 2 of the traffic at various intersections is made up a recapitulation of tabulated traffic, Fig. 3. The average number of units per hour in each direction is totaled, and the total is placed in the street-car column above the number of street cars per hour. Thus at Fourth and Washington Ave. the average per hour of northbound vehicles plus street cars was 175, the 12 below being the average number of street cars per hour. In the average totals per hour and the maximum hour are the whole number of vehicles, placing this sum over the number representing motor trucks and the number of vehicles plus street cars over the number representing street cars.

Traffic Charts

In order to present the traffic data a little more clearly, traffic charts were plotted as follows: (1) Average traffic for each street in the downtown district; (2) maximum traffic for intersections in the downtown district; and (3) traffic of the congested district.

The Average Traffic charts show the average number of vehicles per hour (sum of both directions) and vehicles plus street cars in each block observed on the street under consideration. On these charts, as on Maximum Traffic charts, black lines represent total vehicles and the shaded lines represent total vehicles and street cars combined. On the Average Traffic charts (Fig. 5) the horizontal base represents the street, divided into blocks by the vertical lines representing the intersecting streets. The vertical dimension is ruled off into 1-in. spaces which represent 40, 60 or 100 vehicles (or vehicles and street cars), depending on the scale used, which varied in accordance with the amount of traffic carried. The average number of vehicles per hour (total of all classes) for each block was platted in the middle of the section representing that block on the chart. These points were connected by lines. The combined number of vehicles and street cars was platted for each block, and the points were connected with a shaded line. From the Average Traffic charts the fluctuation of traffic per hour in different blocks can readily be seen. On account of their effect on the volume of traffic there are also shown width of roadway, kind of pavement and number of car tracks on the Average Traffic chart of each street.

The Maximum Traffic chart for each street shows the number of vehicles and vehicles plus street cars crossing each intersection on the street during the maximum hour from all four directions. The horizontal base line represents the street under consideration, and the vertical lines represent the cross-streets. The total number of vehicles during the maximum hour for each intersection is platted on the proper vertical line representing the cross-street. The numbers to use in the maximum charts are most conveniently taken from the totals shown during the maximum hour in the recapitulation of tabulated traffic (Fig. 3). The relative volumes of traffic at the different intersections, as well as that of the 1914 census, are readily compared from these charts.

A Traffic Chart of the Congested District (1915) shows the average number of vehicles per hour (totaling both directions) for each block of every street observed in the 1915 census. The vehicles are platted to a scale of 1,000 = 1 in. in width on a map of the territory drawn to a scale of 200 ft. = 1 in. Thus by comparing the relative widths of the black lines representing traffic we see at a glance the comparative volumes of traffic on different streets and different parts of the same street.

Results Shown by Census

The vehicular traffic in the downtown district, comparing the 1915 with the 1914 census, shows an increase of 20%, considering all classes. However, automobile traffic shows an increase of 53%—passenger automobiles increasing 56% and motor trucks increasing 41%. On the other hand, horse-drawn vehicles have decreased 15%—one-horse vehicles showing a decrease of 17% and two-horse vehicles showing a decrease of 12%.

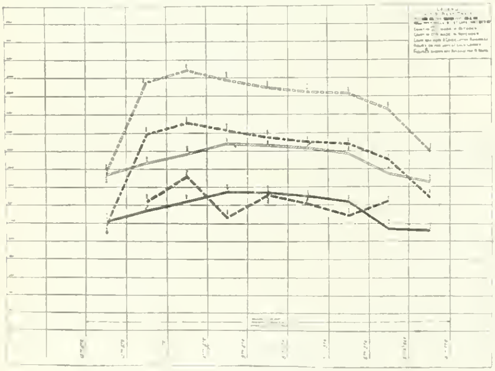


FIG. 5. AVERAGE TRAFFIC CHART

The remarkable one-year increase indicated in motor traffic is due to a certain extent to weather conditions prevailing at the time the census was taken. The counts in 1913 and 1915 were taken in October, during seasonable weather, while the count for 1914 was taken in November and ran into some pretty cold weather. For this reason largely, the 1914 count showed for the combined vehicular traffic only a slight increase over 1913. The number of state automobile licenses issued in St. Louis was 8,789 in 1913, 13,391 in 1914, and 16,362 in 1915. Present records indicate that the number for 1916 will be about 20,000. This shows 67% increase in the two years (from 1913 to 1915).

A count of standing vehicles in the downtown district was made in 1915. The count was for seven business hours one day and for four business hours the following day, which happened to be a Saturday, and the count ended at 1 p.m. The count was taken at the end of October, and weather conditions were good. Observations were made in each block every hour, and the number of automobiles and horse-drawn vehicles standing on each side of the street was noted and recorded.

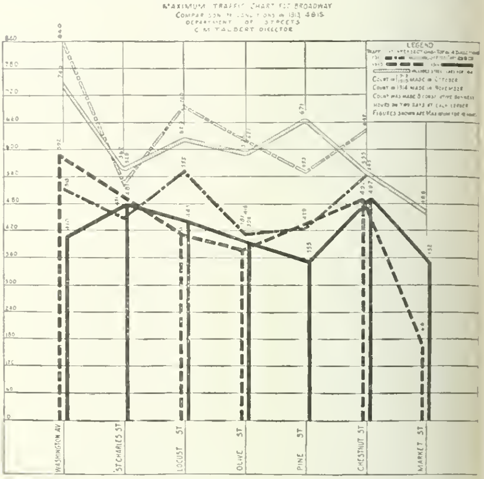


FIG. 6. MAXIMUM HOUR-TRAFFIC CHART

This information was compiled to show: (1) The average number of standing vehicles in each block during the 11 hr. observed, and also the block on the east and west streets and the north and south streets having the largest and the least number of automobiles, horse-drawn and all kinds of vehicles in 1914 and 1915 respectively; (2) the maximum number of standing vehicles observed in each block in the district and the time when it was noted. Finally there was prepared a map showing conditions in the downtown district, on which were platted approximately to scale the number of standing vehicles in each block together with the number of street cars observed in each block and also pedestrian lines, safety zones, etc.

It was found that the public streets were being used to store vehicles for a large part of the day, and from the data thus collected a parking ordinance was passed by the city which permits motor cars to stand for two hours only in the congested districts.

The study of traffic conditions, taking of census and making of regulations were initiated by and have been carried on in the Street Department under C. M. Talbert, formerly Street Commissioner and now Director of Streets and Sewers. For the first two years J. L. Laxton had immediate direction of the work, and for the past year it has been in the writer's charge. The City Plan Commission is now extending traffic observations out to the city limits on the main thoroughfares.

More Data on Test of Montreal Centrifugal Pump

By A. Peterson*

A report of a duty test made upon a steam-turbine-lriven centrifugal pump at the low-level-pumping station f the City of Montreal was published in *Engineering News* of Apr. 27, 1916. The figures presented related rincipally to the conditions of operation and the over-all esults, certain important data having been omitted in aking the results from the log of the test and others aving been eliminated in editing. As these omissions ave been made the basis of certain misinterpretations, t is believed that all available data useful for a critical xamination of the thermodynamic results should be rought together. The latter have a certain interest ecause of the fact that the efficiency of the installation, ncluding pump and auxiliaries, is believed to be higher han has before been obtained from a steam-turbine-driven entrifugal plant.

The pumping unit consists of a 14-stage impulse rbine, operated at 3,600 r.p.m. and driving through ouble-helical reduction gears a 30-in. centrifugal pump t 600 r.p.m. The turbine exhausts to a surface con- enser of the water-works type—that is, with the water rculating outside the tubes. The condenser is equipped ith a primary heater in the steam space, through which e water is forced by the condensate pump into an en feed-water heater receiving exhaust from the con- nser dry-vacuum pump and from the condensate pump d additional steam bled from an intermediate stage the main turbine.

The delivery of the pump was measured by a "Simplex" nturi meter having a 36-in. inlet and 21-in. throat, ing a "Simplex" registering instrument, which was ecked by a mercury manometer, the two agreeing with- 0.2% difference, on the assumption that the coefficient the venturi tube is 0.985. The water delivered from e open feed-water heater to the boiler-feed pump was easured by a "Cochrane" V-notch meter and by platform les.

The points of attachment of the suction and discharge ges provided for by the specifications were such as to lude credit for overcoming the friction through the llowing pipe fittings: On the suction side of the pump, e 42-in. gate valve, one 42-in. 45° bend, one water- rks type condenser, one 42- to 36-in. reducing nipple, e piece of 36-in. pipe about 8 ft. long and one 36- to -in. reducing long-radius elbow; and on the discharge le of the pump, one 30- to 36-in. increasing long-radius ow, one piece of 36-in. pipe about 9 ft. long, one -in. long-radius elbow, one 36-in. check valve and one -in. gate valve. During the test, readings of suction t and discharge head were, however, also taken at the -in. suction and discharge nozzles of the pump.

The following data were given in the article published *Engineering News* of Apr. 27, 1916:

rage water delivered, Imperial gal. per hr.	1,308,808
rage head at gage on discharge pipe, ft	197.271
rage suction lift from water level to center line of pump, ft.	8.6
al average corrected head, ft	205.874
rage water horsepower	1,360.85
m consumption corrected for credits, lb. per hr	17,344
rage absolute steam pressure, lb. per sq.in	159.7
rage superheat at turbine, deg. F.	63
m consumption corrected to contract conditions (110 lb. gage and 0° superheat), lb. per hr	16,638

In order that the test may be calculated according the method given in the power-test code of the American Society of Mechanical Engineers for tests of complete steam-power plants the following figures are now added:

Average feed water, lb. per hr	20,280
Average nozzle-pressure gage, lb. per sq in	138
Average vacuum corrected to 30-in. barometer	28.98
Average actual steam temperature at engine throttle, deg. F.	426
Temperature of feed water leaving heater, deg. F	210
Steam per pump horsepower, lb	12.74*
Total head generated, as measured by gages at suction and discharge nozzles, ft.	213.86

*This last figure was given erroneously in the original article as 12.7

The duty per million B.t.u., based upon the head measured according to the specifications, was 126.2 million foot-pounds. As the superheat, however, was only 63°, whereas 100° F. was specified, this figure was corrected by deducting from the steam consumption (17,344 lb.) 1% for each 9° F., or 4.1% in all, giving a duty of 129.6 million foot-pounds. The duty calculated on the basis of the work delivered by the pump to the water between the suction and discharge nozzles, making the same allowance for lack of superheat, becomes 134.6 million foot-pounds per million B.t.u. No correction is made because of the fact that the steam pressure was higher than the 110 lb. gage pressure specified, since the nozzle pressure was at all times below 140 lb. gage, and the turbine would have shown the same performance even though the steam pressure had been reduced.

The question has been raised as to whether, in stating duties of pumping units, the performance of the auxiliaries should be included with the performance of the main unit and whether credit should be allowed for heat returned in the feed water. Considering the manner in which the present apparatus was designed to operate, there can be no question that it is the over-all duty—that is, the work delivered in the water pumped, as compared with the net heat withdrawn from the boiler—in which the purchaser is primarily interested. Where the auxiliary exhaust cannot be used for heating the feed water, it should be admitted to some intermediate stage of the turbine, in which case it would be included in the turbine condensate. On the other hand, where there is not sufficient auxiliary steam to heat the feed water to the proper temperature, the efficiency of the unit is improved by extracting steam for that purpose from an intermediate stage of the turbine, which gives a more efficient heat cycle. The water rate is then obtained by measuring the water leaving the feed-water heater.

In an article by L. A. Day, entitled "Proper Methods of Testing Water-Works Pumps," which appeared in *Engineering News* of June 29, 1916, an attempt was made to determine the pump and turbine efficiencies implied in the results originally published. The approximate efficiency of the turbine, based upon the Rankine cycle, may be calculated from the data herewith presented, as follows:

First, to estimate the actual amount of steam going to the condenser.

If

X = Steam going to condenser in pounds per hour;
Q = Total amount of feed water, pounds per hour;
H = Total heat in B.t.u. per pound of auxiliary steam and steam bled;
r = Latent heat in 1 lb. of auxiliary and bled steam;
t_2 = Temperature of liquid corresponding to pressure of auxiliary and bled steam;
t = Temperature of condensate leaving condenser;
T = Temperature of feed water.

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*Engineer, De Laval Steam Turbine Co., Trenton, N. J.

The following relation exists among the foregoing quantities (assuming no heat losses):

$X(T - t) = (Q - X)\ r + (Q - X)\ (t_2 - T)$, or

$$X = \frac{Q(r + t_2 - T)}{t_2 + r - t}$$

Let

$Q = 20{,}280$ lb.;
$t = 74°$;
$T = 210°$.

With 2 lb. back pressure on the auxiliary and bled steam, $H = 1{,}120$ B.t.u. (assuming adiabatic expansion and that part of the heat is recovered by reheating during expansion). Also,

$$t_2 = 218°$$

$$r = 1{,}120 - (218 - 32) = 934\ B.t.u.$$

We then obtain

$$X = \frac{20{,}280(934 + 218 - 210)}{218 + 934 - 74} = 17{,}720$$

$$Q - X = 20{,}280 - 17{,}720 = 2{,}560\ lb.$$

represents the amount of steam used for heating the condensate; in other words, the sum of the auxiliary steam and the steam extracted from the turbine.

The auxiliaries used about 450 lb. of steam per hour; accordingly the amount of steam bled was 2,110 lb. per hr. This steam did a certain amount of work in the high-pressure part of the turbine, which work can be calculated approximately by using the entropy diagram. The heat available in expanding from 145 lb. gage pressure, 63° F. superheat, to 2 lb. gage back pressure is 174 B.t.u., which gives a theoretical steam consumption of $\frac{2{,}545}{174} = 14.62$ lb. per hp.-hr., and assuming 65% efficiency of the high-pressure end of the turbine, the horsepower obtained from the bled steam was $\frac{2{,}110}{14.62} \times 0.65 = 94$ b.hp.

The total brake-horsepower delivered at the pump coupling, assuming 82% efficiency of the pump, is 1,725. (An efficiency of 82% is not impossible for so large a pump.) Thus from a steam flow of 17,720 lb. representing the amount of steam condensed, 1,725 — 94 = 1,631 b.hp. will be obtained on a steam consumption of $\frac{17{,}720}{1{,}631} = 10.86$ lb. per b.hp.-hr.

The theoretical steam consumption for the steam conditions existing during the test (145 lb. gage, 63° superheat and 28.98 in. vacuum) is 6.9 lb. per hp.-hr. Thus the efficiency of the turbine and gears based upon the Rankine cycle is $\frac{6.9}{10.86} = 63.5\%$.[1]

From the above figures the gain in economy from the primary heater and bleeding steam can easily be estimated, as follows:

The total heat consumption of a standard 1,725-hp. turbine with independent auxiliaries will be

$(1{,}725 \times 10.86 + 450) \times 1{,}231 = 23{,}611{,}888\ B.t.u.$

The heat returned from the condensate and auxiliary steam, assuming a temperature of the condensate when leaving the condenser of 65° F., equals

$$(1{,}725 \times 10.86 \times 33) + (450 \times 1{,}120) = 1{,}122{,}205\ B.t.u.$$

Thus the net heat consumption is

$$23{,}614{,}888 - 1{,}112{,}205 = 22{,}502{,}683\ B.t.u.$$

With a primary heater in the condenser and bleeding steam sufficient to raise the feed-water temperature to 210° F., the total heat consumption of turbine and auxiliaries will be

$$20{,}280 \times 1{,}231 = 24{,}964{,}680\ B.t.u.$$

and the heat returned

$$20{,}280 \times (210 - 32) = 3{,}609{,}840\ B.t.u.$$

Thus the net heat consumption is

$$24{,}964{,}680 - 3{,}609{,}840 = 21{,}354{,}840\ B.t.u.$$

or a saving of

$$22{,}502{,}683 - 21{,}354{,}840 = 1{,}147{,}843\ B.t.u.$$

per hr., which represents an increase in efficiency of the complete installation of

$$\frac{1{,}147{,}843}{22{,}502{,}683} = 5.1\%$$

This saving is obtained through a very slight increase in cost of the apparatus, although should the saving be capitalized it will be found that a considerable increase in the original investment would have been justified.

Mr. Day also suggested that corrections be made to the readings of gages attached at the suction and discharge openings of centrifugal pumps, where the openings are not of the same size, as follows:

$$h = \frac{v_2^2 - v_1^2}{2g}$$

wherein

v_2 = Velocity through the discharge in feet per second;
v_1 = Velocity through the inlet in feet per second;
$g = 32.16$;
h = Correction to head in feet.

While theoretically correct, this formula should not be used without reservation, as the efficiency of the ordinary increasing fittings is not very high and instea of getting back all of the head represented by the formul the customer is more apt to gain only half as much. The one who benefits by the correction is of course th pump builder, who does not have to provide a diffuse as a continuation of the volute of his pump. He obta the greatest advantage from this correction on low-hea pumps, where the gain may amount to several per cent In order to prevent this the specifications should be s drawn as to consider only pumps having suction an discharge openings of the same size, or to insure tha the suction gage will be located close to the suctio flange of the pump and the discharge gage at a poin on the discharge pipe where it has been increased t approximately the same size as the suction opening.

Mr. Day stated that the high duty claimed for th Montreal pump was made on the basis of "no credi for friction head in the suction pipe, condenser and d s charge pipe up to the city main." This statement erroneous, but attention should be directed to certai desirable modifications in the general practice of draw ing specifications covering this point. The manufactur is often called upon to furnish, besides the pump, certain amount of piping and fittings and is asked t assume the responsibility for friction in such piping an to make allowances therefor in the duty guarantee.

It would be better to require that the duty guarante should be based upon pressure readings taken as clos as possible to the suction and discharge flanges of th ump and that the manufacturer should specify the riction head to be expected in the different fittings urnished by him, together with a description giving izes, kind of elbows, length of straight piping, etc. It ill then be easier for the customer to analyze and ompare the different estimates and to place all manuıcturers upon the same basis in reference to duty uarantees. Owing to the great difficulty in estimating ıe friction in fittings, two bidders may offer exactly ıe same piping and fittings, while estimating upon reatly different figures for friction.

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[1] The efficiency of the turbine is in reality slightly higher, due to the fact that, owing to losses in heat transmission, the amount of bled steam is greater than figured from the formula given above.

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Slaughter-House Sewage Test Plant, Buenos Aires

By Waldo S. Coulter*

The experience of the writer a few years ago with a st plant treating slaughter-house sewage at Buenos ires, Argentina, may be of interest. This plant was stalled September, 1911, at the Frigorifico Argentino, eliminary to the design and construction of an operative ant. Unfortunately, changes in administration and ıancial rearrangements intervened to prevent the entire mpletion of the operative plant.

The test plant consisted of a 2,500-gal. rectangular l-and-draw plant settling tank; a sump communicating th the lower end of the settling tank by an adjustable ir; a small rotary pump, which elevated the settled wage to a head box, and a sprinkling filter inclosed in 15-ft. octagonal-shaped box, 11 ft. high, the upper 5 ft. ting as a wind shield.

The filtering medium was 6 ft. of ¾- to 1½-in. reened and washed coal. Coal was used because it was ımediately available.

The settling tank was first operated as a plain limentation tank and was cleaned out weekly or oftener keep the sewage fresh.

The head on the spraying devices was kept constant pumping an excess to the head box and conducting surplus back to the sump by an overflow trough. ıriation of head for peripheral nozzles was secured by nd operation of controlling valves.

Observations were first made with upward jet nozzles the Taylor and Birmingham types, the net rate being 0,000 gal. per acre per day at the commencement, which s gradually reduced to 335,000 gal. These net rates re secured by long resting periods, the rates of application, while the spray was in action, being 3,000,000 gal. d upward. At the end of two months' operation the rate would "stand up" for only 36 hr. at 15° C. and l retained a decided crimson tinge.

From close observation it became apparent that low es must be secured by a low gross rate, not by plication at comparatively high gross rates alternating th long resting periods. The upward-jet nozzles produced what was in effect a series of flushes through the filter at considerable intervals. If the aperture of the upward-jet nozzles was reduced sufficiently to give a l w gross rate, clogging began at once, caused principally b flies which hovered over the tank and head box, or b any small object which happened to find its way to the nozzle.

Recourse was then had to downward jets with dash plates. It was found that these could be operated at the required low gross rates without clogging. By the use of long, tapered nozzles, with a head of 1 ft. or more above the nozzle point, a smooth, solid column of sewage could be projected downward upon the dash plate without shifting or producing an erratic spray. In conjunction with a suitable wind shield, dash plates as small as 1 in. in diameter, with correspondingly small nozzle apertures, gave good distribution over a wetted area 10 ft. or more in diameter. The optimum size of plate required varied with the diameter of the nozzle and the head on the same.

Tests showed the nozzle and dash plate finally fixed upon to have a distribution coefficient of 0.85 in still air, using Phelps' formula. By so spacing the nozzles that the underwetted peripheral areas will suitably overlap, a coefficient in excess of 0.9 in still air is practicable. For use in an operative plant, expansion joints would be required for the supply piping, in order to keep the nozzles over the plates.

Soon after the downward jets were installed, a marked improvement was noted, samples standing up from 50 to 60 hr., but the degree of purification was still inadequate.

This test plant was at all times supplied with washwater from the killing floors containing large quantities of blood, some manure and small pieces of fat and tissue. The fat content was small, this being mostly confined to tank liquors and tripe washings, etc., which were not treated. The washwater contained much so-called colloidal matter that it was not practical to remove by plain sedimentation, and it has been proposed from the first to resort to chemical precipitation in case ordinary sedimentation failed to effect a sufficient clarification.

The septic tank was not seriously considered, as it rendered the sewage so foul that subsequent distribution on a sprinkling filter would give rise to a nuisance. Furthermore, the septic sewage was of such a character that nitrification in a sprinkling filter was not practicable, as was subsequently demonstrated by trial.

It having become apparent that plain sedimentation was not providing sufficiently complete clarification, chemical precipitation was tried. Laboratory tests indicated that aluminum sulphate was the best precipitant, and to this was added a limited amount of ferrous sulphate, which was found to retard putrefaction of the sewage and produce iron sulphide in the sludge. It was expected that this would tend to prevent the formation of H_2S at the operative plant and reduce the probability of odor nuisance in connection with sludge handling.

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*Of Hansen & Coulter, Consulting Engineers, 2 Rector St., w York City.

ANALYSES OF CRUDE AND TREATED SEWAGE FROM SLAUGHTER HOUSE AT BUENOS AIRES, ARGENTINA

ample	Color	Odor	Nitrites	Nitrates	Chlorine*	Free Ammonia	Albuminoid Ammonia	Total Solids Fixed	Total Solids Organic	Organic Nitrogen	Oxygen Consumed
w sewage..	Deep red	Putrid	0	Trace	7,384	6,755	110	27,080	25,300	4,400	1,100
k effluent.	Reddish brown	Slightly putrid	0	Trace	11,780	...	...	13,920	11,760	2,360	590
ter effluent	Light yellow..	None	21	231	12,560	840	126	42,280	3,900	520	130

*Chlorine was largely from NaCl in well water used for washing. Water from other sources quite free from NaCl was o used. The tank effluent and filtrate above represent well water, but toward the end of the day, when the raw sample s taken, water from other sources constituted a large percentage of the wash. It should be stated that these analyses do accurately represent the condition of the samples at the time they were taken. At least 21 hr. elapsed between sampling l analyzing, probably much longer, and this during very hot weather, without provision for chilling or chloroforming th aples.

Alum was applied at the rate of 1,000 lb. per 1,000,000 gal., with 200 lb. of copperas. The tank effluent at once showed a marked improvement and, soon after, a light, straw-colored, nonputrescible filtrate was delivered.

The sprinkling-filter effluent showed no putrefaction after incubation for 7 days at 37° C., when tested by the Government chemists, and stoppered samples, stored by the writer at room temperature, were stable for an indefinite period.

The plant continued to produce an effluent of this quality until operation was discontinued. It was found possible to increase the rate at the sprinkling filter to 700,000 gal. per acre per day (net) without deterioration. It should be noted that the plant rested from 6 p.m. to 6 a.m. each day, duplicating the operative conditions.

The accompanying analyses, indicating the work done by the test plant, were made by the chemists of the provincial health authorities at La Plata. The filter effluent is of unusual interest, in view of its high organic nitrogen content and passage of putrescibility tests.

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Drainage-Pump Foundation Design Is Dam Problem

By H. L. Hutson*

In a drainage-pumping plant, just as in a water-power plant, either the plant itself must form part of a dam or there must be a dam between the plant and its discharge channel or between the plant and its inlet channel. In water-power development the plant is usually located where there is a rocky formation in the stream and foundation conditions are apt to be favorable. But in the drainage plant the land is of recent formation and more than apt to contain stratified material such as vegetable matter, clay, silt, sand, shells, etc., none of which can be considered good foundation material.

Another difficulty to be borne in mind is that the drainage of the land within the district will alter the natural conditions by lowering the water level so that wood that has been preserved for hundreds of years may rot and quicksand that has been confined, or at least in stable equilibrium, may have a constant flow of water through it in the direction of the intake channel. There may also be a certain amount of hydrostatic head develop in porous or water-bearing strata so that it is undesirable to break the overlying impervious stratum because of causing springs, sand boils, etc.

Pumping Plant as a Dam; Curtain Walls

Not only the design of the foundations, but the location of the plant with respect to the levee, the elevation of the floor line with respect to high and low water levels, and the length of suction and discharge pipes will depend on the strata underlying the plant location.

One of the first requisites, therefore, in the design of a drainage-pumping plant is an accurate survey by borings of the plant site. Such a survey may indicate the desirability of looking for another site, but its chief need is to determine the location of the plant with respect to the levee and whether the plant itself is to act as a dam or whether the levee system is to be carried past the plant.

If there is an impervious subsoil that goes to a depth well below the greatest depth desired on the intake side, the plant itself may be designed as a dam and the suction and discharge pipes kept relatively short. Such a plant is shown in Fig. 1. This plant was located on what might be termed submerged prairie, where the subsoil was a stiff, impervious clay. The discharge canal was dredged across the plant site to a depth of perhaps 8 ft. below the floor line. The dam proper consists of an ample retaining wall on the discharge side of the plant. The foundations are tied into this wall, and the whole rests on round piles and is surrounded by sheetpiling that was used as a coffer-dam while installing the foundations.

If there is a porous stratum of moderate thickness, it may be shut off by a curtain wall or sheetpiling and the plant designed with short suction and discharge pipes and the plant itself as a dam. In this case great care is necessary to insure that the cutoff wall of sheetpiling or other material is in fact tight, that it is long enough to prevent seepage around the ends of the plant and that it makes an impervious joint with the underlying strata. The danger of this construction is that we cannot know to a certainty that we have cut off the flow, and there is a chance of gradual erosion undermining the plant and causing a failure after years of useful service.

Fig. 2 shows a plant where great care has been exercised to prevent danger from this cause. This plant was located on fairly firm ground, but where borings showed a stratum of porous material, such as broken shells, sand, etc., at a depth that would be exposed by the intake excavation. To prevent danger from this source, the plant was built within a permanent coffer-dam of Lackawanna steel sheetpiling, and wing walls of the same material were carried out from the corners of the building to serve the double purpose of cutting off seepage below and acting as a bulkhead above to prevent earth from falling into the intake. All these sheetpiles were 30 ft. in length. The concrete wing walls on the discharge side act as abutments for a bridge and are carried far enough to prevent wave wash from the discharge pipes. The space beneath the discharge pipes is filled with clay puddle.

Dams on Porous Foundations

If there is a porous stratum that will be exposed by the excavation of the intake canal or that may be exposed by subsequent scouring under the suction or discharge pipes, then the plant and adjacent levee should be considered as a dam on porous formation and designed accordingly.

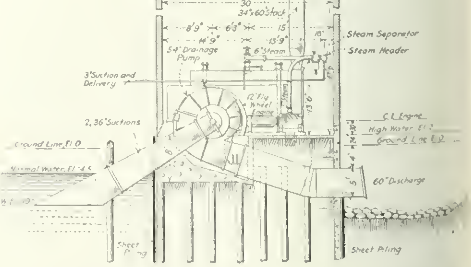

FIG. 1. ELEVATION OF WHITELAKE PUMPING PLANT

Reproduced from machinery manufacturer's layout and not intended to show actual proportion of foundations. Retaining wall at the front contains more concrete than indicated

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*A. M. Lockett & Co., Ltd., 533 Baronne St., New Orleans, La.

The proper rules for the design of such dams have been iven by W. G. Bligh (in an article in *Engineering News*,)ec. 29, 1910). The solution of the problem is to see that ie water which seeps through the porous stratum under a am has to travel a sufficient distance through this stratum or the friction to be great enough to prevent a flow of ater that would move the material of the stratum. Mr. ligh gives the following coefficients for the different orous material, where

H = Head or difference in water level above and below the dam;

L = Distance water would have to travel through porous material to render dam safe:

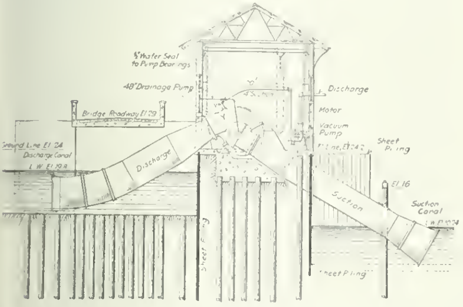
$$\frac{L}{H} = C = 18 \text{ for very fine sand and silt;}$$

$$= 15 \text{ for fine sand;}$$

$$= 12 \text{ for course sand;}$$

$$= 9 \text{ for sand and gravel;}$$

$$= 4 \text{ to } 6 \text{ for boulders and gravel.}$$



. 2. ELEVATION OF NEW ORLEANS LAKE SHORE CO. PLANT

As an example, we will assume a plant for draining irsh lands where test borings show muck, 2 ft.; soft clay, ft.; fine sand, 3 ft.; moderately hard clay, 8 ft.; and ernate layers of sand and clay for the next thousand t. Such a plant may have a normal lift of 3 to 6 ft. h a maximum at storm tide of 10 ft. From Mr. Bligh's le, 18 is the proper "percolation factor." We have for 10-ft. head condition that L = 180 ft. This means irly that there must be 180 ft. horizontal distance ween the end of the suction pipe and the end of the harge pipe unless some other provision is made for reasing the distance L that the water must travel.

As Mr. Bligh has pointed out, where a cutoff wall or of tight sheetpiling is used, the vertical distance that water must travel both down and up in order to pass und this cutoff wall may be added to the horizontal ance traveled in figuring the length L. This will re- e the actual horizontal distance between the ends of suction and discharge pipes. In the case of small nts with low lifts it would seem cheaper in many cases lepend only on the lengths of the pipes. In such a nt the use of moderately long suctions is advisable, as laces the plant some distance from the intake end . if the plant rests on piles, permits cutoff of these s at a higher level without danger of rot from the re- tion of water level within the district.

n a report[1] recently prepared by engineers of the United States Department of Agriculture the problem to be met and its solution are very well stated. Fig. 3 is reproduced from this report, which states:

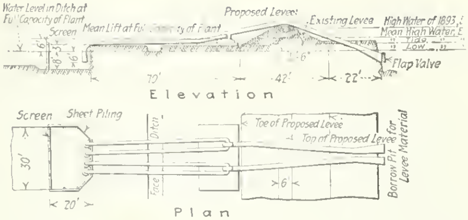


FIG. 3. COMBAHEE CORPORATION PUMPING PLANT

> Extensive borings in and around the pumping plant show that the first 8 ft. of material is a heavy impervious alluvial mud. This layer rests on a nearly level bed of fine, clean fairly sharp sand, which is very firm. It is believed that by placing the suction pit at a distance of 50 ft. from the pumping plant a greater protection from seepage will be assured than would be the case if the pit were placed adjacent to the plant and seepage intercepted by sheetpiling. According to the testimony of local parties, sheetpiling driven along the inside toe of the levee have been detrimental, as they have formed a channel for water to follow up through the impervious layer at the surface.

In this case it is evident that the sheetpiling around the intake pipes is intended only to prevent caving and would serve its purpose equally well were it equipped with weep pipes to prevent any water pressure behind it. Here, therefore, they depend solely on the horizontal distance between the suction and discharge pipes for resistance to undermining.

A condition where it is considered unsafe or undesirable to drive sheetpiles under a plant is unusual, but specifications were issued recently for a plant on the lower Mississippi where the engineer had such a wholesome fear of a known water-bearing stratum that he would allow no piles to be driven at all. In this case 100 ft. of discharge pipe was specified with 70 ft. separating the plant from the intake basin.

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The Future Supply of Gasoline was discussed by Van H. Manning, Director of the Bureau of Mines, in an address at Washington, D. C., on Oct. 4. Dr. Manning said we are facing a serious condition in the petroleum industry. According to the U. S. Geological Survey, our future supply of petroleum is only sufficient to last us from 27 to 30 years at the present rate of consumption, without taking account of the increasing demand due to increasing use of automobiles and other machines driven by gasoline engines. The low price of gasoline a year ago was due to the tremendous production of crude oil rich in gasoline from the Cushing field in Oklahoma. This field which was producing 300,000 bbl. of crude oil a day a year ago is yielding less than 60,000 bbl. today. Cushing crude oil yields 25 to 30% gasoline. Crude oils now being used in place of the Cushing oil yield but 15 to 17%. The 2½ million automobiles in use on Jan. 1, 1916, will increase, it is estimated by automobile manufacturers, to 4½ million by January, 1918. In addition, there is the increased use of gasoline in motor trucks, farm tractors, motor boats, etc. The automobile of today, due to improvements in the engine and carburetor, can use much heavier fuel than would have been practicable a year or two ago. The cracking process for converting kerosene and heavier oils into gasoline produced 2,000,000 bbl. of gasoline a year ago, and this year will produce more than 5,000,000 bbl. Tests made by the Bureau of Mines do not substantiate the claim that there is any considerable difference in the power developed from gasoline of different gravities. Tests in engines using gasoline from 71° to 60° showed a difference in the power developed of less than 2%. The engines using the heavier gasoline, however, were equipped to use it efficiently. If this is not the case, of course the lighter gasoline might give much better results. The Bureau of Mines is now preparing standard specifications.

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[1] "Report on the Drainage of the Combahee Corporation ds," by Charles W. Okey, Senior Drainage Engineer, and . Eason, Drainage Engineer

Water-Works Improvements at Sioux Falls, S. D.

SYNOPSIS—The new reservoir has novel floor construction and interior wells as its interesting features, and the new pumping plant is operated by oil engines that also drive electric generators.

Recent improvements to the municipal water-works plant at Sioux Falls, S. D., include a covered storage reservoir of 1,200,000 gal. capacity, two triplex pumps with 160-hp. Diesel engines and 135-kv.-a. generators, new electric lift pumps in the wells, and a 350,000-gal. elevated tank.

In 1915 the city authorities engaged Dabney H. Maury, consulting engineer, Chicago, to examine and report upon the water-works. His recommendations for improvements having been adopted, he prepared the plans and specifications. F. G. Gordon, as his resident engineer, supervised the entire construction. The city voted a bond issue of $140,000 for the improvement, and work was completed in April, 1916.

The city has a population of about 20,000, which is estimated to increase to 27,000 by 1930. At the time of Mr. Maury's investigation in 1915, it had about 42 mi. of 4- to 20-in. distribution mains, 3,581 service connections, 3,087 meters (91.5% of all active services being metered), 241 fire hydrants and 480 valves. The number of hydrants (about five per mile of main) was much too small for good fire protection. The average daily pumpage was 1,482,300 gal. and the maximum (for July) was estimated at 2,300,000 gal., while during sprinkling hours on the maximum day the water was being used at the rate of 4,400,000 gal. daily.

Water-Supply System

Sioux Falls was originally supplied by a private company, but some years ago the city built a competing plant, and the company was compelled to go out of business. The supply is obtained from wells in a water-bearing stratum of sand 20 to 30 ft. deep, which is covered by 4 or 5 ft. of loam and gumbo, and overlies a stiff, blue clay.

The quantity is abundant for many years to come, and the quality is good from a sanitary standpoint. The water is hard, however, and contains a large amount of iron (4 p.p.m.). The engineer recommended treatment for removal of the iron, and the authorities were strongly in favor of this improvement, but feared that if the cost of the iron-removal plant were included the bond issue might be voted down. The new reservoir, however, is built with columns of sufficient strength to support a treatment plant at some later time.

When first built, the city's plant took its supply by direct suction from a number of driven wells, but these proving inadequate, open wells were sunk. There are four open wells in the water-bearing stratum, located at distances of from 100 ft. to ¾-mi. from the pumping station on the outskirts of the city. Well No. 1 (at the station) is 25 ft. in diameter and 26 ft. deep. This was at first a supply well, but of late years it has served mainly as a pump well, receiving the water from the other three wells. No. 2 (1,600 ft. north) is 35 ft. in diameter and 28 ft. deep; No. 3 (2,400 ft. west of No. 2) is 50 ft. in diameter and 30 ft. deep; No. 4 (2,500 ft. west of No. 3) is 50 ft. in diameter and 32 ft. deep.

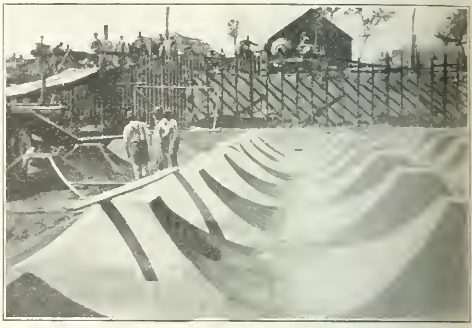

FIG. 2. GROINED-ARCH FLOOR OF RESERVOIR

The delivery to the pump well, No. 1, was formerly by siphon action, but to increase the supply the other three wells were later equipped with motor-driven centrifugal pumps. The pipe line has a rise of 27 in. from well No. 4 to the pump well. It is turned down to reach nearly the bottom of the latter well, and when the siphon is in operation a steam-driven vacuum pump is used to facilitate the siphon action by exhausting any air that may collect in the upper end of the pipe. The engineer recommended that the plant should be made capable of supplying for domestic purposes 3,000 gal. per min. distributed throughout the city at pressures adequate for lawn sprinkling on the higher parts of the city. Also that it should be capable of supplying for four hours for fire purposes 3,000 gal. per min. in the congested-value district, or 2,000 gal. per min. in the residence district.

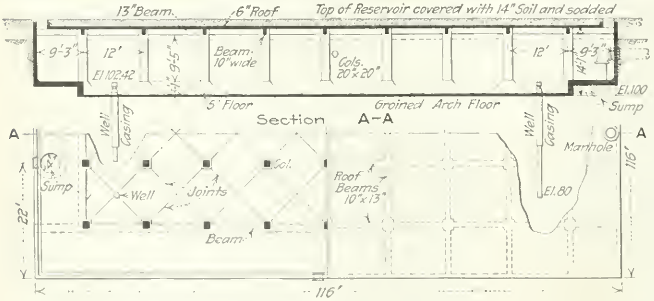

FIG. 1. RESERVOIR WITH GROINED-ARCH FLOOR FOR CITY WATER-WORKS OF SIOUX FALLS, S. D.
Note the wells in bottom of reservoir

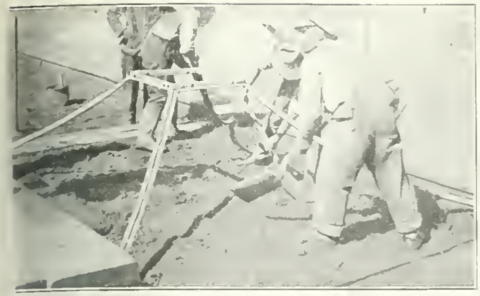

FIG. 3. FRAME USED FOR GROINED-ARCH FLOOR

The three supply wells noted could not supply ore than 2,000,000 gal. daily by siphon action alone, d the lift pump equipment in the wells was not satisctory. By placing adequate pumping machinery in ese wells, and drawing also upon well No. 1, it was timated that it would be possible to develop a supply 4,200 gal. per min. (6,000,000 gal. per day) even ring dry weather. This plan was adopted and each ll now has a vertical-shaft submerged centrifugal pump iven by a 20- or 25-hp. motor.

COVERED STORAGE RESERVOIR OF CONCRETE

To enable the wells to maintain a supply sufficient for and domestic requirements, a storage reservoir of 00,000 gal. capacity has been built near the pumping tion. This reservoir is of concrete, 116 ft. square, 10 ft. deep, with its top about 15 in. below the fin- d surface of the ground. As the bottom is below ground-water level, the floor is of the groined-arch in order to resist upward pressure. Columns spaced ft. c. to c. support a slab and girder roof. This res- oir was built by Fanebust Brothers, of Sioux Falls, contract price of $15,956. There were no extras. he construction of the reservoir is shown in Fig. 1. first portion built was a bottom slab 6 ft. wide on side, these slabs taking the thrust from the outer s of groined arches. The walls were then built, the ace of the construction joint being first thoroughly ned.

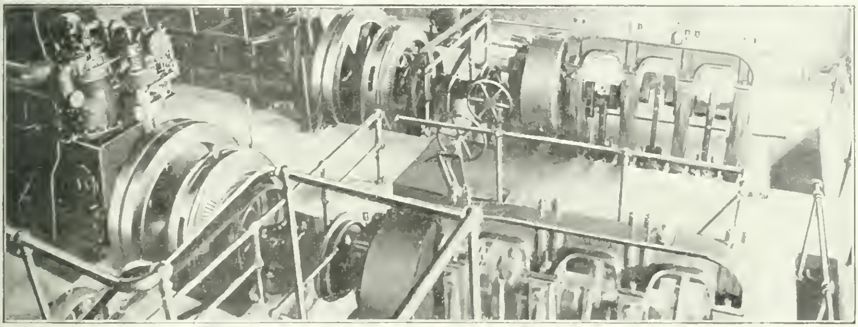

FIG. 4. PUMPING PLANT AT THE WATER-WORKS AT SIOUX FALLS, S. D.
Each unit consists of an oil engine at the left, a generator and a triplex pump

n building the floor, each column seat formed the er of a panel, which was in effect a truncated pyra- with curved faces, as shown in Fig. 2. The more usual practice has been to lay out the panels with dividing lines through the column seats. This method involves construction joints centering under the column. In other words, the column rests on a pedestal or footing divided in both directions by these construction joints. By the method described above, each column rests on the center of a solid block.

This method was devised by the contractor and was carried out by the use of light skeleton frames, as shown in Fig. 3. Each frame consisted of a top and bottom square frame of the size of the top and bottom of the block or panel, with four corner angles curved to the shape of the groined arch. These light frames were easily placed. Fairly stiff concrete was placed within them, and a wetter mix formed the surface, which was then screeded or struck to the required curved shape, using the corner angles of the form as templets.

The concrete was made in a mixer at the ground level and distributed by wheelbarrows, being dumped from the barrows into the forms. All reinforcing steel was cut and bent at the mill. The contractor used a commercial spacer for all bars in the roof, and special devices of his own to keep other bars in correct alignment. Excellent results were secured in this way. The excavation was done by slip and wheeled scrapers, which were driven up an inclined roadway and dumped the material into piles for future use in grading, etc.

The bottom of the reservoir excavation being about 3 ft. below ground-water level in the gravel bed while the work was in progress, steps had to be taken to enable the work to be done in the dry. The novel plan adopted by the consulting engineer was to drive within each corner of the site a 10-in. well extending about 20 ft. below the bottom of the excavation. These were blown out with a steam siphon to get them clear of sand, and were then connected to the main pumping plant, and pumped continuously. In this way they served the double purpose of lowering the water level during construction and affording an additional supply of water for the city. The wells proved sufficient at all times to keep the ground-water level below the bottom of the excavation, even after very heavy rains.

These wells are maintained permanently, and now serve the additional purpose of preventing excessive upward pressure on the floor of the reservoir. Each is fitted with a check valve which prevents the escape of water from the reservoir, but in case the water level in the reservoir should be lowered by heavy pumping, the ground-water pressure will open the valves and admit water into the reservoir.

Pumping Plant, Etc.

Previously to the new improvements, there were two steam pumping engines, each of 3,000,000 gal. daily capacity: A Holly vertical triple-expansion engine with surface condenser, and a Snow horizontal compound duplex engine with jet condenser. The latter is usually run noncondensing owing to the large amount of cooling water required to be taken from the mains. Connected to the distribution system was a standpipe and an elevated tank. The former was 115 ft. in diameter and 20 ft. high, of 275,000 gal. capacity. The old tank is of 230,000 gal. capacity, 29 ft. in diameter and 36 ft. high, on a steel tower with a height of 129 ft. from base of tower to top of tank. The tops of the standpipe and tank are at the same elevation, giving a pressure of 72 lb. at the pumping station. For the 108-lb. fire pressure the standpipe and tank are shut off by hydraulic valves controlled electrically from the pumping station.

The new oil-engine pumping plant will practically supersede the Snow engine. It consists of two Aldrich triplex pumps, each driven by a 160-hp. Diesel oil engine of the Busch-Sulzer type. The capacity of each pump is 1,500 gal. per min. against a head of 190 ft. for domestic service and 260 ft. for fire service. Each engine has a 135-kv.-a. generator mounted on its shaft, furnishing current to operate the lift pumps in the supply wells, the current for which was formerly purchased from a power company. These generators are also available for helping out the city lighting. The engine shaft is connected through a clutch coupling to the crankshaft operating the pumps.

The fuel oil is stored in two horizontal cylindrical tanks of 11,500 gal. capacity, housed in a separate building equipped with heaters. From these storage tanks it is pumped to a 30-gal. supply tank in the engine room. During the test the fuel consumption was 10 gal. per hr. with the pump delivering 1,500 gal. per min. against an average head of 170 ft. and the generator delivering 40 kw. This plant has worked very satisfactorily.

The 16-in. cast-iron delivery pipe from the pumps makes both a horizontal and vertical curve near its connection to the pumps. To prevent blowouts, all joints where the pipe changed direction were fitted with clamps and tie-rods.

A new steel water tower, built by the Chicago Bridge and Iron Works, supplements the old standpipe and tank. This has a 350,000-gal. tank with elliptical bottom on a six-post tower, the height being 96 ft. from top of pedestal to the flow line of the tank. A 6-ft. riser pipe supplies the tank.

Other improvements include about five miles of 4-in. to 16-in. distribution mains.

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Rules for the Use of the Dry Docks on the Panama Canal are published in the "Panama Canal Record" of Oct. 4. The new dry dock at Balboa is 1,000 ft. long and 110 ft. wide, with a depth of 35 ft. over the blocks at mean tide. The dock at Cristobal is 300 ft. long, 48 ft. wide, with a draft at mean high water of 13 ft. 6 in. over the blocks. The rates charged for use of the docks are at the Balboa dock 25c. per ton for docking and undocking, and 15c. for each lay day. At the Cristobal dock these charges are 15c. and 10c. In addition, minimum charges are fixed for vessels of small size.

Obsolescence in Appraisals for Rate Making

By C. C. Harshman*

To determine the amount of money that must in a year be set aside from the revenues of a public-servic corporation in order to secure the integrity of th corporation's investment and at the same time work n hardship on either consumers or the corporation becaus of excessive or of confiscatory rates for service, a carefu consideration is required of the rate at which the com ponent parts of the plant become unfit for further servic

Any given element of the plant becomes unfit f further service in two ways: (1) By physical deterior tion or wearing out; (2) by becoming obsolete—(a either through advances in the manufacture of mo efficient units so that it is unwise from an econom standpoint to longer operate the installed unit, (b) fro insufficient capacity due to large growth of the plan (c) through legislative action.

The general subject of depreciation has been discuss at great length by engineers engaged in valuation wor Probably most of the difference in opinion concernin and difficulty in handling, the subject is occasioned the fact that the distinction between true depreciati and obsolescence has not been recognized and kept mind, but those two elements have been lumped togeth for consideration and loosely termed depreciation. Sin true depreciation is a function of time and obsolescence not, the sum of the two is not a function of time, b varies from it just enough to cause different consider tions of it as a function of time to vary greatly. Obsole cence should be considered separately from deterioratio

Obviously, those who are consumers served by public-service plant should pay during the life of a piece or part of that plant, through the rates they a charged for service, an annuity that will have complete reimbursed the corporation, at the end of the element natural life, for the cost of purchasing, installing a removing[1] the piece or part that is being worn out.

Were it possible accurately to forecast the period usefulness of the different component parts of a pla this reimbursement could be easily accomplished. T length of time it would take any given part to beco unfit for use from wearing out can in general be qu closely estimated from past experience. It is, howev impossible to estimate with any degree of certainty t period within which that same part of the plant m become useless due to one or more of the last three caus

Thus it becomes necessary, is by no means unjust a is indeed exactly proper that the consumers for a giv time after a part has become useless from any of the three forms of obsolescence should pay, in their rat an annuity necessary to reimburse the corporation f such part of the expense of placing the supers element in service and removing it as has not been tak care of in the fund built up from the depreciati annuity allowance.

In this way during the time any piece is in usef service those who are consumers and are receiving t service that piece is giving are paying an annuity bas n the assumption that the part will have what might e styled "normal" useful life; and those consumers who eceive service after that piece has been replaced by nother better piece at an earlier time than the state f physical deterioration of the superseded part would ave necessitated and who thus receive the advantage, hrough rates or service or both, of the replacement re paying an annuity that compensates the corporation or the difference between the cost installed of the part uperseded, less whatever value it had as salvage, and he amount that had accumulated from the annuity payents during its life.

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*Valuation Engineer with H. T. Cory, Nevada Bank Buil ing, San Francisco.

[1] The cost of removing will be a credit if the scrap val exceeds the expense of taking out. In any event, this co should not go into capital account; otherwise the latter w depart from the true value of the plant.

As an example, consider that a piece of transmission ne had cost $1,000 and that, as a result of legislation, e poles and crossarms had to be replaced by higher oles and longer crossarms, but that the wire was fit r further use reinstalled on the new line. Suppose e original cost had been subdivided into poles, crossrms, etc., $600; wire, $400; total cost installed, $1,000. urther, consider that the normal useful life of these o parts had at the time of installation been so timated that, at the date of the change, the sums llected from the annuities covering these items amounted ith interest to $500 and $150 respectively. Thus the -called "present value" of these at the time of reconruction—taking "present value" as the difference been "original cost" and "amount in fund"—would be 00 and $250 respectively. As a measure of actual esent value these figures are subject to criticism, but ey do represent the portion of the original expense installing these items for which the corporation has t been reimbursed. The company is fairly entitled to me arrangement that will reimburse it.

Consider further that the new line cost, exclusive of wire, $850 and, for simplicity, that the scrap value the poles, crossarms, etc., just equaled the cost of noving the old line. The condition is then:

	Original Cost	Amount in Fund	Original Cost Less Amount in Fund	Cost New Line
les, crossarms, etc...	$600	$500	$100	$850
re ...	400	150	250	250
	$1,000	$650	$350	$1,100

The proper procedure would be to credit capital with $1,000, or if the depreciation had been annually dited to capital, with the $350. The capital account uld then be charged with $1,100, being the cost of new work. The obsolescence fund should be charged h $100, being the original cost less salvage value, nus the amount in fund, or ($1,000 — $250) — $650 $100.

The obsolescence annuity must be such that the same e of interest can be paid on the obsolescence fund as used in making up the allowable rate of return on capital invested, in addition to whatever part of the d it is desired to retire during that year. In case conditions are such that only a very small annuity be set aside annually, it simply means that the ortization of the obsolescence fund will be spread over reater number of years. As the number of years over ch the amortization is spread is increased, the conon, as far as the rates to be charged are concerned, roaches that which would be in effect if the obsoence fund had been charged to capital. The limiting ditions are:

. Where the business is so prosperous that all of the d can be charged off with interest in a single year which is equivalent to charging the obsolescence into operating expenses, which is frequently done.

2. Where only the interest on the obsolescence fund can be carried by the rates that are possible—this is equivalent to charging the obsolescence to capital, as is also sometimes done, with the very important exception that, when the business has become such that more than the interest on the obsolescence fund can be paid, the fund itself may begin to be charged off and not, as if it were charged to capital, be a penalty for all time against the rate payers, interest on which they must always pay.

When a new company is unable to earn its full just rate of return, the difference between the amount that it does earn and the amount that it is entitled to earn is charged to capital under the head of development expense, or some such item. Similarly, if there cannot be provided from the rates possible at a given time an annuity sufficient to pay even the full amount of interest on the obsolescence fund, then the difference between that interest which is paid and that interest to which the fund was entitled must be charged into the fund itself, to bear interest at the same rate. When the business of the company improves, the annuity may be increased sufficiently to retire the fund.

This last phase of the matter is in individual cases frequently of great importance. In certain instances the opportunities for increasing the sales of the commodity are at present limited, but will at some future time be large enough to yield substantial profit. At the same time, much inefficient and obsolete equipment may now be in use which for economy's sake should be replaced at the present time. In such cases it might well be possible that rates which would provide for amortizing such obsolete equipment at present would be prohibitive, killing off what meager business the utilities might now have. However, this is no reason why obsolescence should be charged into capital for rate payers to pay interest on for all time. Nor is it, either, any reason why the utility should lose the money remaining in the investment, which was, when made, strictly in accordance with what was considered at that time good engineering practice.

By charging the obsolescence into the obsolescence fund and disposing of it as suggested, with whatever rapidity a careful investigation might indicate advisable, both of these errors, the one unfair to the rate payers, the other to the utility, would be avoided.

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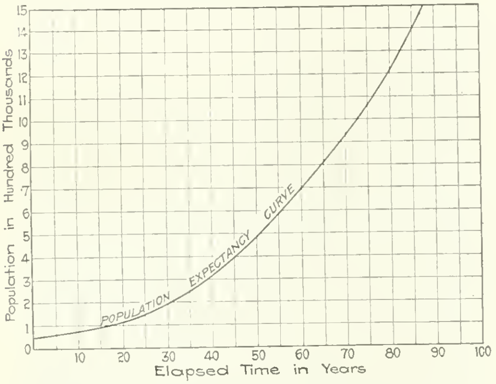
A Ladder Dredge for Excavating Snow on the line of the Chilean Trans-Andean Ry. has been designed by William T. Lucy, of the road's engineering staff, and was described by him in a paper entitled "The Working of a Rack Railway" read before the Institution of Civil Engineers. This railway is already equipped with a Leslie rotary snow plow built by the American Locomotive Co., but Mr. Lucy states that in deep cuts when the snow is filled in to a greater depth than 15 ft., the Leslie plow does not work well, as snow has to be shoveled off by hand from the top of the cut. More serious trouble is experienced when a deep cut is filled with snow by an avalanche, as pieces of rock are often brought down with the snow and cause much damage when struck by the rapidly moving blades of the rotary excavator. Mr. Lucy has therefore designed a snow-clearing machine consisting of two parallel ladders carrying endless chains of buckets of the pattern usually employed for excavating stiff clay. The snow excavated by these buckets is discharged into a hopper, from which it is discharged by gravity upon a centrifugal ejector which throws it either to the right or left of the track as required. The approximate weight of the machine is about 60 tons. The Chilean Trans-Andean Ry. has not yet been financially able to purchase the machine, but intends to try it as soon as circumstances permit.

Population Studies by Moore Expectancy Curve

By George Holmes Moore*

What the author has named the Moore expectancy curve is a graphical representation of the population a city may be expected to have after any given elapsed time in years. The curve is derived by plotting on cross-section paper the actual populations of selected cities after equal periods of elapsed years, ignoring exact dates and choosing such values for "elapsed time in years" as may enable the respective curves to conform most nearly to a final mean value for the group. After the several curves have been plotted, the mean or composite curve is sketched in. This alone is traced off on transparent paper, as shown in the accompanying diagram, for use by itself or for superimposing upon other curves for various comparative purposes.

To illustrate a simple use of the curve: Suppose one desires to obtain the most probable population that a city of 500,000 will possess after a lapse of 20 years. It is necessary only to mark the 500,000 point on the expectancy curve, add 20 years to the elapsed time, which in this case will give a final of 71 years, and read off 960,000.



MOORE EXPECTANCY POPULATION CURVE
On the original each year and each 10,000 population were shown

The method can be used in almost every problem that involves either population estimate or population analysis. It can be used to predict the most probable population of a city of any size whatever at any given future time. Or, on the other hand, by comparing the plotted curve for any city with the expectancy curve it becomes evident at a glance whether the city in question is growing, or has grown, faster or slower than the average of its class.

Finally, it will be evident after a little reflection that analyses based on the expectancy-curve method are exactly as reliable as are insurance risks written on the basis of mortality tables. And since by its use the three quantities of maximum, minimum and mean populations to be provided for are readily obtainable, it is claimed that the expectancy curve provides a thoroughly defensible method—possibly the first—for the exact analysis of population problems.

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*City Hydrographer, Seattle Wash.

Experience in Paving Roads of a Washington County*

By David H. White†

Pierce County has 64.39 mi. of hard-surfaced roads, completed and under construction, exclusive of macadam roads, which method of construction has been found unsatisfactory and has been abandoned. There are seven different types of pavement: Granitoid, sheet asphalt, one-course concrete, Bitulithic, Warrenite, brick and Bitucrete. In order to determine which is the most economical and satisfactory, a complete permanent cost record is kept of both construction and maintenance on each contract section. All the pavements are constructed without bonded or other indebtedness.

Some of the items kept on record as a part of the cost sheet are: Cost of common labor per day; cost at mill of cement and freight on cement; cost of gravel at bunkers and freight on gravel; cost of sand at bunkers and freight on sand; cost of crushed rock at quarry and freight on rock; asphalt f.o.b. Tacoma and freight on asphalt; traffic census; condition of pavement; probable life of wearing surface; ultimate renewal value per square yard; cost of right-of-way; probable annual maintenance per square yard.

Remarks on Various Types of Pavement

Granitoid Pavement—Pierce County has 8.009 mi. of Granitoid, costing $1.40 per sq.yd. without subgrade and extras. This pavement consists of 4½-in. concrete base of 1:3:6 mixture and a 1½-in. top of 1:1½ mixture, the stone in the surfacing being: 50%, ⅜-in.; 25%, ¼-in.; 25%, ⅛-in. All smaller material is removed. From present indications this pavement is not equal in value to our best one-course concrete pavements, costing considerably less, and is not recommended in future construction.

One-Course Concrete—There is 21.8501 mi. of one-course concrete paving, costing exclusive of subgrade and extras, 85.6c. per sq.yd. In addition to this we are now building 1.836 mi. in conjunction with the Western Washington Hospital for Insane. A number of paving methods are being used in this pavement, the idea being to experiment with all the different approved types of construction so as to determine the best. One method being tried is that used in Sioux City, Iowa, described in *Engineering News*, July 27, 1916.

In repairing concrete pavement where holes have appeared all loose concrete was removed and the edges were squared up so that the sides were perpendicular; then an additional 2 in. was excavated, making a depth of 7 in. The hole was cleaned out and the bottom thoroughly tamped with a 50-lb. tamper. Crushed rock varying from ¾ to 2½ in. in size was well tamped into the hole and coated with approximately 1½ gal. of "D" asphalt per square yard, after which a second layer of crushed rock of sufficient depth to bring the surface to grade, after tamping, was placed and coated with approximately 1 gal. of asphalt per square yard.

The patch was covered with screenings and left for traffic to pound down for a couple of days, after which it was swept clean and 1 gal. per sq.yd. of "E" grade asphalt was spread and well coated with screenings. The ock used was thoroughly dried on a half-section of metal ulvert pipe over a fire.

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*Based on a paper read before the meeting of the Washington Association of County Engineers, Sept. 14 to 17, 1916

†County Engineer of Pierce County, Tacoma, Wash.

The cost of repairing 571 sq.yd. in this manner was 1.49 per sq.yd. This was done by county forces. A imilar kind of patching was done by one of the asphalt ompanies at a cost of $3 per sq.yd.

The one-course concrete pavements hitherto laid in this unty have practically all been built under two different ecifications, one being a 1 : 2 : 4 mix on a curved subrade and 5 in. thick, the other a 1 : 2 : 3½ mix with a at subgrade and a thickness of 5 in. at the edge and in. at the center. The latter construction has proved far superior to the former that we do not consider sing the older specification.

Monolithic Brick—This office has abandoned the oldyle specifications for brick pavements, which usually ovided for a 1½-in. sand cushion between the concrete se and the brick. We now specify only the monolithic nstruction, wherein the brick is laid directly on the esh concrete without the intervening sand cushion. The se course of concrete is laid; and immediately before e concrete begins to set, a ½-in. layer of sloppy 1 : 3 ortar is spread over the fresh concrete. The bricks are id directly in this mortar, leveled by light tamping and outed with a 1 : 1 mixture.

Pierce County has 0.744 mi. of brick paving (on sand shion) costing $1.79 per sq.yd. exclusive of subgrade d extras.

Bitucrete—We are now building 6.066 mi. of Bitucrete ving on the National Park Highway, or Mountain ad, at a contract price of $1.29 per sq.yd. exclusive subgrade and extras. A 1 : 3 : 6 concrete base 5 in. ck is used, and on it asphalt heated to from 200° to 0° F. is spread evenly to a sufficient depth to give the antity of asphalt required to fill the voids in the gregate, which consists of rock or gravel passing a -in. ring, and clean and well-graded sand mixed in the portion that will obtain maximum density and low centage of voids.

This aggregate is heated in a drier to a temperature ficient to melt the asphalt and draw it up by capillary raction. The heated aggregate is spread over the halt to such a depth that, after firmly compacting it rolling, the wearing surface is 1 in. thick. After the halt has been liquefied and drawn up by capillary attion, the pavement is again rolled with a five-ton roller til there is no appreciable compression. A flush coat hot asphalt is then applied, on which fine aggregate ated to between 300° and 400° F. is spread, and the ement is again rolled.

Sheet Asphalt—Pierce County has 8.17 mi. of sheethalt paving, the average cost without subgrade and ras being $1.587 per sq.yd. A portion of this pavent 1½ mi. long became so slippery after every light n that hundreds of accidents occurred, and five pers lost their lives.

To remedy this condition the pavement was covered h Roadamite and sand. No trouble has been reported e. The 90% Roadamite was used, ¼ gal. per sq.yd. ng applied with a pressure distributor. The oil was ted to from 250° to 350° F. The entire surface was n sanded with coarse washed sand, using 1 cu.yd. to ut 108 sq.yd. of pavement. This treatment cost 6½c. sq.yd.

The Roadamite had the following analysis: 90% residue had a penetration of 77 at 70° F.; Osborne test for adhesiveness, 1,290 sec.; flash point, 338° F.; burning point, 415° F.; solubility in carbon tetrachloride, 99.9%; solubility in carbon bisulphide, 99.9%.

Bitulithic and Warrenite—There are 15.5448 mi. of Bitulithic and 3.709 mi. of Warrenite, costing respectively, without subgrade and extras, on an average of $1.377 and $1.48 per sq.yd.

The foundation was crushed rock, macadam, concrete or what is known as "black base," an asphaltic concrete. The difference between Warrenite and Bitulithic is slight, some of the specifications being identical, with the exception that not to exceed 25% of gravel is to be used in the Warrenite pavement. The Warrenite is usually the cheaper pavement.

GRAVEL AND EARTH ROADS

Pierce County has about 200 mi. of earth roads, the average cost for construction in 1915 being $1,156 per mi., and about 300 mi. of graveled or spread crushed-stone roads costing in 1915 an average of $1,850 per mi., of which labor was 89%, powder 6% and culvert pipe 5%. The average cost of grubbing in an ordinary timbered country was about $170 per acre for a number of jobs in this vicinity. These roads were built from 12 to 24 ft. in width, with a crown of 1 in. per foot of width, particular care being taken to provide good side ditches for drainage. Deep ditches, being dangerous to traffic and easy to fill up, are not recommended, and wide shallow ditches are required. Corrugated-metal culverts are allowed in remote districts, but in all paving contracts concrete pipe is specified.

A grading machine propelled by horses gives very satisfactory results and costs on our prairie soils or similar locations about $150 per mi., but in many cases where a steam roller is the tractive power better results are gained on account of the compacting power of the roller. Where a road is well shaped, the steel drag is used to preserve the crown of the road and keep the surface free from ruts.

The best piece of earth road discovered in this vicinity is a stretch of the National Park Highway between the Mashel Bridge and La Grande. This road is in fine condition during both winter and summer, with but little maintenance. In collecting material for graveling the road a portable sand tester was used and has been found very satisfactory. An analysis of the surfacing material in this road, made with the portable sand tester, gives the following results:

SAND FROM LA GRANDE—MECHANICAL ANALYSIS

Pass No.	Pit, % Passing	Road, % Passing
200	4.1	6.4
100	8.0	8.1
80	6.6	4.7
50	16.3	7.4
40	13.1	6.9
30	10.2	6.5
20	14.7	12.1
10	14.5	12.7
8	2.6	3.4
4	5.2	9.5
2	3.5	8.3
¾-in.	1.2	5.7
....	100.0	
1-in.		....
1¼-in.		1.9
1½-in.		6.1
		100.0

Testing Laboratory—Pierce County has a testing laboratory for the purpose of testing cement and bituminous mixtures and making volumetric analyses of sand, gravel and crushed rock. This department has proved itself very successful and satisfactory.

Notes from Field and Office

Keeping clearance unobstructed while building a concrete crossing—Bending expanded metal on job—In Octob rails were oiled on 950 miles of track to prevent corrosion—A canvas coffer-dam—How 41 railways handle small concrete jobs—Culvert for 150-ft. fill—Fill shrinkage

Arch Centers Suspended from Old Plate Girders

In the construction of a reinforced-concrete arch bridge crossing over the Lackawanna R.R. at Millburn, N. J., the right-of-way was kept clear of falsework by suspending the arch forms from plate girders spanning the abutments. This part of the line is subject to very congested commuting traffic in morning and evening on all three of the tracks, so that it was highly desirable that the usual falsework posts be omitted. Rather than use steel arch centers (which would reduce the top clearance to dangerous limits) or attempt to space falsework posts for clearance, the engineers decided to suspend the forms from above, utilizing an abandoned plate-girder bridge that could readily be brought to the site.

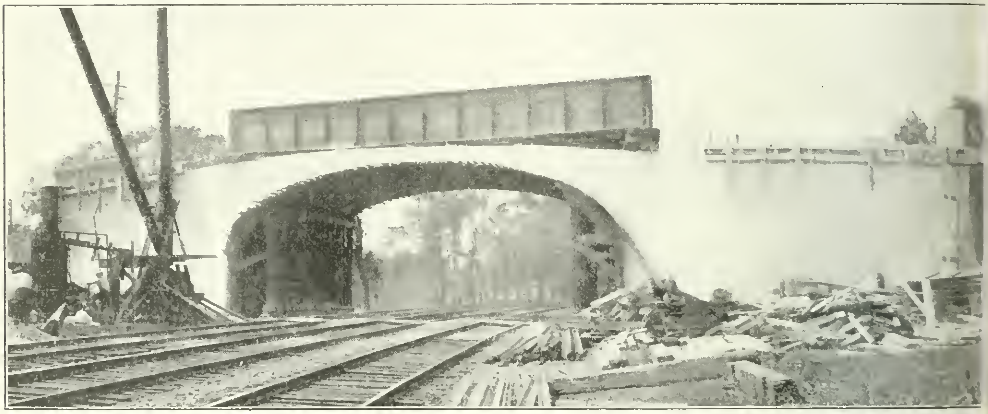

FIG. 1. OVERHEAD BRIDGE ON LACKAWANNA R.R. CONCRETED IN SUSPENDED FORMS

The accompanying views and sketch show the details of construction. The arch is on a skew with a single rib carrying an earth fill between gravity spandrel walls. The abutments and the arch were constructed first, the arch being carried up to the limit of its overhang on segmental forms supported from struts footing well outside the outside tracks. The arch rib was finished here with jogged skewbacks normal to the line of thrust. The intervening section, 45-ft. span, was carried by the suspended centering.

On the abutments there were then placed the four plate girders. Each girder was about 60 ft. long and 6 ft. deep. The outer two were blocked up on the side walls of the abutment and the middle two on piers purposely cast on the slope of the abutment. After the girders were up, their floor-beams were bolted in place in the outside two of the three openings; on their lower flanges 12x12-in. timber stringers were rested, four stringers to each of t three floor-beam openings. In the middle opening, timl cross-beams resting on the flanges of the main gird were used instead of the steel floor-beams. This arran ment is shown by Fig. 2.

The stringers acted as the main carriers of the cent ing, which consisted of 3x3-in. angles shaped to the a curve and running lengthwise of the bridge. These w hung from the stringers by $\frac{3}{4}$-in. rods spaced about c. to c. and carried transverse 2-in. lagging, which additionally held by spiking on crosspieces and bra The suspender rods were covered with tubing so that could be readily removed when the arch concrete reached a proper set.

The method proved very successful, and more nomical than using steel ribs embedded in conc

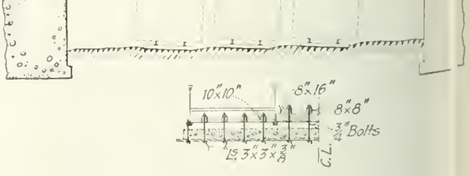

FIG. 2. DETAILS OF METHOD OF SUPPORTING MILLB ARCH ON SUSPENDED CENTERS

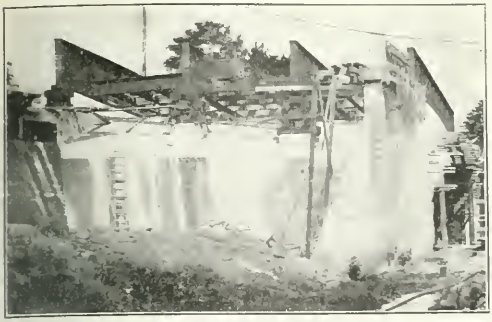

FIG. 3. VIEW IN REAR OF MILLBURN ARCH

considering the high cost of such steel at the time this work was done. The proper curve could be readily controlled by the screws at the top of the suspender rods and the arch easily sprung by the same method. It was found that the suspension girders were somewhat too close to the top of the rib for easy concreting, but this is a matter of detail that can be corrected in future similar work.

The bridge is being built for the Lackawanna R.R., George J. Ray, Chief Engineer, by James A. Hart, contractor, of New York City. G. B. Barackman was assistant engineer in charge of construction, under G. T. Hand, division engineer. A. B. Cohen was designing engineer.

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Expanded Metal Bender Built on Construction Job

By P. Beall*

The accompanying drawing and view illustrate a bender for rib metal reinforcement used in a recent building construction job. The floor was of concrete incased I-beams with the 6-in. slab reinforced with No. 3 rib metal, 18 in. wide and 18 ft. long, bent 3 in. over the top of each I-beam, requiring 16 bends to each piece.

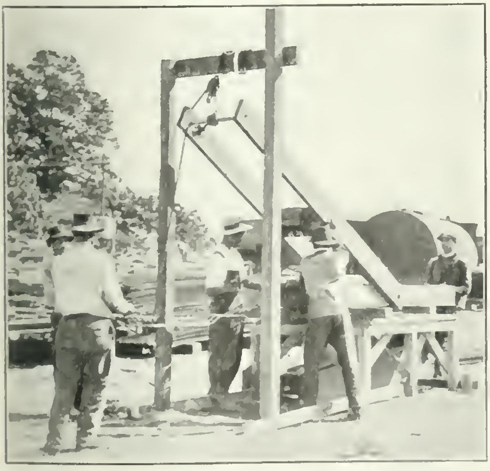

FIG. 1 METAL BENDER IN OPERATION

The body of the bender consisted of two 2x8-in. planks 8 ft. long separated by three 8x8-in. blocks 21 in. long and 4 ft. on centers, all well spiked together. The bender was made of an 8x8-in. crossblock 25 in. long, swinging on two 2x8-in. handles 11 ft. long and pivoted at the center of the middle block of the body on ¾-in. lag screws. The bender on the handle cleared the anvil on the body by ½ in., and the corners of the bender and anvil that did the shaping were protected with 1½x1½-in. angles. Over the anvil block on the body, where the shaping took place, an angle was set 1 in. off the top, so that the metal sheet could be slid under. This was held by ½-in. screws at each end, and one end was slotted so that it could be swung to one side while the sheets of reinforcing were being turned over. The bender was built 3 ft. off the ground on a frame for convenience of operation, and another frame was built from which the handle could be raised by block and fall.

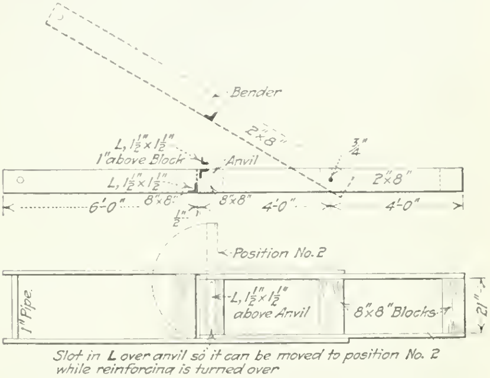

FIG. 2. DETAILS OF MACHINE FOR BENDING EXPANDED-METAL REINFORCEMENT

In operation the momentum of the block falling 2 ft. was sufficient to bend sheets, the number of blows depending on the angle of bend wanted. On account of the 16 bends it was necessary to turn each piece over eight times. After the gang was organized, the average cost of bending per sheet was 12c.

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*223 West 78th St., New York City.

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Oiling Rails and Fastenings To Prevent Corrosion

The corrosion of rails and fastenings due to the brine dripping from refrigerator cars has been an increasing trouble for some years, and although the Master Car Builders' Association has taken some steps to check this dripping the condition still continues. The damage and destruction to track by such corrosion as well as by that due to weather conditions is an important item in track maintenance cost and is especially serious where high-priced materials and devices are used in the track.

About three years ago A. J. Neafie, Principal Assistant Engineer of the Delaware, Lackawanna & Western R.R., undertook to meet this problem of protecting the track by spraying oil upon the rails and fastenings. Experi-

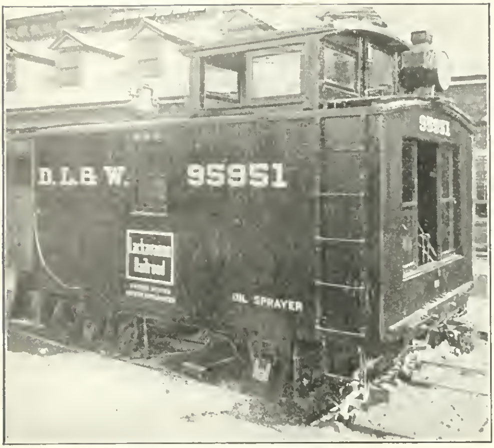


FIG. 1. CAR FOR SPRAYING OIL ON RAILS AND TRACK FASTENINGS

ments were made with hand-operated apparatus mounted on a flat-car, and the results were so satisfactory that a special car has been built for this service.

The track-oiling car resembles a four-wheel caboose and has the front end open for the observation of the operator, who controls the oil feed and the raising and lowering of the spraying apparatus by means of a series of air valves. In front of each forward wheel is a forked pipe with ends bent so as to discharge a spray against either side of the rails and joints and down upon spikes and the plates. A shield covers the top of rail head, and behind each wheel is a wiper or pad clean the rail head) and a sand pipe. The car is coup at the head of a train of oil tank-cars (or a single ta car), and the train is pushed by a locomotive, the oil car being fitted with a bell and signal whistle. work is done at a speed of 20 to 30 mi. per hr., using to 125 gal. per mi.

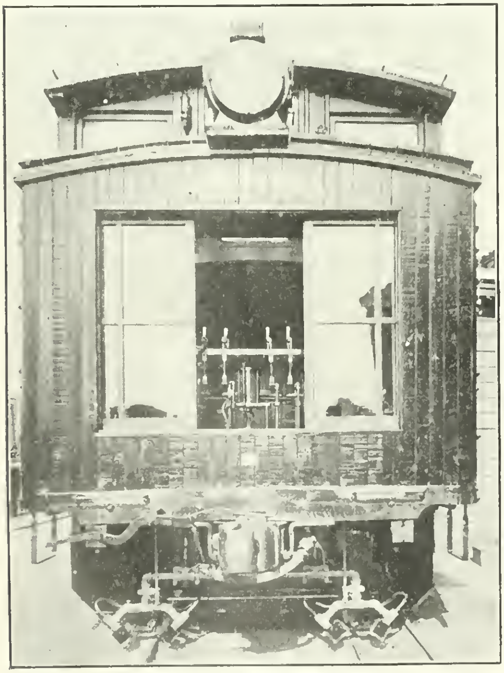


FIG. 2. FRONT OF OIL-SPRAYER CAR, SHOWING NOZZLES AND CONTROL LEVERS

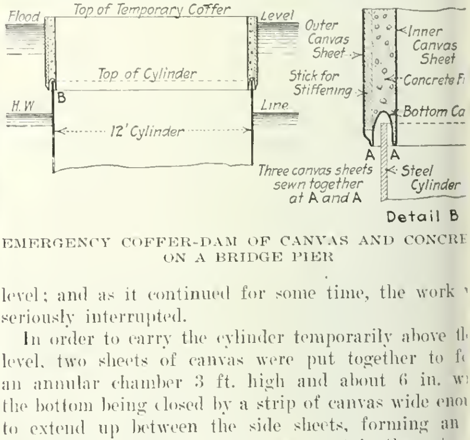
The oil pipe is 2 in. in diameter, and ½-in. air pi are led from a receiver to the nozzles, with a pressure 30 to 40 lb. for spraying the oil. A 2-in. pipe conn the outlets of the tank-cars, this being laid along frames or running boards. A ½-in. air pipe is led al the train and tapped into the dome of each car, to f nish pressure (30 to 40 lb.) for forcing out the Live steam or the exhaust steam from the air pump is to the heater coils in the tanks, giving the oil a temp ture of about 150°. Valves provide for connecting or ting out any oil-car as desired. A heavy oil is used its adhesive properties.

About 800 mi. of track was oiled in this way in Octo 1915 (with the hand-operated apparatus), and the car oiled about 950 mi. of track during October, 1 The cost for oil, operator, engine and crew, etc., is ab $4 per mi. Mr. Neafie, who has furnished the informat as to this interesting feature of trackwork, states t the results are beyond the original expectations.

⁂

Emergency Canvas Coffer-Da

An emergency coffer-dam of canvas and concrete an interesting feature in the construction of a 92 Strauss bascule bridge over the inland-waterway cana Coinjack, N. C., for the United States Government. piers were 12-ft. steel cylinders, having their tops 2 above the normal high-water line. During the floods the spring of 1915 the water rose nearly 3 ft. above t



EMERGENCY COFFER-DAM OF CANVAS AND CONCRE ON A BRIDGE PIER

level; and as it continued for some time, the work seriously interrupted.

In order to carry the cylinder temporarily above th level, two sheets of canvas were put together to f an annular chamber 3 ft. high and about 6 in. w the bottom being closed by a strip of canvas wide eno to extend up between the side sheets, forming an verted trough. Vertical sticks were set in the outer thus formed, to keep the canvas in shape. Then canvas cylinder was sunk to rest on the top of the s cylinder. When the canvas was wet, it shrank so t the "trough" closed up and gripped the top of the st The space between the canvas sheets was then filled w concrete.

After the concrete had set, the interior of the cylinder was pumped out, and the work of filling it with concrete was commenced. There was no leakage at the connection of the permanent and temporary cylinders.

The bridge was built by the Penn Bridge Co., of Beaver Falls, Penn., and the emergency work described was devised by W. J. Howard, superintendent in charge.

⁂

Concrete-Lined Oil Reservoir

An earth reservoir with 3-in. concrete lining has been built by Bent Bros. at El Segundo, Calif., for the Standard Oil Co. This reservoir, which will be used for oil storage, is 460.5 ft. in diameter at the top and 403 ft. at he bottom, the width of the bank at the top being 15 ft. Both slopes are 1½ to 1. The total depth is 19 ft. 2 in. The reservoir is built in sandy loam formation, and durng the construction the banks were sprinkled and rolled until they were solid.

LAYING CONCRETE FLOOR OF OIL-STORAGE RESERVOIR AT EL SEGUNDO, CALIF.

The accompanying view shows the floor under contruction. This is 1 in. thick and reinforced as shown. The capacity of the reservoir is 550,000 bbl.

⁂

Experience of 41 Railways in Small Concrete Jobs

The economical handling of concrete on work not exeeding 200 cu.yd. in volume was the subject of an inestigation by a committee of the American Bridge and Building Association during the past year. The committee members are L. D. Hadwen, J. W. Wood, C. F. Green and G. H. Stewart. Information was obtained rom 41 railways, having a total mileage of 127,500. A ummary of these replies shows that 31 railways, repreenting a mileage of 100,280, handled their small concrete ork with their own forces, while only two of the roads, aving a mileage of 2,839, handled such work exclusively y contract. The question of safety and a desire to have he company's own employees handle construction under perated track or in the yards and shops have an imortant influence in eliminating contract work.

In regard to organization, 25 of the railways employ ivision forces, while 11 report a departmental organiation. The supervision is generally furnished by master rpenters or division superintendents of bridges and uildings, and in some instances by the assistant engineers the engineering department.

The rates paid, of course, vary largely according to the ection of the country, the rate for laborers running from 13½ to 25c. an hour; for carpenters, from 21 to 35c., while foremen are paid from $90 to $100 a month. The size of the gang varies from six to twelve men, with one or two carpenters and a foreman. It is difficult to get adequate carpenter help on work of this kind, and a larger proportion of carpenters in a crew would promote the economy of the work, could they be obtained.

Of the 41 roads, 31 indicate that they are able to organize the work so as to admit of a regular program through the season, while five are unable to do this. Three handle work of this kind by means of regular floating gangs. In most cases a program is mapped out in the spring, and forces are organized to cover the season's work. A good way of taking care of such small jobs would be to have a crew organized under the district authority to take care of the work on each district or division, where the volume of work makes this justifiable. Some roads keep a regular gang all the year handling this class of work and moving from one division to another. A feature called attention to by the Nashville, Chattanooga & St. Louis Ry. is the use of suitable boarding cars for the crews. In the matter of providing material there is considerable divergence in practice. Local aggregate is used by 23 roads wherever possible. Generally, material for structures on the line appears to be handled by way freights. Where crews can be combined and material ordered sufficient for a day's work-train service, it is preferable to handle the material for three or four jobs rather than handle it by regular train with a small force.

AVERAGE COST AND THE TOOLS REQUIRED

The cost of this class of work varies with conditions. Prices were quoted of $5 to $8 per yd. for mass work and $7 to $20 for reinforced work. As to a list of tools considered essential for a small concrete outfit, the following, submitted by the Chicago, Milwaukee & St. Paul, is regarded as typical:

1	Concrete mixer
10	Wheelbarrows
1	Cant hook
50	Ft. 1-in. water hose
1	Small track-jack
1	Combination vise
1	Hand axe
1	Double bit axe
1	Sheetpile pounder
1	Timber bar
1	Crosscut saw
1	No. 4 sand screen
12	D. H. S. P. No. 2 shovels
6	Pairs knee boots
1	D. H. spade
1	8-lb. sledge
1	16-lb. sledge
1	8-ft. straight-edge
1	Grindstone and frame
4	Clawhammers
4	Pairs carrying hooks
2	Heavy mortar hoes
2	⅞-in. bridge augers
3	Tubular lanterns
1	Single bit axe
2	Water barrels
6	Heavy galvanized water pails
1	Gasoline diaphragm pump
1	Pinch bar
2	Combination nail pullers
1	Measuring box
1	Tool box
1	Steel broom
3	Common brooms
1	Stone-mason trowel
1	16-ft. straight-edge
1	Plasterer's trowel
2	Pairs wire pliers
200	Ft. 1-in. line
6	Track chisels
2	12-in. monkey wrenches
2	18-in. pipe wrenches
1	Set 8-in. double blocks for 1-in. line

In most cases the carpenters are required to furnish their own tools, but it is economy to have a liberal supply of hammers, saws, etc., on hand, so that laborers can be pressed into service for sheathing the forms, etc., when they would otherwise be waiting. For crews making frequent moves a tool car is worth having.

The size of mixer recommended shows considerable variation. Only six railways stated a preference for hand mixing for small work; 16 recommend mixers of from 6 to 9 cu.ft. capacity, unmixed charge, which corresponds to a one-bag batch mixer. A ½-yd. or two-bag batch mixer is preferred by eight roads, while two use ¾-yd. machines.

Opinions as to the smallest job on which the use of a mixer is justifiable vary widely. Four roads use some form of mixer for quantities as small as 5 yd.; six would use one where the quantities are from 10 to 30 yd.; five set 50 yd. and six 100 yd. as a minimum.

⁂

Building Culvert for 150-Ft. Fill

A 5-ft. concrete arch culvert 533 ft. long is being completed on the Southern relocation in Georgia, just south of Toccoa. The unusual length of the culvert is explained by the fact that the fill will be 150 ft. high by 530 ft. wide at the base. The culvert is built almost (85°) at right angles to the center line of the fill. The wall is 4 ft. thick at the floor and 2 ft. 10½ in. at 1 ft. above springline. The concrete above springline is 1:2:4; below springline, 1:2½:5. Granite screenings are used instead of sand. In the early part of the work the contractor, C. W. Lane & Co., was not permitted to use granite screenings, but following tests which showed concrete containing them to be stronger than concrete with sand, these screenings were used exclusively. In addition the concrete flows better, that there is less separation and that it retains the water better than does concrete containing sand.

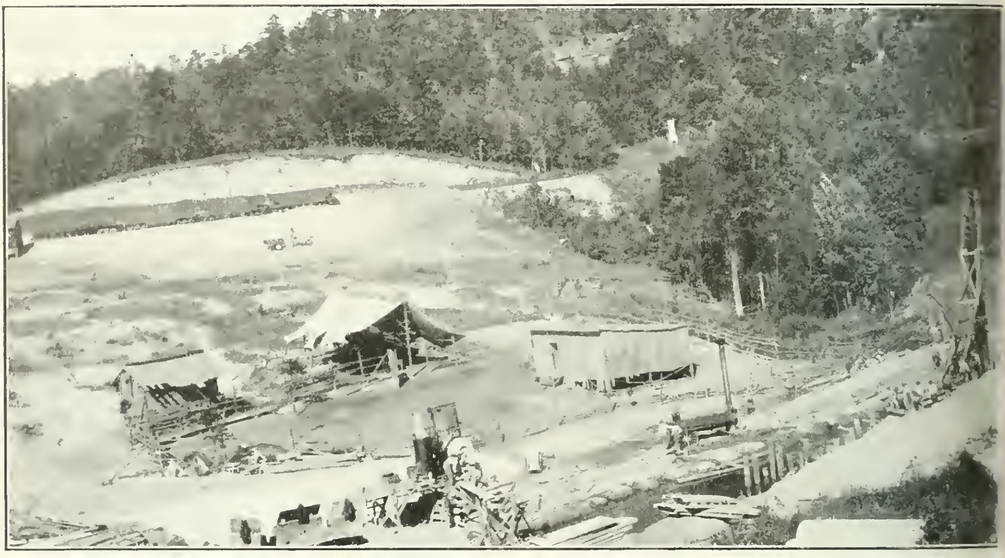


FIG. 1. GENERAL VIEW OF CONCRETING PLANT AND WEST END OF CULVERT SITE

FIG. 2. NEAR VIEW OF MATERIALS DEPOT SHOWN IN BACKGROUND OF FIG. 1

For the greater part of its length, including that portion under the deepest part of the fill, the culvert is on rock, which occurs near the surface. For about 200 ft. on the west end, however, the rock dips, and piling is resorted to. Two lines of piles, staggered, are driven under each side of the arch. The soil is earth and soft rock. The piledriver at the extreme right in Fig. 1 was built on the job and is equipped with an 1,800-lb. Vulcan hammer. A boiler was part of the equipment, but instead of mounting this on the platform of the driver, steam was piped from the horizontal Farquhar boiler shown near-by. Unencumbered and unweighted by a boiler, the piledriver is much more easily portable.

The concreting plant should be examined in connection with Fig. 1. A 1¼-yd. Lakewood mixer is mounted on timber cribbing about 8 ft. high, with a platform or walkway extending out over the forms. Concrete is transported from mixer to form in ⅛-yd. two-wheel sk pushed by men.

Concrete materials are delivered on the track show in the background of Fig. 1 and at close range in Fig. The stone and screenings are dumped down the emban ment; the concrete is stored in the house built for t purpose. The materials are hauled in wagons to t piles behind the mixer.

⁂

Engineering Contractor Talks on Earth Shrinkage

By S. P. Baird*

Writers of books are as prone to copy the mistakes other authors as they are to copy the matter that w stand test—giving due credit, of course. I have be reading several books on engineering subjects, especial the chapters given to earthwork and more particula the paragraphs devoted to the change in volume wh r is disturbed. The information generally conveyed e reader is that earth will shrink when moved from to a fill; in other words, a yard of cut will *not* make d of fill.

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*315 West Ninth St., Columbus, Ohio.

servation convinces me that there is an *apparent* rkage in volume; but I am also convinced that it t necessarily a shrinkage of the earth making the ut rather a combination of the following factors: settlement of the original ground on which the fill de; (2) that the actual yardage removed from the less than the calculated quantity; (3) the actual ge in the fill is more than it was calculated to be.

garding the settlement of the original ground under lded weight of the fill, I can call to mind a number of instances where drain pipes under the center of fills settled until they have become inverted si- . In an extreme case, while making a fill by ing from a trestle, the fill, trestle and train settled in a very few minutes. The total settlement at lace was more than 200 ft.

ther case that I have in mind, showing the settle- of the ground under the weight of the fill, was orcibly called to my attention during the construc- f an undercrossing through a heavy fill. The orig- urface was well defined by the grass line between riginal earth and the filled material. This line d a gradual settlement increasing toward the center fill. The original field notes showing the ground t the point at which the undercrossing was being ucted were available and showed no such depression.

more instance to indicate that the settlement of iginal ground is not an infrequent factor in the nt shrinkage of excavated earth: A railroad l a creek and valley on a timber trestle about 20 h. It was decided to fill most of the trestle, span- he main stream with a deep plate-girder span on legs on low masonry piers, with a short girder at each end resting on masonry abutments. The and abutments were constructed and the steelwork rected before the filling of the trestle began by ng from trains. The earth-fill had not reached ttom of the stringers before it was noticed that the had settled very noticeably (about 2 ft. where the s highest), except near the abutment. The driv- the piling under the abutment probably packed the l by side pressure. The remainder of the fill was with ashes, and the track was jacked to its orig- eight. When the stringers were removed, it was that the total settlement amounted to 3½ ft. It en my experience that comparatively shallow fills unyielding bottom can be made from cuts having me yardage. The lower portion of heavier fills somewhat compressed by the weight of the earth but not to the density of the original earth.

Shrinkage Tests with Cellar Spoil

fully made cellar excavations are capable of quite te yardage measurements. On one occasion all rth from the cellar was weighed and then dumped t for filling. The surface of the lot was flat and was about half the depth of the cellar. The vol- f this fill was about 14% greater than the cellar tion. At the end of a year it was 10% greater. le the cellar was being excavated, a number of tests un by filling a stout box, 3x3x3 ft., with freshly ted material and tamping in layers; the box of earth was then weighed. It was found that the weight approximated the weight of a yard of the original material.

Another experiment was tried. The box was filled with loose earth, and a loosely fitting piston was placed on the material in the box and weighted with pig iron to give a pressure equivalent to a 20-ft. fill of earth. Two weeks' compression brought the earth in the box to about the same density as the original earth. Of course, in this test there was side friction, which would not occur in an open fill.

Contractors Do Not Boast About Profits

The general run of contractors never admit that they are making any money, but rather give the impression that they are losing. It is but human for the rodman, the instrumentman and the tapeman to give them the benefit of the doubt, as it is very unlikely that there will be a remeasurement on account of the quantities being too large. In cross-sectioning muddy or soft ground it is easy to get readings a couple of tenths low, on account of the rod sinking in the mud. Fills are more likely to be on this kind of ground than cuts. I have remeasured several pieces of work and never have found much difference that could not be accounted for by the weathering of the cuts, difference of the viewpoint and difference in the time of the year as affecting the shadows and as affecting the height of the surface due to freezing (quite a factor in shallow work). This latter tends to reduce the yardage of cuts and fills alike by raising all the rods from $0\ \frac{1}{10}$ to $\frac{3}{10}$ ft., according to the material. The weathering erodes narrow grooves down the slopes. These grooves are not measurable, but owing to their length and multiplicity they raise the bottom of the cuts by filling in with the eroded material. This gives too small a quantity on remeasurement.

Ground-line elevations taken on grass, forest and plowed land will invariably be a couple of tenths above the solid earth. These tend to increase the apparent cut yardage and to decrease the apparent fill yardage.

As for the fill yardage being more than calculated, the method of making fills causes the edges of the fill to overrun the slope stakes, as clods will roll down the slopes and out on the original ground, increasing by just that much the apparent yardage of the fill. Engineers generally insist on measuring borrowed material in the borrowpits rather than in the fill, knowing that there is less material in the solid earth than in the fill that it will make.

⁂

Asphalt-Joint Filling Machine

By J. S. Bright*

Difficulty in making a bituminous carpet stick over the expansion joints on the 87 mi. of recently constructed concrete pavement in San Bernardino County, California, led to the invention of a special joint-filling machine. It has proved a success in use.

The pavements are of 1:2:4 concrete, 5 in. thick, and are finished with a wearing surface or carpet of asphaltic oil and screenings. Expansion joints of the Carey sandwich type were provided at intervals of from 30 to 75 ft., depending on the season and relative humidity at

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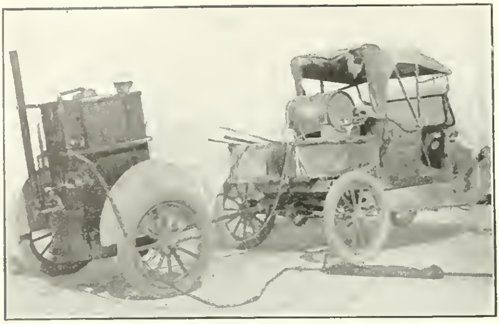
*Engineer, County Highway Commission, San Bernardino County, San Bernardino, Calif.



JOINT-FILLING MACHINE, SAN BERNARDINO COUNTY, CALIFORNIA

the time of placing the concrete. Generally, expansion followed the uncovering of the pavement after construction, forcing the joint filler nearly all out. The ejected asphalt was ironed out into a mat over the joint, which did not adhere to the concrete, and as a result formed a weak spot under the asphalt carpet coat that was afterward applied, so that it would not remain over these places.

To remedy these defects it was found necessary to dig out the joints to a depth of ½ in., clean the adjoining pavement and refill the joint with 90% asphaltic oil, heated to a temperature of over 200° F. To do this economically it was necessary to have a machine different from any on the local market.

After experimenting and making several changes, the machine shown was perfected. This device consists of a 100-gal. drum mounted on a pair of Ford automobile wheels. Beneath the drum is a firebox containing four distillate burners. These burners are supplied from a small drum carried on the front vehicle and connected to the burners by a flexible hose.

The hot asphaltic oil is drawn from the drum and sprayed through a chisel-shaped nozzle by a hand-power rotary pump. A bypass connects the discharge line with the top of the drum so that the oil can be circulated when the machine is not in use, to prevent the pump and lines from cooling and clogging.

The burners are generally kept burning low at night to prevent the oil from cooling, as it takes about three hours to reach a sufficient temperature to spray. It is usually necessary to clean the pump and discharge line either at night or in the morning with distillate.

The oiler is filled at a central heating plant and is towed to the work or filled from 5-gal. buckets distributed along the road. The heavy asphaltic oil in the buckets must be heated before it can be emptied into the drum.

The thickness of the coat of oil applied can be regulated by the rate of rotations of the pump and by a valve in the discharge line under the control of the nozzleman. It is surprising how thin a coat can be applied by this machine, but the oil has to be at a temperature of 300° F. to obtain the best results.

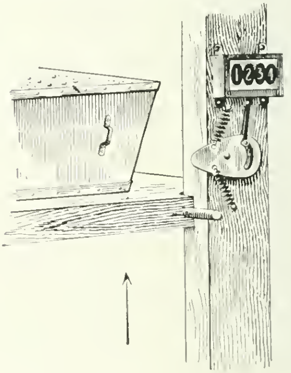
The crew ordinarily consists of a foreman, pumpman, nozzleman, one man to shovel screenings, one man to sweep, two men to pick out the joints, and teamster and team hauling about 2 cu.yd. of crushed-rock screenings and towing the oiler. This crew has finished joints on 48 mi. of road in one month at a cost of about $10 per
mi. The oil and screenings had to be hauled f
to 35 mi. The outfit can cover from 1 to 5 mi. o
per day, depending upon its condition.

To protect the refilled joints prior to the appli
of the wearing surface it is necessary to use a s
of oil in filling them. In order to avoid a bump
the wearing surface is applied the surplus of oil
joint is removed, which is best done by using a hot
or a mattock just in advance of the application
wearing surface.

FINE AGGREGATE

To Erect a Large Factory Building in 42 Days
schedule set down in a bulletin just received from the
thaw Construction Co., of Boston. The building whic
be erected for Colt's Patent Fire Arms Manufacturi
at Hartford, Conn., will be 490x60 ft. in plan, with t
wings. It will be four stories high and have a floor
2.8 acres. On Oct. 6 the superstructure was begu
second floor was to have been concreted by Oct. 21,
Nov. 2 the third floor is to be completely concreted;
13 the fourth floor, and on Nov. 23 the roof.

Automatic Counter for Concrete Elevator—In the co
tion of a reinforced-concrete building at Philadelphia
desired to count the number of buckets of concrete d
to each floor. These buckets were delivered on the
timber-frame elevators with platforms carrying one



of standard size,
to check the am
concrete it was
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number of times
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floor. To do this
dinary dial coun
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panying pers
The dial was a
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cam that was pi
the elevator post
ing up, the pin
firmly into the
platform tripp
cam and depres
link, thus mark
counter. In goin
the same pin also
the cam; but a
placed in the rear end of the cam so that the link
actuate the counter, but traveled along freely in the sl
cam was pulled back to its proper balance by coil spr
tached above and below. The device is reported by
Tailer, of 3634 North 12th St., Philadelphia, Penn.

Anchoring a Submarine Water Main was recently
a rather novel manner by the operating bureau of
Diego, Calif., Water Department. F. M. Lockwood, n
A 10-in. main 665 ft. long was laid across the San Die
at a cost of $1,902.18. This main was buried 2 ft. be
bed of the river, and at each joint two 60-lb. rails wer
full length (30 ft.) into the ground and clamped to t
both above and below, making it practically imposs
the pipe to rise up or become displaced.

Problem of Interest Rates in Loan Repayment—
plicated problem is submitted by A. F., Ottawa, involv
culations of the sinking-fund type. It is stated as fol

A city makes a loan for $1,000,000, to be paid in 12
installments of $120,000 yearly, the first payment bei
6½ months after contracting the loan. What will
annual rate of interest on the loan?

Starting with the fact that the accumulated valu
loan after the period of 11 years 6½ months must l
to the accumulated value of the repayment, the f
equation is obtained:

$$1{,}000{,}000\,(1+i)^{11\frac{6\frac{1}{2}}{12}} - 120{,}000\,\frac{(1+i)^{12}-1}{(1+i)-1} = 120{,}000\,\frac{(1+}{}$$

Some reader may be able to suggest how this can b
other than by trial, or give a direct methed for sol
problem.

Editorials

A School for Training Executive Officers

e of the most notable developments of the past 20
a in industrial education has been the rapid increase
e establishment of training courses for employees.
pioneers in this field were probably the railway com-
s which established schools for training employees
use of air brakes and the operation of signaling
t is. In the manufacturing industry, while training
s for apprentices are of course very old, schools for
ng men and women of mature years in specific tasks
mparatively recent.

Q of the largest concerns in the iron and steel trade,
on the belief that its high-salaried executive officers
e as much benefited by training as the ordinary
yee who is tending a machine, has established a
o for training executives. The students in this school
m 40 to 60 years of age, and the average age is 52.
ad of the school is a Cornell graduate of the class
2. The course of instruction includes shop practice,
istration and theory. The course of instruction
s over six weeks, during which time the students
eir entire time to the school work. Their salaries
e as usual during this time, and their traveling
s in visiting different works of the company during
rse are paid. The cost of the school apart from
tems is about $35,000 per annum. The usual
is to spend a forenoon in the shop and the after-
n attending lectures, while the evening is devoted
h study of textbooks. The students are given exam-
i s at stated intervals, and their markings in the
ations are sent to the head office of the company.

* * *

vided Authority Produces Bad Results

led authority is divided responsibility, which often
ame as no responsibility. Unless engineering re-
ility is centralized, in the design and erection of
r ture, the structure may prove a failure.

se of this kind is pictured in the statement of
out a recent reservoir break. As the statement
rom an engineer familiar with local conditions,
d be fairly accurate.

reservoir that later failed was built under the
n of the Water Department. But the Water
nent did not design the reservoir. Instead, it
a design from a civil-engineering professor of
nding. The authority of the designer ended with
gn. He had nothing to do with the execution,
ng in the hands of a contractor employed and
t by the Water Department.

nsibility being thus already divided, the case was
complicated by the fact that a large part of the
s built without any engineering inspection. An
r appeared on the work when the side walls of
the reservoir were nearing the roof. This was an important period, because the construction work had to insure that the roof would be tied to the walls very thoroughly. The design intended the walls to act as vertical beams held at floor and roof, but did not provide means that would positively assure the necessary anchoring.

The results show that even the belated presence of an inspector on the work did not secure a proper tying of the walls to the roof; but as the inspector was inexperienced, he ought not to be blamed, perhaps.

The reservoir so constructed was successfully filled with water and used for half a dozen years. Earth banked up around the outside of the reservoir held the walls against the outward pressure of the water. Recently, however, work was started on an extension directly alongside.

A firm of consulting engineers was placed in full charge of this work, and thereby part of the responsibility for the old structure fell to them, for the time being. They specified that the contractor should brace the old wall. But the contractor says that he found nothing handy against which to brace the wall, and therefore he did not brace it. He took the chance of digging away the embankment and hurrying the work sufficiently to get the new wall in before the old one could fail. In this he did not succeed.

The responsibility for the final failure is thus distributed over a whole group of individuals. As the facts show, what was everybody's business was nobody's business; and the public, which trusted to the engineers for a safe reservoir, found itself deceived.

* * *

Locomotive-Flange Oiling To Save Rail Wear on Curves

A committee report presented at the recent annual meeting of the Traveling Engineers' Association calls renewed attention to the advantages of flange oiling of locomotive driving wheels in saving rail wear. The committee states that on the New York, Susquehanna & Western Division of the Erie R.R. the rail wear on curves has been reduced two-thirds by the use of flange oilers on the locomotives. The committee also believes it to be fully demonstrated that the flange oiler tends to prevent derailments. A number of railways reported that before applying flange oilers they had considerable trouble with wheels climbing the rails on sharp curves, but this trouble has been eliminated since flange oilers have been applied.

For success in the use of the flange oiler a very heavy asphaltum oil must be used. The oil should contain 40 to 60% of asphaltum in solution and be low in grease and paraffin. This heavy oil acts as a lubricant between the wheel flange and the head of the rail when a lighter oil would be forced out. Further than this, the heavy asphaltum oil sticks to the flange and will not work over onto the tread of the driving wheel, as will an oil with a paraffin base. Many of the troubles that have been experienced with flange oilers are due to the use of oil that runs over onto the tread and causes the driving wheel to slip.

From an operating point of view, the saving in tire turning is even more important than the saving in rail wear. The committee estimates that the cost of tire metal used up, labor and loss of engine service every time a six-driver locomotive has to go to the shop for turning tires on account of sharp flanges represents an outlay of $219. The committee also states that where freight locomotives not equipped with flange oilers will run 9,000 to 12,000 mi. before requiring shopping to have their tires turned, they will run between 25,000 and 42,000 before shopping if equipped with flange oilers. In passenger service, locomotives that have to be shopped every 15,000 to 25,000 mi. should run 60,000 to 80,000 mi. if equipped with flange oilers.

Notwithstanding these practical advantages, the flange oiler appears to have as yet comparatively limited use. The reason apparently is inertia on the part of the operating force and dislike to equip locomotives with any appliances not absolutely necessary. It is inertia of this sort, however, that is responsible for a great deal of the unnecessary expense in connection with large-scale operations, whether carried on by corporations or by the Government.

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Allowances for Obsolescence in Making Appraisals

The contribution of C. C. Harshman on obsolescence, elsewhere in this issue, serves to call attention to one feature of the work of appraisal that has been too much neglected by engineers. Doubtless this neglect is unconscious. Most engineers would claim that they had made full allowance for obsolescence in figuring depreciation, but when two items of a different sort are lumped together in an appraisal there is always a likelihood that one or the other may not receive sufficient attention. The main advantage of making a separate item of obsolescence is that there is greater certainty of this element receiving thorough and careful study.

One of the reasons why obsolescence is often neglected in making estimates is that a tool or machine may continue in use year after year with apparently no loss from obsolescence and then suddenly, by some new development, become out of date. A few months ago, a member of the staff of this journal visited a small pumping plant in southern California, used to raise underflow water for irrigation. The plant was built within the past ten years. A pair of horizontal return-tubular boilers furnished steam to a duplex direct-acting pumping engine with necessary auxiliaries for boiler feeding, fuel handling, etc. The machinery was erected on substantial foundations and housed in a permanent fireproof building. The plant was well designed and economical in operation; and as it was used only for a short time during each year, the physical depreciation had been practically nil. Since this plant was built, the electric motor-driven centrifugal pump had been made a commercial success. In one corner of the station stood a centrifugal motor-driven pump occupying not a twentieth part of the floor space of the steam plant and involving a trifling expense for maintenance and operation compared with its rival. At one stroke the practically new steam plant had had its value reduced to scrap. This instance is merely t of the sudden losses of value that may be expected t cur sooner or later with almost all mechanical e ment as a result of the steady progress of inve and design.

No engineer is wise enough to foresee when a machine that is now the best of its class and perf adapted to its work will be rendered obsolete by new invention. The engineer knows, however, tha *liability* to such a loss occurring is always present, as there is a certain liability that any plant will b stroyed by fire. Why is it not then as reasonable to an annual charge for the risk of loss by obsolescen it is to make an annual charge for the risk of lo fire? The payments made for fire insurance are a of the annual operating expenses; and even where a cern does not carry insurance, the risk due to loss b should be charged just the same. Exactly the same should be applied in making a charge for the r obsolescence destroying the value of the machine which the company has invested its money. Unles is done by a public-utility corporation, it may event have to suffer serious losses that should in equit borne by those who have the benefit of its service. present obstacle to adequate treatment of obsolesce the lack of accumulated experience as a guide.

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Grade-Crossing Dangers A For the Foolhardy

"The deadly grade crossing," according to sta recently made public by the Pennsylvania Railroad chiefly dangerous to those who are guilty of fool recklessness. Safety gates at crossings are provid prevent the traveling public from crossing the tracks a train is approaching; but the Long Island R.R., has numerous grade crossings subjected to heavy mobile traffic, finds its safety gates continually b down by motor cars running too fast to be stopped striking the gates.

This is bad enough, but what shall be said of th who runs his motor car into the side of a moving The Pennsylvania R.R. officials state that during th eight months of the present year, drivers of 23 moto ran their machines into sides of trains, that were par over the crossings. Besides these vehicles, six m cycles, two bicycles and four horse-drawn vehicles driven into the sides of trains. The accidents caus this way resulted in the deaths of six persons an injury of 65.

It is sometimes argued that because of the high sp which present-day highway traffic is carried on, all crossings should be abolished. Great progress has been made in this work in the past 20 years. The sylvania R.R. alone, on its lines east of Pittsburg expended $10,000,000 in grade-crossing removal 1902. To abolish all grade crossings, however, in a try of the enormous extent of the United States is a that will require the accumulated capital of gener to accomplish. Meanwhile, it will be well to rem that the grade crossing is only one point on the hig where danger confronts the reckless motorist. To th who uses reasonable care in his driving, the d element in the grade crossing is trifling.

Letters to the Editor

Sense or Sentiment To Govern in Sewage Treatment?

Sir—In the course of the discussion on activated sludge at the recent convention of the American Society of Municipal Improvements, F. A. Dallyn, provincial sanitary engineer, Toronto, Ont., made the statement that while methods of sewage purification could be depended upon to give an effluent from 95% to 98% pure from a pathogenic standpoint, public sentiment in Ontario was demanding an effluent whose pathogenicity was zero, principally because cattle make use of the streams below the point where the purified sewage is discharged.

He admitted that typhoid could not be transmitted because of cattle drinking such waters, but stated that it could be transmitted by reason of the unsanitary practice and carelessness in milking cows whose udders had been wet by water in rivers into which treated sewage 95% to 98% pure had been discharged. This unclean practice, he stated, consisted in wiping off the udders with a dirty cloth or washing the udders with dirty hands, using the milk for washing.

In view of the fact that no sewage-disposal plant can under present conditions be guaranteed to yield an effluent at all times even approximating 95% to 98% pure pathogenically, and in view of the further fact that the only need of such an effluent is to enable us to tolerate the unsanitary practice and carelessness in dairies pointed out by Mr. Dallyn, can the engineering profession afford to permit the public to believe that its safety lies in a futile effort to prevent the very remote possibility of typhoid contagion due to contact of the udders with water in streams receiving treated sewage? Does it not rather lie in the insistence upon drastic regulations requiring cleanliness in dairies, where, along with the care against the remote possibility of typhoid infection from the cause stated, we can prevent the direct entry of the dirt and filth through which the milk must run the gantlet?

Why permit the setting up of impractical and impossible standards, the failure to attain which will bring disrepute to the engineers, when better results can be obtained in a more simple and positive manner, and more economically withal? ALEXANDER POTTER.

50 Church St., New York City, Oct. 16, 1916.

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Canadian Engineers and Alien Appointments

Sir—Referring to your editorial under the caption "Canadian Engineers Object to Appointment of Aliens," published in *Engineering News* of Oct. 12, 1916, I have spoken with quite a few prominent engineers on this subject, and they are unanimously of the opinion that you struck the nail on the head when you said: "Any organization of engineers should beware of placing itself before the public as seeking to claim appointments for its members. There could be no surer way of forfeiting public confidence and respect."

If the arguments and statements made by "J.G.S." and published in *Engineering News*, page 180, Vol. 51, issue of Feb. 25, 1904, were true, it would appear that the students of 1904 have advanced to the control of the Canadian Society of Civil Engineers in 1916.

Winnipeg, Man., Oct. 21, 1916. J. G. SULLIVAN.

[In the letter referred to by our correspondent, published in *Engineering News* 12 years ago, it was denied that the members of the Canadian Society of Civil Engineers were by any means unanimous in favoring legislation to give members of that society a monopoly of the engineering work in Canada. The writer said:

> I am proud to be able to say that not a single engineer voiced approval of the idea, and the cheering was apparently done by the land surveyors and some of the younger members of the society, who constituted the majority of those present at the dinner.

The letter presented reasons why the engineering profession would make a mistake if it adopted labor-union methods to promote its interests—Editor.]

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A Fishy Sewage-Treatment Scheme

Sir—By hearsay, I have come across the following story. It may or may not be true, but will serve as an illustration of the need of expert advice for laymen when they consider matters of a nature foreign to their own business.

A large tannery in one of the Eastern States is located on a fresh-water stream that is small enough for one to jump across. The wastes from the tannery have been allowed to flow into the stream for some time. Recently the State Board of Health has protested, and the owners of the tannery have expressed their willingness to spend money on a treatment plant if some method can be devised to properly treat the wastes. Shortly after this the State Fisheries Commission began demanding the cessation, at once, of the practice of putting the wastes into the stream. It contended that all fish would be killed. No doubt this was true; probably all fish had been killed in that stream long ago. The owner of a patent on a device for treating tannery wastes then came to look over conditions. He stated that by installing his process the regulations of the State Boards of Health and Fisheries could be observed and all difficulties be eliminated.

It seems that the device contemplates holding the wastes in a tank for 90 days, and the cost for the installation to treat the wastes for the one tannery would be over $100,000.

The owners have objected to any such proposition but are being backed into a defensive attitude by the insistent demands of the Fisheries Commission.

The fact that makes the whole affair smell queerly—fishy, as it were—is that the gentleman who owns the patent on the process for treating tannery wastes is a State Fisheries Commissioner. OBSERVER.

Somewhere, Oct. 20, 1916.

Mechanical Agitation of Sewage Proved Unsuccessful

Sir—In your issue of Sept. 21 there appeared an editorial on drifting-sand filters. You suggested that some of the devices might be used in the activated-sludge process and called attention to the fact that some investigators, more particularly in England, had urged mechanical agitation as an economical substitute for enforced aëration. Probably the view that stirring with compressed air is inefficient has been taken because engineers are well aware that ordinarily considerable energy is lost in the transmission of power by compressed air, but a little thought will show that the loss is, to a great extent, avoided in enforced aëration.

When air is compressed, the energy input is absorbed in two forms. The air is put under tension, and it is heated. The heat is dissipated before the air is used, and hence this portion of the energy is lost. The loss manifests itself when the air is expanded to release its energy, as it then cools below normal temperature and occupies less volume than it otherwise would. This particular loss is eliminated when the air is used to stir a liquid whose temperature is approximately that of the free air. The heat is lost in transit just the same, but is reabsorbed from the liquid as the bubbles rise from the tank bottom.

Moreover, the expansion of the air is perfect, and it is rejected at the surface of the water with practically zero velocity. These favorable conditions are not exactly fulfilled by any other devices used for transforming into work the stored energy of compressed air.

The only losses in transmitting work from the prime mover to the liquid are the slip of the blower and the frictional losses in compressor and air lines, but these should not total over 25 to 30%. It would seem likely that losses in mechanical agitation would total higher. Unless the plant were very small indeed, a number of agitating units would have to be provided. These units would either have to be driven individually by small and hence comparatively inefficient motors or else by shafting and gearing, which would absorb power, particularly under the exacting conditions that would have to be met.

It is evident, therefore, that from the standpoint of merely transmitting power to the water the compressed air is fully as satisfactory as any mechanism would be. Undoubtedly, however, the nature of the agitation afforded in either case is somewhat dissimilar. The question then occurs as to whether the particular kind of agitation furnished mechanically might not be the more efficacious.

About a year ago the writer conducted at the Milwaukee testing station a series of experiments that were designed to throw light on this particular point. Sewage and sludge were agitated in a tank 22 in. square and 4 ft. deep by means of screw propellers and stirrers, of which a number of sizes and forms were tried out from time to time. The power input to these was brake tested and so regulated that it was equivalent to the power afforded by aërating the tank with about ⅓ cu.ft. of air per minute per square foot of tank surface, which had been found ample for complete clarification in 4 hr. Two sides of the tank were of glass, so that good visual observation of the stirring could be had.

The experiments showed that absolutely no clarification could be obtained by mechanical agitation even when it was prolonged to 24 hr. or more. If some air was added, clarification resulted; but the strength of the reaction seemed to be dependent entirely on the volume of air and to be independent of the amount of agitation. This would make it appear that the main factor in the process is absorption of oxygen and that agitation is only incidental or at least only a minor consideration. Additional evidence of this was obtained the following spring, when a practical way of finely subdividing the air was discovered. It was then found that, with well-activated sludge, clarification could be obtained by agitating with only ¼ cu.ft. of finely divided air to the gallon of sewage, which provided only one-sixth of the energy afforded when mechanical agitators were run 4 hr. and only one thirty-sixth of the total energy input when the 24-hr. run was made. Yet in the first case good clarification is secured and in the second none at all.

The writer does not want to be understood as saying that it is practical to operate an activated-sludge plant with only ¼ cu.ft. of air to the gallon. It distinctly is not practical to do so at the present time. It is a well-known fact that the amount of air used can be very materially reduced for a short time if the sludge is well activated, but the activity of the sludge is quickly lost if the practice is continued.

This, by the way, is additional evidence that agitation in itself plays a minor part, for it is difficult to conceive of the sludge as storing up energy when the agitation is violent and releasing it when it is less intense; but it is easy to see that the bacterial activity induced by liberal aëration would not be so quickly lost when the air supply was cut down.

Paradoxical as it may seem, it is only when aëration is proved to be all important and agitation incidental that mechanical stirring will prove economical. The reason is that the amount of agitation necessary to maintain the sludge in suspension and which, patently, cannot be dispensed with, can best be furnished by a mechanism, for the object will then be to move the water in stream near the tank bottom rather than to cause violent eddie and swirls, and it is probable that a stirring device woul be best adapted to this end.

This combination of mechanical stirring plus aëratio cannot of course be used at present, as the amounts o air required in practice are more than ample to stir th mixture, but will only come into use if some very mucl more efficient means of introducing the necessary oxyge are found. Carl H. Nordell.

Milwaukee, Wis., Oct. 9, 1916.

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Defining the Right and Left Bank of a Stream

Sir—As a matter of information, I would like to kno which is the right and which is the left hand bank of a stream; that is, whether you call it the right hand sid when facing the source of the stream, or the right han side when facing the mouth?

Herbert Henderson,
Constructing Engineer, Gulf Refining Co.

Port Arthur, Tex., Oct. 7, 1916.

[The question that our correspondent raises was discussed at length in various issues of *Engineering New*

Vol. 54, July-December, 1905. The information brought out at that time from numerous sources was that according to the rule laid down in the United States Manual of Land Surveying, the right and left banks of a stream are those on the right and left hand of an observer facing *down*stream. On the other hand, in the mountain districts of the South where old deeds refer to the right and left bank of a stream, it is almost invariably found that what is meant is the right and left bank when the observer is facing *up*stream. This latter rule also applies, according to the best information, to forks.—Editor.]

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The Quebec Bridge Accident

Sir—Referring to the several communications in regard to the Quebec rocker stresses published in your issue of Oct. 19, and your editorial comments thereon, the final sentence in the latter: "The casting is in fact subjected to such a complex set of stresses—both direct and secondary—that analysis can only lay emphasis on the need for ultraconservative design in such a case," suggests that the following simple analysis indicates that, although the exact internal stresses cannot be determined, an indication of their character should not be ignored.

At either the top or the bottom of the casting we have the extreme fibers of one rib in compression with the extreme fibers of the other rib in tension at right angles to it. Resolving these stresses into their components with reference to a diagonal section, shown in diagram, it is seen that there will be a shearing stress on this diagonal section; and if the two ribs are of the same width and the tension stress equal to the compression stress, this shearing stress will be exactly the same in pounds per square inch as the tension or compression. As this shear s horizontal in direction and the edge of one of the ribs nclined, the other being horizontal, the complexity of the stress at this point is apparent; and in all probability the shearing value of the metal is more important than the tension value.

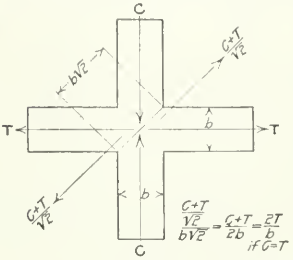
Howard C. Baird.

149 Broadway, New York, N. Y., Oct. 20, 1916.

Sir—Concerning the loss of the suspended span of the Quebec Bridge, on page 529 of the issue of Sept. 14, it was stated that "so long as the span remained absolutely evel, and absolutely central on the lifting girder, there was no tendency to tip or rotate the girder. . . . As the truss shoe settled down through the broken fragments of the casting, it was bound to destroy irrecoverably the delicate condition of central loading." Subsequently, attention has been directed to the rocker casting and its design, and the evidence has been believed to point to this casting, rather than to a rotation of the girder, as the source of the disaster to the suspended span. After considering the general arrangement of the slings supporting he suspended span, it would seem advisable to ask whether anything else beside the breaking of the rocker casting could have been the cause of the failure.

The upper or transverse pin, supporting the span, was but 2¾ in. below the two lowest pins in the lifting chains, on which rotation of the lifting girder could take place. Had the center of the rocker pin been slightly more than [illegible]-in. off the centers of the lifting-chain pins just mentioned, the slope of the lower or longitudinal rocker pin would tend to be 5%, which is probably about the angle of friction of the rocker casting on the pin. To insure all hree of these pin centers being in a vertical plane, it would be necessary that the workmanship on the lifting girders be accurate; that the lowest castings be bolted to the girders just right longitudinally; that the centering plates be correctly placed, and finally that the girders be in a vertical plane just at the time they received the load. That all these conditions were not obtained when the weight was transferred from the barges to the slings is not outside the range of the probable, and it is likely that initial inexact centering would be aggravated later.

On the excellent photographs of the insert of Sept. 21, there is no sign of a heavy vertical blow on the southwest lifting girder. The most prominent effects are the tear through the hitch angles, which looks as if it were done by a sharp corner of the falling mass dragging through it, and the squeezed-out lead, which proves that there was an eccentric load or a blow; if it were the latter, it was not heavy enough to break the casting. The direction of motion, indicated by the several sheared bolts, might merely indicate motion of rotation of the lifting girder, combined with the vertical motion of the falling mass. It hardly seems positive proof of a broken casting.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PLAN OF ROCKER CASTING, SHOWING DIAGONAL SHEAR

Had the lifting girder been properly braced by a strut to the bottom chord of the suspended span, the equilibrium of the structure would not have depended on friction. It would seem that unnecessarily flexible design might have been the primary cause of the disaster. Would it not have been better to have connected the chains directly to the ends of the span?

Regarding the rocker casting that supported the suspended span of the Quebec Bridge, and the computations recently appearing in your columns for the strength of the section at the center, would it not be well to call attention to some additional points of interest.

The midsection, for which the moment of inertia was figured, has inclined sides and is irregular. As in the case of a circle, the distribution of stress on such a section does not seem to follow the simple law that it does in a rectangular section with vertical sides. A pin, for instance, will resist more bending than the ordinary computation would indicate. In addition, the midsection has on each side of it sections increasing in depth and area. On this account the midsection would probably stand more load, as the circumstances are analogous to the nicked tensile specimen, which will stand a greater stress per square inch than one not nicked. Furthermore, at the middle of the casting there are stresses of opposite kind, in planes at right angles to each other at the top of the casting, the fibers running longitudinally with the span being in compression and those running transversely being in tension. At the bottom of the casting the condition is just the reverse. It would seem a very difficult matter to get stresses actually existing, especially when so many assumptions can be made regarding distribution of the load.

Roberts S. Foulds.

Phoenixville, Penn., Oct. 21, 1916.

Public Health Association Has Model Convention

In striking contrast to some conventions of other societies held this year the forty-fourth annual convention of the American Public Health Association at Cincinnati, Ohio, last week, was a model of how to do it. Although 159 papers and reports were scheduled for presentation in a four-day convention, and although the only business done at the single evening session was the president's address, yet the program was carried out without confusion and with apparently plentiful time for discussion.

This high convention ideal was attained by skillful planning and equally capable execution of the program by men who knew just what was wanted and exactly how to get it. The subjects were live ones and well grouped. Competent men and women were chosen to present them. The sessions opened on time or very nearly so. The presiding officers kept their sessions thoroughly in hand, holding authors and discussers of papers to the set time limits and not only leaving time for free discussion but judiciously stirring it up by calling on this or that person in case the discussion did not move fast enough.

Obviously, 159 papers and reports could never have been presented in four mornings, three afternoons and one evening of business proceedings were not the association divided into sections. These sections include Public Health Administration, Laboratory, Vital Statistics, Sanitary Engineering, Sociological, and Industrial Hygiene, besides which there was a special period devoted to Foods and Drugs and three General Sessions.

The recent marked progress of the association is shown by the rapid increase in membership during the past few years to a present total of 1,647 and a 40% increase in the circulation of the *Journal* to 2,400 copies. Moreover, a *Journal* deficit of $2,800 reported a year ago has given place to a surplus of $30 for the year just closed.

Before passing on to brief mention of a few of the scores of papers and reports it may be noted that the President Elect is Dr. W. A. Evans, not long ago health commissioner of Chicago. Prof. Selskar M. Gunn, of Boston, Mass., will continue as secretary and editor, it is understood. The new chairman of the Sanitary Section is Theo. Horton, Albany, N. Y.; and of the Laboratory Section, Dr. Henry Albert, of Iowa. The 1917 convention will be held in New Orleans.

Substantial contributions were made by a number of committees. Mention will here be made of the reports to the Sanitary Engineering Section, only, except to note that some changes in existing laboratory standards were recommended by the committees on bacterial and on chemical analyses of water and sewage. These changes will come up for action next year.

The Committee on Water Supply, through F. F. Longley, New York City, chairman, called attention to the need for more careful and extended observations on the results of water disinfection—there now being about 600 chlorination plants in use, as compared with 60 at the beginning of 1914.

A carefully devised score system for rating the sanitary condition of public water-supplies was presented by Theo. Horton, and E. S. Chase, Albany, N. Y. H. A. Whittaker, Minneapolis, Minn., submitted statistics showing how necessary it is to have a field survey or sanitary inspection of water-supplies instead of relying upon analyses alone. On this subject Mr. Horton remarked that for three-fourths of the water-supplies a sanitary survey is sufficient.

Fundamental principles and a proposed code were submitted by the Committee on Sanitary Control of Waterways, H. P. Eddy, Boston, chairman. This report was warmly and generally commended. The section voted that not only this but also the other committee reports submitted for adoption by the Section should be sent to the Executive Committee with a request for early printing in the *Journal*; that reprints of the reports be sent to Section members about 30 days before the next ensuing annual meeting, at which the reports should come up for discussion and adoption. The proposed code will be printed in a later issue. In this issue there are given parts of the reports of the Committee on Sewage Works Operation and Maintenance, W. L. Stevenson, Philadelphia, chairman, which was devoted largely to an advocacy of State Board of Health supervision of the operation of sewage works, and of the report of the Committee on Sewerage and Sewage Disposal, Geo. S. Webster, Philadelphia, chairman, which presented a series of definitions of sewerage and sewage disposal terms. These definitions, in full, will go to members of the Section and be presented for action by the section next year. H. P. Eddy thought the states should stop with insisting that sewage works be properly operated, leaving detailed supervision to engineers in private practice. The committee might well define just what it means by state supervision. M. N. Baker, of New York, remarked that the state should say what must be accomplished rather than how. Mr. Stevenson said in closing the discussion that the committee did not intend that the state should usurp the functions of private engineers.

The report of the Committee on Refuse Collection and Disposal, Samuel A. Greeley, Chicago, chairman, mentioned a five-ton garbage reduction plant at Pontiac, Mich. Rudolph Hering, New York City, read a paper discussing at length what sort of contract plans and specifications are needed for obtaining incinerators on a most economical basis. He advised taking into account cost of collection and transportation; that general plans and specifications be prepared by a competent engineer for the city, but that each bidder submit his own detailed plans; and that contract prices be submitted on the basis of annual unit costs of operation, including capital as well as operation charges.

A valuable study of the relation between street cleaning and street dirt and disease was presented by Samuel Whinery, New York City, Chairman of the Committee on Street Cleaning. Some of the main conclusions of this paper are given elsewhere in this issue.

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Definitions of Sewerage and Sewage-Disposal Terms

The need for a careful definition of terms used in sewerage and sewage disposal has been growing more and more evident for years past. The Committee on Sewerage and Sewage Disposal of the Sanitary Section of the American Public Health Association, with the coöperation of a dozen eminently qualified sanitary engineers, submitted a long series of definitions to the recent Cincinnati convention of the Association. A few of the least obvious definitions, or those most likely to arouse differences of opinion, are here quoted from the report:

Drain is a conduit intended to carry storm, surface and ground water.

Separate Sewer is a sewer which is intended to receive only sewage and not storm water or surface water. ("Separate Sewer" is preferable to "Sanitary Sewer," which latter term should be discontinued.)

Sewage Treatment is the process to which sewage is subjected in order to partially remove its impurities and render it fit for final discharge. (The term "Sewage Purification" should be abandoned.)

Contamination is the introduction into a water of bacteria or other substances which tend to render it unsuitable for domestic use.

Pollution is the introduction into a water of substances of such character and in such quantity that they tend to render the body of water or river objectionable in appearance, or to cause it to give off objectionable odors.

Clarification is the removal of the suspended and colloidal matters.

Colloidal Matter is suspended matter which is so finely divided that it is no longer acted on by gravity, and remains suspended indefinitely, yet will not pass through a parchment membrane in the ordinary process of dialysis.

A Screen is a device containing openings of proper size to etain a part of the suspended matter of sewage.

Coarse Screen is one having openings in excess of ½ in. n least dimension.

Fine Screen is one having openings of ½ in., or less, in east dimension.

Bar Screen is one composed of parallel bars or rods.

Mesh Screen is one composed of a fabric, usually of wire.

A Grating consists of two sets of parallel bars in the ame plane, the sets intersecting at right angles.

Perforated Plate Screen is one made of perforated plates.

Band Screen is one consisting of an endless band, or belt, hich passes over upper and lower rollers.

Wing Screen is one having vanes, uniformly spaced, which otate on a horizontal axis.

Drum Screen is one in the form of a cylinder or cone, consisting of perforated plates or a wire mesh which rotates on horizontal axis.

Disk Screen consists of a rotating circular perforated disk, ith or without a central truncated cone of similar material ounted on the center.

Cage Screen consists of a cage having three sides made f parallel bars, or rods, so arranged that it may be lowered nto the sewage, and raised therefrom for cleaning.

Sedimentation Tank is a tank for the removal of suspended atter either by quiescent settlement or by continuous flow t such a velocity and time of retention as to allow deposition f suspended matter.

Dortmund Tank is a vertical sedimentation tank, usually ylindrical, in which the raw or partially treated sewage nters the lower part, flows upward and passes out near the op. The sludge is drawn before it becomes septic from the onical or hopper-shaped bottom.

Hydrolytic Tank is a tank in which by biological processes a portion of the suspended matter is converted into quid and gaseous form.

Septic Tank is a horizontal, continuous-flow, one-story sednentation tank through which sewage is allowed to flow lowly, to permit suspended matter to settle to the bottom, here it is retained until anaerobic decomposition is estabshed, resulting in the changing of some of the suspended rganic matter into liquid and gaseous substances and a onsequent reduction in the quantity of sludge to be disosed of.

Tarvis Tank is a two-story tank consisting of an upper, r sedimentation chamber, with steeply sloping bottom, terminating in one or more slots through which the solids may de as deposited into the lower or sludge-digestion chamber, r ugh which a predetermined portion of the sewage is al wed to pass for the purpose of seeding and maintaining acterial life in the sludge and carrying away decomposition roducts, thus inducing digestion of the sludge attended by its eduction in volume.

Imhoff, or Emscher, Tank is a two-story tank consisting f an upper, or sedimentation chamber, with steeply sloping ottom, terminating in one or more slots through which the lids may slide as deposited into the lower or sludge-digeson chamber—these slots being trapped so as to prevent the se of gas and solids from the lower chamber—the lower hamber being provided with vents for the escape of the gases, e tank being so constructed as to facilitate the passage of he sewage quickly through the upper chamber and prevent the flow of sewage through the digestion chamber, and so perated that the sludge may be thoroughly decomposed, rendered practically free from offensive odor and so filled with gas that it can be readily drawn off and dried.

Activated-Sludge Process consists in the agitation of a mixture of sewage with about 15% or more of its volume of bacterially active liquid sludge in the presence of ample atmospheric oxygen, for a sufficient period of time to at least coagulate a large proportion of the colloidal substances, followed by sedimentation adequate for the subsidence of the sludge flocculi; the activated sludge having been previously produced by aeration of successive portions of sewage and maintained in its active condition by adequate aeration by itself or in contact with sewage.

Trickling Filter. (The committee is of the opinion that the term "Trickling Filter" is preferable to the term "Sprinkling Filter" or "Percolating Filter.")

Disinfection is the destruction, by the agency of some chemical, of a large percentage of the bacteria in sewage or contaminated water, so as to reduce the danger of infection to a negligible quantity.

Sterilization is the destruction by the agency of some chemical, of all the bacteria in sewage or contaminated water, including their spores.

Nuisance (in relation to a polluted stream) is a condition which is offensive to the sense of sight or smell.

A Clean River, in regard to sewage, is one which gives no sensuous evidence of sewage pollution and from which a wholesome drinking water can be obtained by practicable methods of water purification.

It should be understood that the report is a preliminary one. The committee wishes full and free discussion from all persons interested. George S. Webster, 550 Bourse Bldg., Philadelphia, is chairman of the committee. The other members who signed the report were Kenneth Allen, New York City, Frank A. Barbour, Boston, and Langdon Pearse, Chicago.

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State Board of Health Control of Sewage Works*

For the purpose of this report the 48 state boards of health in the United States have been divided into three groups:

1. Those states whose boards of health have no engineer upon their staff or have no specific legislation giving them control over the disposal of sewage, or have so few sewage-treatment works under their jurisdiction that the subject is negligible. These 21 states in 1910 had a population of over 21,250,000, or 26% of the total population of the United States, and are: Alabama, Arizona, Arkansas, Colorado, Delaware, Georgia, Idaho, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, South Carolina, Tennessee, Utah, Washington, West Virginia, Wyoming.

2. Those states whose boards of health have an engineer or other officer charged with supervision over disposal of sewage, but whose legal powers are limited and the number of sewage-treatment works are small. The officers of this group of states have all signified their willingness to coöperate with your committee and have furnished valuable data. These nine states in 1910 had a population of 12,753,000, or 14% of the total population of the United States, and are: Connecticut, Florida, Indiana, Kentucky, Louisiana, Maine, New Hampshire, North Carolina, Rhode Island, Vermont.

3. The remaining 15 states have boards of health with engineering divisions and either have legal authority or otherwise exercise control over the disposal of sewage and operation of sewage-treatment works. The 1910 popula-

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*From report of Committee on Sewage-Works Operation, etc., Sanitary Section, American Public Health Association, presented at Cincinnati, Ohio, Oct. 26, 1916. The members of the committee are F. E. Daniels, C. A. Emerson, Jr., C. B. Hoover, Richard Messer, W. L. Stevenson, chairman, City Hall, Philadelphia, Penn.

SEWAGE WORKS AND THEIR CONTROL BY 15 STATE BOARDS OR DEPARTMENTS OF HEALTH

State	Officer Furnishing Data		Population of State in 1910	Number of Works in State For Population of				Number of Works with Laboratory	State Board or Department of Health				
	Name	Title		Total Number	25 to 500	500 to 10,000	Over 10,000		Requires Approval of Plans for Sewage Prior to Construction	Exercises Supervision Over Operation	Makes Inspection	Makes Analyses of Sewage and Effluent	Receives Reports of Operation
Calif	C G Gillespie	Chief engineer	2,377,500	100±	Numerous	90	3	. . .	Yes	Yes	Occasionally	Yes	Have power; not yet
Ill	P Hansen	Chief engineer	5,638,600	75	4	61	10	. . . .	Yes	Not yet	Not yet	By State Water Survey	Rule passed; not yet
Iowa	L Higgins	Sanitary engineer	2,224,800	85	1	82		2	Yes	To some extent	Yes	Yes	Yes, after Jan. 1, 1917
Kans	C A. Haskins	Chief engineer	1,690,900	67	9	53	5		Yes	Yes	Yes	Yes	Just installed
Md.	R B. Morse	Chief engineer	1,295,300	13	†	12	1	1	Yes	Yes	Yes	Yes	Not yet
Mass.	X H Goodnough	Chief engineer	3,366,400	58+	34+	11	13	3	Yes	Yes	Yes	Yes	Yes
Mich.	E. D. Rich	State sanitary engineer	2,810,200	38	22	14	2		No	Yes	Yes	Sometimes	Soon
Minn	H A Whittaker	Director	2,075,700	79	44	32	3	.	No law, but nearly all submit plans	To some extent	Yes	Yes	No
N. J.	C. G. Wigley	Chief bureau of engineer	2,537,200	168*	66	89	13	2	Yes	Yes	Yes	Yes	Sooo
N. Y.	T. Horton	Chief engineer	9,113,600	178	73	90	15		Yes	Partial	Yes	Yes	In some instances
Ohio	W H Dittoe	Chief engineer	4,767,100	162	92	64	6	1‡	Yes	Yes	Yes	Yes	No
Penn	C A. Emerson, Jr	Chief engineer	7,665,100	117	61	47	9	17, 32 partial	Yes	Yes	Yes	Yes	Yes
Tex.	V. M. Ehlers	Sanitary engineer	3,896,500	40	2	37	1	2	No law, majority submit plans	Standards required	Yes	Yes	Yes
Va.	R. Messer	Sanitary engineer	2,061,600	44	22	22	0	1	No law, but plans passed on	No law but supervised	Yes	No	No
Wis.	W. G. Kirchoffer	Sanitary engineer	2,333,800	70+		60±	10±	. .	Yes	Yes	Yes	Yes	No
			Totals..	1,294	437	764	93						
			% ..	100	34	59	7						

* Fifteen trade-wastes plants, not included. † Many small institutional plants not included. ‡ Four additional laboratories planned for.

tion in these states was about 54,000,000, or 60% of the total population of the United States.

The conditions in these states are given in the accompany table from which it will be seen that, generally, sewerage plans must be approved before construction; supervision, inspection and analyses are made, and in some states reports of operation are made to the state board of health.

It will be noticed that commonwealths representing more than half the population of the United States have given their state boards of health supervisory powers, but it will be further observed that at the present time only in Massachusetts, Pennsylvania and Texas is the operation of the sewage-treatment works regularly reported to the state officials. Several other states are preparing to inaugurate this means of exercising supervision.

Upon completion of the construction of sewage-treatment works it very frequently happens that the operation is intrusted to persons entirely unfamiliar with the intent and purpose of the designer. It is particularly important that early operation, where adjustment of parts must be made to meet unanticipated conditions, should be intrusted to either the designer or some engineer familiar with all the intricacies of operation. This provision can be met by a requirement in the permit of approval issued by the state for the construction of the works.

The table shows that over one-third of the plants given therein are designed for population of less than 500, over one-half for populations between 500 and 10,000, and only 7% for populations over 10,000.

State supervision should include inspection of the works, analyses of sewage and effluents, and examination of records of operation. With these data the state officials can advise those in charge of the works how to operate them to obtain the optimum results.

Inspections and sampling by the state should be done not at regular intervals, but when critical conditions exist, in order to be familiar with the results obtained at times of maximum load when defects are most noticeable.

Generally, reports should be submitted to the state board of health by all sewage-treatment works. In cases of small domestic or institutional plants it may be felt that there is practically nothing to report. But in such cases, if the owner is required to send a report to the stat setting forth the condition of the plant, it is an incentiv to at least examine its operation occasionally, which otherwise would be overlooked.

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Errors in Liquid-Measuring Pumps used in the sale of gasoline are exceedingly common, according to a bulletin jus issued by the Bureau of Standards. Examinations of measuring pumps of various types, chosen at random in a numbe of different cities, were made by an inspector of the Burea of Standards and showed that 70 to 80% of the pumps examined had excessive errors. In nearly all cases these error consisted in deficient delivery. An approximate estimate indicates that in Illinois alone the loss to purchasers of gasoline, due to short measure, may exceed half a million dollar per annum.

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The Boston Elevated Railway Co. is in need of additiona capital for the purchase of rolling stock for the existin rapid-transit lines and also for equipping the Dorchester tunne and the extension to Everett, now under construction. It unable to secure this capital from the sale of stock, becaus under existing laws it cannot sell stock at less than par, an the stock is now selling at 73. It cannot sell additional bond since the law limits its bond issues to the amount of stoc outstanding, and it is already up to that limit. A speci board created by the legislature of 1916, consisting of th Massachusetts Public Service Commission, the Boston Trans Commission and members of the Senate and House, is holdin hearings in Boston, beginning on Sept. 25, to consider mean of extending relief to the company. The testimony thus fa presented shows that the company's present financial condition is due principally to increased cost of labor and material and the enormous increase in the company's investme on which fixed charges must be met, this increase being a much greater rate than the growth of its traffic.

Permanent investments in the Boston Elevated system o June 30, 1916, amounted to \$116,000,000, which is 4½ times great as in 1907. The number of paying passengers has onl doubled in the same time. Further than this, the increasin length of the average journey in connection with the fr transfer system has prevented the revenue from increasing proportion to the service rendered. The proposals which th board is considering for the company's relief include the fo lowing:

1. An increase in the rate of fare.
2. The adoption of the so-called zone system of fares.
3. Charging for transfers.
4. Establishment of inclosed areas at transfer poin where practicable, so as to reduce the number of paper tran fers.
5. Elimination of the 8c. check.
6. Purchase of the Cambridge subway by the state its rental to the company.
7. Temporarily charging off depreciation against pr miums paid in on stock and bonds.
8. Return of the \$500,000 deposited with the state, so th it will be available for ordinary capital purposes.
9. Reimbursement for subway rentals.

The Cantilever Bridge at Cernavoda, Roumania

Probably the largest bridge that has thus far suffered destruction in the European War is the great cantilever bridge at Cernavoda, Roumania, which was wrecked by the retreating Roumanian army on Oct. 26. The bridge was completed and formally opened for traffic 20 years ago and was, so far as we are aware, the longest span cantilever bridge in continental Europe.

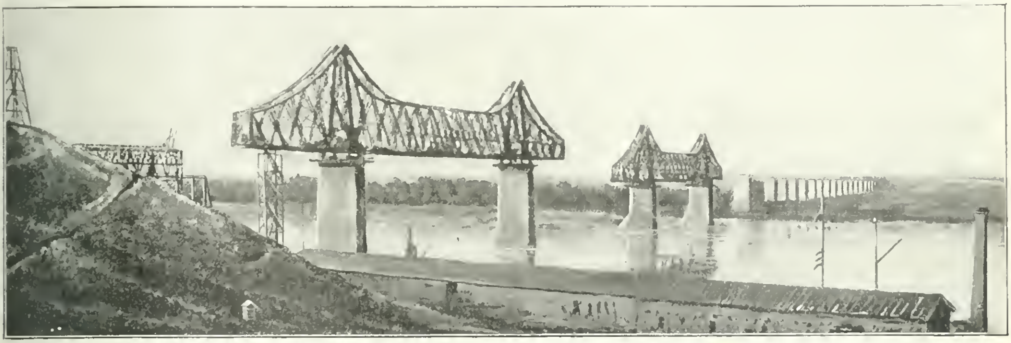

FIG. 1. VIEW OF THE CERNAVODA BRIDGE OVER THE DANUBE UNDER CONSTRUCTION

(Two main cantilever spans completed and piers supporting them under construction)

A full description of the bridge was published at the time of its completion, in *Engineering News* of Aug. 27, 1896. We reproduce from that issue the accompanying photograph showing the bridge partly completed, with a side elevation of the structure and a cross-section making clear the extreme batter of the trusses. The photographic view also makes evident the unusual plan adopted for the erection of the structure. The main cantilever spans were erected when the piers were only a short distance above the water level, and the spans were raised by hydraulic jacks as the piers themselves were built up until they reached their final elevation.

The bridge was built by the Roumanian Government, and nearly 5½ years were occupied in its construction. Some of the chief features of interest with respect to the structure, as printed in *Engineering News* 20 years ago, are as follows:

At the point on the river where Cernavoda is located, and where it was determined to place the bridge, the Danube is divided into two branches by the island Balta. The river flows in a northerly direction at this point, and it is the easterly channel that retains the name of Danube, the westerly being called the Borcea River. The island is swampy, and at certain times is entirely covered with water. It is between seven and eight miles in width. Two bridges are thus necessitated, and on the island a long stretch of embankment with an open viaduct about halfway across.

The total length of iron structure is about 13,460 ft., or 2.6 mi., this being divided as follows: Cernavoda bridge, 2,460 ft.; approaches to Cernavoda bridge, 3,000 ft.; viaduct on Balta island, 4,770 ft.; Borcea bridge, 1,380 ft.; and approaches to last named, 1,840 ft. The first two mentioned portions may be seen in Fig. 1, showing the Danube bridge in course of construction. The piers for the 15 spans of the approach lead away westward to the end of the embankment in the distance.

The contract for the construction of the Cernavoda bridge, not including approaches, was awarded to the Société de Fives-Lille, of France, for $1,570,000. This estimate was based on a rate for the superstructure of $135.40 per ton weight, including erecting and painting. The estimated weight was 5,150 tons; the actual is about 5,500.

The construction of the river piers was attended with unusual difficulties. It was required that they be built on bedrock, and to accomplish this it was necessary to sink the caissons to a depth of 101 ft. below water level. Much difficulty was experienced in working at this great depth, the extreme pressure proving fatal to a number of laborers. The total height of the pier is 207 ft., giving the floor of the bridge an elevation of 121 ft. above high-water level.

There are four river piers, each two supporting a span 790 ft. long, consisting of two end cantilevers, each 164 ft. in length, and a central truss construction. The spaces remaining are filled with three 295-ft. truss spans, having half-parabolic top chords. An elevation of the bridge, showing length of various parts, is given in Fig. 2. The width of the bridge at the floor level varies from 29 ft. at the piers to 21 ft. at the ends of the cantilevers. These widths are maintained throughout the 467-ft. and the 295-ft. portions. Fig. 3 is the end elevation of the superstructure at a pier. One of the most noticeable features of the construction, the rapid narrowing from bottom to top chords, is here shown. The slope of the trusses is 1:10 with the vertical. Basic open-hearth steel of a tensile strength of from 59,000 to 68,000 lb. per sq.in. is used in the main bridge. The elongation at failure in tests of this steel was about 20%, and the elastic limit was about 34,000 lb. per sq.in. On the approaches a milder grade of steel was used.

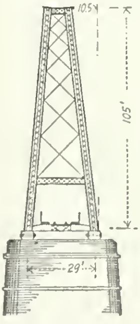

FIG. 3. SHOWING INCLINATION OF TRUSSES

The two main spans of the superstructure, as shown in Fig. 1, were erected at the same time with the piers themselves. They were first lifted by trestles to high-water level. From that point they were raised by hydraulic jacks on the piers. The jacks were supported on pipes embedded in the masonry of the piers, there being four pipes in each pier, used in pairs. While one pair was being extended, the other supported the weight of the jacks. In this way ample space for working at the top of the piers was obtained. The bridge is crossed by but a single track.

The approaches and viaduct present no features of particular interest, except, per-

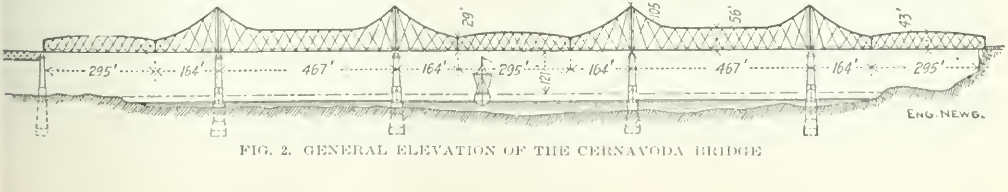

FIG. 2. GENERAL ELEVATION OF THE CERNAVODA BRIDGE

haps, the solidity and permanency of construction prevailing throughout. The masonry piers are surmounted by trusses of ordinary type. The embankment is built in a substantial manner, with a generous use of riprap.

The Borcea bridge is similar in appearance to the larger structure. It has but two river piers, which support a 790-ft. span like the central spans of the Cernavoda bridge, and connection to shore is made by two 295-ft. half-parabolic spans, as before. The bridge floor is 62 ft. above high-water level.

The total cost of the work, including both bridges and all approaches, was, in round numbers, $6,000,000.

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How the Engineer Should Use the Technical Journal

By R. Fleming*

Upon graduation every engineer should subscribe for an engineering journal, or two if he can afford them. It is always best to have one's own copy. More careful attention will be given to the subject matter than if the copy is borrowed, or read hastily in a public library. Any man will lose ground who does not keep in touch with the current events of his profession. It is the "growing" engineer who takes a technical paper. The engineer who is not growing has but little use for one.

The engineering journal furnishes a graduate course in engineering. The application of the laws of mechanics may be seen even in articles that are purely descriptive. In technical articles a wider range is given to fundamental laws. For example, Newton's three laws of motion have been carried to fields undreamed of by the great philosopher.

An analysis of the contents of a number of *Engineering News* shows 48 to 56 pages devoted to technical and descriptive articles, book reviews, personals and similar items, 16 pages of construction news and 100 pages or more of advertisements. The growing engineer does not confine his reading to subjects that affect him directly. He may be vitally interested in the strength of steel compression members, but this does not prevent him from reading papers on dam failures or the artificial disposal of sewage. If he has to deal with contracting, he will give special attention to construction news. An editor of a well-known engineering paper writes:

> It is hardly necessary to point out that if magazines did not have advertisers the technical journal, as we know it today, could not exist. It costs from $12 to $17 per annum to send a high-class technical journal to a subscriber, yet he pays but $3 or $5 for it. From $9 to $12 must therefore be taken from the advertising revenue and paid out in expenses for each subscriber on the list.

That the advertising pages are indispensable to the subscriber interested in buying and selling goes without saying. The general reader makes a mistake if he supposes that they are without value to him. He should occasionally read them from cover to cover. It is significant that in the best technical libraries the portions devoted to advertisements are bound in separate volumes and given a permanent place on the shelves. Advertising today is educational. Witness the following from the weekly page of a national advertiser:

> But friction represents a curious paradox in the various fields of engineering and mechanics. It is at once essential to efficiency and opposed to it. Practically all applications of power depend finally upon friction; also all power applications are subject to serious losses due to friction.

Industrial processes often first become known through the advertising columns. The technical paper or article follows, and finally the description is embodied in textbooks. Publishers announce their new books in th advertising columns. These announcements with th book reviews are often neglected by engineers. Her are two quotations applicable to engineers "too busy t read" and others "too poor to buy" books and periodical

> The busier the engineer or the leaner his pocket-book th greater the need that he should know just what is the newe and the best in engineering literature.
>
> . . . .
>
> Are you too busy to read? Seriously ask yourself: Am I If you are, then you have cut off almost every road to furth knowledge and power save such narrow pathways as yo may laboriously hack for yourself, unaided, through th jungle of ignorance.

What use shall be made of the technical journal aft it has been read? The obvious answer for an engine taking but one or two papers is to have each volun bound for his reference library as soon as the index published. In addition, he should have a system indexing or recording information. In this way he m make subservient to him books and papers that he do not own. If he has access to large libraries, he is baffl by the mass of engineering literature that confronts hi Real value can be derived therefrom only by a proc of elimination and a judicious system of note-takin Davies, in his "Engineering Office Systems and Method says:

> The author has many times sincerely wished that, in add tion to the usual graduation exorcisms to honesty, hard wor etc., he had at that time been introduced to the loose-le method of keeping engineering data and sketches.

While the pleasure of an hour or two of desulto reading among a score of periodicals is admitted, mu trouble and after-search will be saved if notes are ma on the spot. An abstract from an article should be brief as possible. Often the title is sufficient. In cases care should be taken that the authority, with na and date of publication, is copied correctly.

Many systems of filing and indexing information f because they undertake too much. The card index, indispensable to office and library, is seldom adapted the needs of the individual engineer. For a general ind of technical periodicals attention is called to "T Industrial Arts Index," covering a wide range of subje in an excellent manner.

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Marketing Engineering Abilit

By C. F. Harding†

The engineer has been freely criticized as "narrow It is said that he is unable to discuss subjects that not immediately pertain to his profession. His estima and recommendations are often considered as impr tical by the business man who is seeking engineer advice. In correspondence and upon the witness sta his statements are said to be too academic and involv

Engineering ability *per se* is not to be seriously cr cized, but rather the marketing of that training in t public mart of twentieth-century demands. The avera young engineer of today has the latent technical abili but lacks the wherewithal to provide that ability w the handle that the layman, the business manager a the town council must necessarily grasp if the engine ing profession is to be elevated to the position occupied in the public mind by the physician and the lawyer.

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*American Bridge Co., 30 Church St., New York City.

*Abstract of a paper read before the American Associat of Engineers, at Chicago, Oct. 6.

†Professor of Electrical Engineering, Purdue Univers Lafayette, Ind.

It will be granted that the average engineer is technically well trained. The employer and the public, however, justly demand more than this relatively small portion of the qualifications necessary for engineering success. The importance of such qualities as good habits, self-reliance, industry, honesty, punctuality, initiative, system, popularity, etc., might be considered at considerable length. The object is not solely to secure more salary, for success and enjoyment of life are not measured in dollars and cents alone.

How is this bond between the engineer and the employer or the public to be strengthened? First, it may be said, convince the young engineer of the importance of good written English and the necessity of clear and concise verbal presentation of his recommendations to a nontechnical individual or audience. If an illustration of this need were called for, the following clause taken from an architect's specifications applying to a building of considerable value would suffice:

> Material and Workmanship—The entire framework, columns, beams, etc., as indicated by the framing plans, or as specified, is to be of wrought steel, of quality as hereinafter designated, all materials to be provided and put in place by this contractor. All work to be done in a neat and skillful manner, and is to guarantee the construction and workmanship with a bond equal to amount of tender for a term of five years, satisfactory to the proprietor and architects, to properly carry or support the loads it is designated to carry, namely its whole weight, the weight of the several floors, roof and walls resting thereon, a 10,000 gravity tank, and the pressure of any wind which may not be designated a hurricane, and future three stories.

The engineer should acquire knowledge of business principles, with which his audience is too often more conversant than himself. Who shall interpret into the language of dollars and cents the estimates and findings of the engineer? Can anyone but him analyze as intelligently the valuations upon which the corporation is to base its rate schedules? Surely, no one will question the justification of such a one suggesting to commission or court the fair and equitable gross income that should be allowed a railway corporation in order that it may pay a reasonable dividend upon its stock, when he is perhaps more conversant than anyone else with the construction, operating problems and costs of the particular utility in question. But the average young engineer knows little or nothing about rates, dividends, capitalization, stocks, bonds, etc. And what is worse, many consider it none of their affair.

An estimate of the cost of an engineering project often forms the connecting link between the business world and the engineer. The business manager, the banker, courts and commissions judge the engineer by that portion of his work with which they are familiar—that is, estimated cost of construction, court testimony or appraisals of property. One commissioner severely criticized the engineering profession in general, because two or three engineers varied by a margin of 10% upon a $5,000,000 appraisal in which "going value" entered as a large factor. He argued that engineering was an exact science, and that unless the estimates of engineers could be made as exact as the science they represent the profession was at fault. This example is quoted to indicate the basis upon which the profession as a whole is often falsely judged. Engineering was in this case shorn of its art, and the important element of personal experience behind the judgment of able engineers was left out of consideration. Accounting practice and the proper treatment of depreciation reserves should be matters of common knowledge to the engineer.

Business knowledge, however, even when coupled with a command of one's mother tongue, would fall short of the market demands upon the engineer without the necessary tact that must be exercised in all relations with the public. In a recent investigation made by a subcommittee of the National Electric Light Association the following significant statement was submitted by one of the prominent managers of the West:

> Tact is one of the most important things in the public-utility business today, if not the most important. Tact and the habit of accurate thinking are essential, and we must add to these a good allowance of energy. My observations in the whole Northwest lead me to believe that most of the executive failures in this part of the country were due to lack of tact, and also to lack of ability to think rapidly. A technical graduate is too often inclined to follow strictly the letter of the law. This is because he has to deal so much with absolute natural laws which could not be tinkered with, whereas the executive and the commercial men have to deal with human beings, who as far as I can discover, do not follow any laws at all.

The executive quite often fills the gap between the engineering department and the board of directors or the public. He acts as the buffer to receive the rough edges of the average engineering report, and to polish its surfaces that they may make better contact with the layman and the financier. Unfortunately he must frequently stand upon the fence picking the rough burrs from the tree of scientific investigation, which he must laboriously open before the tender kernels of opportunity for investment are disclosed. The term "executive ability" has come to mean "marketing ability" in many corporations. It is a comprehensive quality involving many of the factors previously discussed.

George Westinghouse was an engineer, first, last and always. There are many such in executive offices in this day. The number is rapidly increasing. Whereas we may grant for the sake of argument the claim of skeptics that executive ability is born and not made, it must be admitted that such a quality is often latent and lies dormant for years in many a human system.

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Light-Excluding Effect of Plate Girders—The question of the comparative light-excluding effect of lattice girders and plate girders in elevated-railway construction has been the subject of considerable controversy in connection with the third-tracking of elevated lines in Brooklyn (New York). The easterly half of the Fulton St. line was reconstructed a year ago with plate girders for both transverse and longitudinal supporting members to accommodate the third track. When drawings were submitted by the railroad company for the westerly or downtown portion of Fulton St., showing a similar type of construction, considerable objection was raised by property holders because of the amount of light and air which the proposed construction would exclude from the important stores which line this thoroughfare. The new three-track structure will be considerably wider than the present one and will require much heavier girders than the present girders, which are of the lattice type. The railroad company failing to obtain the approval of the Public Service Commission for the plate girder design has now submitted drawings showing transverse girders of a combination type. These girders have a central portion about 22 ft. in length with lattice web members, while at each end is a web plate about 12 ft. in length. The loads on these girders are such that the end members of a full lattice girder would require very large connection plates, which would exclude practically as much light as a web plate. The Chief Engineer of the Public Service Commission has approved this type of girder, and Commissioner Henry W. Hodge has recommended approval by the Commission.

News of the Engineering World

Hopple Street Viaduct Open

The Hopple St. viaduct, Cincinnati, Ohio, consisting of reinforced-concrete cantilevers supported on 26 sets of concrete piers, is now open for traffic and will be completed as soon as the electric-lighting system is installed. All piers are on a skew to the center line of the structure. and each one independently supports two balanced cantilevers. The total length of the viaduct proper is 1,930 ft., and with the approaches approximately 2,600 ft. It provides a direct connection between Camp Washington and Fairmount, eliminating grade crossing for the Cincinnati, Hamilton & Dayton, the Baltimore & Ohio and Big Four railroads as well as providing a bridge over Mill Creek. In times of high water due to Ohio River floods all street traffic between the eastern and western hills can be routed over this structure. The total cost is about $430,000, of which amount the city will pay $66\frac{2}{3}\%$ and the railroads $33\frac{1}{3}\%$. The construction work was done by the Kirchner Construction Co., Cincinnati. The superintendence of the work for the city was by Frank L. Raschig, principal assistant engineer, and F. S. Krug, chief engineer; and for the Baltimore & Ohio R.R. by A. M. Kinsman, engineer of construction, and C. W. Millholland, resident engineer.

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Concrete Symposium at Meeting of Albany Engineers

The Albany Society of Civil Engineers conducted a symposium on concrete on the general subject of "Present Day Concrete Practice, or Safety First in Concrete," on Oct. 24, under the leadership of R. S. Greenman. Concrete aggregates were discussed by D. A. Watt, Assistant Engineer, U. S. Engineer Department, who stated among other things that hardness of stone is not so important for mass concrete, giving several examples where soft rock and even shale has been used successfully in concrete piers. He preferred gravel to stone. The matter of using both gravel and broken stone in the same concrete was brought up, the opinion being that such practice was permissible. Joseph Ripley, Consulting Engineer to the State Engineer, discussed various methods of placing concrete, with special regard to chuting. He stated that the slope of chutes on the Barge Canal work was 1 on $1\frac{1}{2}$, maximum length being 700 ft. When the slope is too steep segregation results. With a flat slope there is too much water. Attention was called to the fact that some contractors are slow to move the spout in the forms, preferring to run the concrete to one end of the form and throw the soft material toward the other end. This, of course, is a matter for the inspector to adjust.

H. S. Mattimore, First Assistant Engineer, State Highway Commission, discussed concrete roadwork. The state built its first concrete road in 1912. This was a $1:2\frac{1}{2}:5$ mix, and the maintenance cost has been $1,000 per mile per year. At the present time a first-class concrete road costs to maintain only $129 per mile year. Of course, a rigid road requires a rigid shoul and a large part of the maintenance work is done on shoulders.

Before placing concrete on an old macadam road, practice is to scarify the old road and re-roll it. T concrete roads of New York are 7 in. thick in the cer and $5\frac{3}{4}$ in. at the sides.

G. T. Murphy discussed concrete in buildings, choos "Inspection" as his text. He maintained that ci should provide inspectors to watch the placing of conc for private buildings. In reply the city engineer s gested that it was up to the architect and owner provide adequate inspection.

Mr. Greenman's subject was concrete fads, the grea of which appeared to be waterproofing. He called att tion to the necessity for exercising stringent care selecting the aggregates, and repeated what is generally accepted, that hydrated lime in proportions from 8 to 10% by weight makes a smoother flowing a denser concrete. He stated his belief in the possibi of making too rich a mix.

⁂

Texas Engineers Discuss License Law*

The most important subject considered at the ann meeting of the Texas Association of Members of American Society of Civil Engineers, held at Dal Tex., Oct. 20 and 21, was the proposal to license engineers in the State of Texas. About 40 meml and as many engineer guests were present.

The subject of licensing Texas engineers has been un study and investigation for the past 18 months b committee of the Texas Association, of which J. M. H is chairman. The report of this committee covered investigations of the workings of similar license laws Louisiana and Wyoming and the architects' law in Illin the activities of the Texas architects for a proposed ar tects' license law, as affecting the practice of structu engineers and designers of buildings for engineer purposes, together with a draft of a proposed license as drawn by the committee.

The proposed Texas license law provides for licens surveyors and engineers separately under distinct qu fication requirements, provides for a Board of Examin with authority to revoke licenses for cause, and provi for temporary licenses without examination for quali engineers from without the state, together with penal as a means of enforcing the law.

A number of letters were presented, which had b sent in response to inquiries from local members engineers in the North familiar with the discussion a investigations made on the subject by the Ameri Society of Civil Engineers. The discussion brou a lively debate as to the advisability of the proposed l

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*Contributed by Terrell Bartlett, of Bartlett & Ran San Antonio, Tex.

The sense of the meeting was unanimous that some method should be found for eliminating the impostor engineer with the public loss and injury to the profession resulting from his operations. As to the efficacy of the proposed law to this end there was sharp division of opinion. There was no apparent advocacy of the law for the purpose of making a close corporation of the engineering profession of the state. There was an expressed feeling that no legislation should be attempted unless the engineers of the state were fairly unanimous as to its desirability and character.

A motion by John B. Hawley, a director of the American Society of Civil Engineers, indorsing the proposed law and voting the committee plenary powers to carry on negotiations for the legislation was lost by a close vote. The final action taken authorized the committee to continue its investigations, and to ascertain further the sentiment of all engineers in the state on the subject of licensing engineers.

⁂

Completion of Calcasieu River Bridge; Lake Charles, La.

There was recently completed over the Calcasieu River, near Lake Charles, La., the notable reinforced-concrete bridge shown in the accompanying view. From south to north the bridge comprises one 30-ft. girder span; three arch spans of 96 ft. each (clear); one double-leaf deck plate-girder drawspan of the Strauss trunnion bascule type, 118 ft. c. to c. of main bearings; three arch spans of 96 ft. each; and twenty-eight 30-ft. girder spans. There is a 20-ft. roadway.

The minimum depth of water at the bascule piers is 32 ft. All piers were constructed by the open-caisson method. Each arch span consists of two ribs with spandrel columns supporting the concrete deck. The bascule lifts are operated by two 5-hp. electric motors.

The contractors for the concrete work were the Missouri Valley Bridge and Iron Co., Leavenworth, Kan., and the ruin-Conlon Contracting Co. The bascule lift drawbridge was fabricated by the Federal Bridge Co., Waukesha, Wis., and erected by the Missouri Valley Bridge and Iron Co. All electrical equipment was designed by H. Norwood, electrical engineer, Chicago, Ill. F. H. Franklin, consulting engineer of St. Charles, La., prepared plans and specifications, and had general supervision of construction of the bridge, which was built for the Parish of Calcasieu at a cost of $131,000. It is on the Spanish Trail Highway from New Orleans to Houston, Tex.

⁂

New St. Paul Union Station Plans Approved

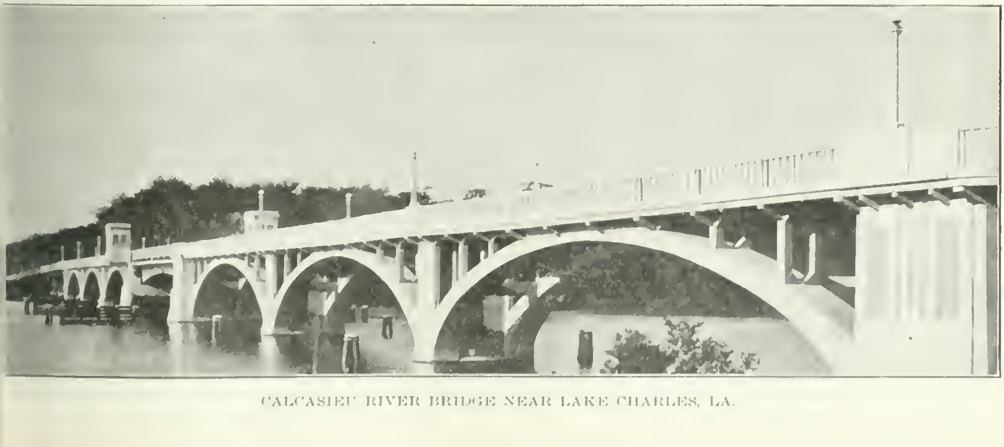
On Sept. 28, 1916, the St. Paul Union Depot Co. approved the new plans for a union station at St. Paul, Minn., and authorized the executive committee to proceed with the acquiring of land and the construction work. Plans for this union station, which involved the changing of the Mississippi River channel, were prepared over a year ago, but were vetoed by the Chief of Engineers because of improper provision for navigation requirements. The new scheme does not contemplate any change in the channel.

The revised layout makes it necessary that the Great Northern, the Northern Pacific, the Chicago, Burlington & Quincy, the Chicago, St. Paul, Minneapolis & Omaha and the Chicago, Milwaukee & St. Paul railways turn in considerable land, the basis for which has already been made. Only one piece of private property remains to be taken.

⁂

Limit Set to Court Review of Utilities Commission Orders

The New York Court of Appeals has recently rendered a decision of far reaching importance with respect to the powers of a public service commission to control the operations of the companies under its jurisdiction. The commission is given authority under the New York law to direct public service corporations to undertake "reasonable improvements." On Mar. 19, 1915, the Commission for the First District directed a gas company to extend its mains and supply service in certain outlying territory. The gas company appealed to the courts against the enforcement of this decision, contending that the cost would be greater than the financial return would warrant. The Appellate Division upheld the gas company and annulled the order of the commission as unreasonable. This ruling has now been reversed by the Court of Appeals in a unanimous decision. The important point in the decision is



CALCASIEU RIVER BRIDGE NEAR LAKE CHARLES, LA.

the declaration that courts have no right to exercise such administrative powers as those possessed by the Public Service Commission. The court could only annul the commission's order if it found it to be an unreasonable, unlawful, arbitrary, or capricious exercise of power. The court had no authority to go into all the details of the case and practically act as a public service commission of a superior order. The Court of Appeals declared that if the decision of the Appellate Division had been allowed to stand it would "go far toward defeating the efforts of the Legislature to establish agencies to regulate great public service corporations."

*

Engineers' Advice Not Heeded

Sharp criticism of the Mayor of Cleveland, Ohio, for not following the suggestion of a committee of the Cleveland Engineering Society that engineers be chosen for directors of public service and public utilities was a feature of a recent address before the society by Mayo Fesler, secretary of the local Civic League and secretary to ex-Mayor Newton D. Baker. Mr. Fesler said in part:

> The Cleveland Engineering Society, always alive to the best interests of the city, sent the newly elected mayor, Harry L. Davis, a courteous letter offering the most generous coöperation of the society and its members in the improvement of the public service.
>
> In that letter the committee wisely pointed out how much more economically and efficiently the technical service could be performed if men with engineering training and experience were appointed. This was in full accord with the mayor's own statement in his platform and on the stump.
>
> The letter specified particularly the offices of director of public service and director of public utilities as positions that should be filled "by men having broad engineering experience combined with administrative ability."
>
> What did the mayor do? He appointed to the directorship of public service a lawyer whose only training for the office was three terms in the city council and effective political service in both Mayor Davis' mayoralty campaigns.
>
> The directorship of public utilities was given to the secretary of the Federation of Labor, whose training had been that of business agent for the waiters' union.
>
> Immediately under the director of public service are two offices which only engineers can fill satisfactorily and efficiently, the city engineer and the commissioner of streets.
>
> The city engineer, a member of the engineers' society, was not disturbed, but in the new position of commissioner of streets, to which the citizens' street committee, appointed by the Cleveland Automobile Club, had urged the appointment of a competent engineer, the director appointed a horseshoer, a ward leader whose only experience had been a few months' service in the street department under a previous Republican administration.

*

Highway Bridge Wrecked by Concrete Mixer—The bridge carrying Beale St., Quincy, Mass., over the tracks of the New Haven R.R., was wrecked on Oct. 27 by a large concrete mixer on a flat-car in a train passing beneath it. The bridge was nearly 50 years old and is said to have afforded less headroom than more modern structures on the line. The concrete mixer projected above the box-cars in the train high enough to cause the damage. A 12-in. water pipe that crossed on the bridge was broken. As considerable time elapsed before the water was shut off, the neighborhood was flooded.

A Septic Tank Patent Infringement Suit has been brought against Shelbyville, Ky., by the Cameron Septic Tank Co., Chicago, Ill. Since Shelbyville is a member of the National Septic Process Protective League, the City will be defended by Wallace R. Lane, of Parkinson & Lane, Chicago, attorney for the League. Mr. Lane defended the Knoxville, Iowa, suit.

The Relative Cost of the Different Essentials in road building, according to statistics compiled by the American Highway Association, are given as follows: In the case of 87 gravel roads the grading and drainage averaged 41% and the surfacing 59% of the total cost; in 104 waterbound macadam roads the grading and drainage cost 37% and the surfacing 65%. In 53 bituminous macadam roads these proportions were 2" and 73%. These figures show that more than half the cost of a surfaced road is generally spent for the materials labor employed in surfacing the graded and drained roadl

New Passenger and Freight Terminals for the City Cincinnati, Ohio, have been definitely decided upon, accor to a statement published in the "Cincinnati Enquirer" of 4. It is stated that the three most important railways tering the city, the New York Central Lines, the Pennsylv and the Baltimore & Ohio, have agreed upon a tentative for a passenger terminal that will place the tracks and station at least 75 ft. above low-water mark, so that op tions will not be interrupted even by a record-breaking fl The plans include reconstruction of the city's freight-term facilities as well.

City Operation of Private Gas and Electric Plants been proposed by the Memphis (Tenn.) Municipal Commis to two local electric companies. The utilities would be lowed annually 6% return and 3% depreciation on appra value. The Commission made an alternative proposition the general reduction of local rates, seeking a maximun 6c. per kw.-hr. for current in place of 10c.; 85 and 80c. 1,000 cu.ft. for gas in place of $1; and lower prices for st lighting. The companies have made a counter proposal rate adjustment after appraisal. The city some time authorized the issue of $1,500,000, bonds for a municipal tric plant, and these bonds have now been advertised sale on Nov. 14. The Commission has employed F. W. Bal of Cleveland, as its engineer, and has asked him to sele site for a municipal station.

PERSONALS

F. T. Cadmus has resigned as Manager of the Amb plant of the American Bridge Co. to become Manager of Pottstown plant of the McClintic-Marshall Co.

George H. Gascoigne, Assoc. M. Am. Soc. C. E., Assis Engineer of the city engineering staff of Cleveland, Ohio, been appointed Sanitary Engineer at a salary of $2,400 annum.

T. J. Turk, Chief Engineer of the Inter-State Motor Muncie, Ind., has been appointed Assistant General Man of the company. He is a mechanical-engineering gradua the University of Michigan.

Myron E. Fuller, recently with George W. Fuller, sulting Engineer, New York City, has accepted a position the engineering staff of the City of Philadelphia, Pen connection with proposed sewage-disposal works.

C. P. Collins, Assoc. M. Am. Soc. C. E., has resign Sanitary Engineer of Johnstown, Penn., together with members of his staff, as a result of friction between the Department of Sanitary Engineering and the City Engi ing Department.

William A. Duff, Assoc. M. Can. Soc. C. E., Engine Bridges of the Canadian Government Ry., at Moncton, has been promoted to be Assistant Chief Engineer. He have the duties of both Engineer of Bridges and Engine charge of the Halifax ocean terminals.

John H. Bringhurst, Assoc. M. Am. Soc. C. E., has res as Instructor in Civil Engineering at the University of igan to become Associate in Civil Engineering at Johns kins University under Prof. C. J. Tilden. Mr. Bringhu a graduate of the University of Michigan.

Alfred D. Flinn, M. Am. Soc. C. E., Deputy Chief Eng of the Board of Water-Supply of the City of New York been appointed Secretary of the Mayor's Advisory Comm on the extension courses of the College of the City of York, which have been organized for the benefit of mun employees.

C. C. Harshman, of San Francisco, who is the author article on "Obsolescence in Appraisals for Rate Ma appearing elsewhere in this issue, is a graduate of the trical Engineering Department of the University of Cali and has been valuation engineer on the staff of H. T. Co San Francisco, since September, 1914. In this position h had chief responsibility in connection with the valuati some of the principal public utilities of California, n the Los Angeles Gas and Electric Corporation, with a ation of $16,000,000, the People's Water Co., $16,000,00 the Mount Whitney Power and Electric Co., $4,000,000.

L. W. Baldwin, General Manager of the Central of G Ry., has been elected a Vice-President of the railway pany. He was graduated from Lehigh University in 189 began his engineering experience as a chairman on the I Central R.R. in July of the same year. He was in th gineering and maintenance-of-way departments until when he became a trainmaster. After being promoted in the operating department to the position of Division Superintendent, he returned to the engineering corps as Engineer of Maintenance-of-Way. But three years later he again became Division Superintendent and in January, 1915, became General Superintendent of the southern lines of the Illinois Central R.R. at New Orleans. Since November, 1915, he has been General Manager of the Central of Georgia Ry.

OBITUARY

Samuel Brown, for 30 years Superintendent of Erection for the T. H. Brooks Co., Building Contractors, Cleveland, Ohio, died Oct. 14. He had charge of construction of several Cleveland skyscrapers.

Robert Edgar Noyes, M. Am. Inst. E. E., former Instructor in Electrical Engineering at Pratt Institute, Brooklyn, N. Y., died Oct. 21 at his home in Pittsfield, Mass., from infantile paralysis (acute anterior poliomyelitis). He was born in Crowell, Neb., Dec. 14, 1879. He is survived by a widow and two young daughters.

Charles W. Hotchkiss, M. Am. Soc. C. E., Chairman of the Board of Directors of the Virginian Ry., President of the Richmond Light and Railroad Co. of Staten Island, New York, and widely known in the railway and financial fields, died Oct. 29, at Battle Creek, Mich. He was born in Unadilla Forks, N. Y., June 17, 1863. His engineering experience began at 18 years of age as a rodman on the New York, West Shore & Buffalo R.R. Subsequently he was for 10 years Assistant Engineer of the Michigan Central R.R. From this position he was promoted in 1896 to that of Chief Engineer of the Chicago Junction Ry. From 1899 to 1900 he was Chief Engineer of the Chicago Transfer and Clearing Co. For the following five years he was President of the Indiana Harbor R.R., then General Manager of the Chicago, Indiana & Southern R.R. In 1912 he was elected President of the Chicago Tunnel Co. Mr. Hotchkiss moved from Chicago to New York in 1913, when he was elected President of the Rail Joint Co. of America. He was a member of the Western Society of Engineers, the American Railway Engineering Association, the Engineers Club of New York and other clubs in Chicago and New York.

Theodore Newell Ely, M. Am. Soc. C. E., formerly Chief of Motive Power of the entire Pennsylvania R.R. system, died Oct. 29 at his home at Bryn Mawr, Penn. He was born at Watertown, N. Y., June 23, 1846. He was graduated from Rensselaer Polytechnic Institute in 1866 and was employed at the Fort Pitt foundry at Pittsburgh, Penn. His railway experience began in 1868 with the engineering department of the Pittsburgh, Fort Wayne & Chicago Ry., at Pittsburgh, Penn. Soon after he was appointed Assistant Engineer of the Philadelphia & Erie division of the Pennsylvania R.R. He was promoted to be Superintendent in 1869 and Assistant General Superintendent in 1870. Three years later he was appointed Superintendent of Motive Power of the Philadelphia & Erie division and from then on his rise to the head of the motive power department of the entire system was steady and continuous. He was Chief of Motive Power of the Pennsylvania R.R. lines east and west of Pittsburgh for 18 years—1893 to 1911. He was then retired on a well-earned pension. Mr Ely was a member of the American Society of Mechanical Engineers, the Institution of Civil Engineers (Great Britain), the American Institute of Mining Engineers, the Franklin Institute and many other learned and scientific societies. He was President of the Eastern Railroad Association and was a member of the permanent commission of the International Railway Congress. He received the honorary degree of Master of Arts at Yale University in 1897 and that of Doctor of Science at Hamilton College in 1901.

ENGINEERING SOCIETIES

AMERICAN MINING CONGRESS.
Nov 15 In Chicago, Secy., J F Callbreath, Munsey Bldg., Washington, D. C.

AERO CLUB OF AMERICA.
Nov 15 Annual meeting in New York City Secy Wm. Hawley, 297 Madison Ave., New York City

NATIONAL COMMERCIAL GAS ASSOCIATION
Nov 13-18. Convention in Atlantic City, N J. Secy., Louis Stotz, 61 Broadway, New York City

RICHMOND RAILROAD CLUB.
Nov 13 Annual meeting. Secy., F O. Robinson

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov 14 Convention in Washington, D. C Secy., W. H Connolly, Washington

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H Roth, 1410 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The National Builders' Supply Association will hold its annual meeting at the Hotel Sherman, Chicago, Feb. 12-13. The secretary is L. F. Desmond, 1211 Chamber of Commerce, Chicago.

The Tenth Chicago Cement Show will be held in the Coliseum Feb. 7 to 15, under the management of the Cement Products Exhibition Co. (Blaine F. Smith), 210 So. La Salle St., Chicago.

The American Concrete Institute will hold its annual meeting coincidently with the Cement Show, at the Hotel La Salle, Feb. 8 to 10. The secretary is Harold D. Hynds, 1418 Walnut St., Philadelphia.

The Illinois Lumber and Builders' Supply Dealers' Association will hold its annual meeting at the Hotel Sherman, Chicago, Feb. 14 to 16. The secretary is Geo. W. Jones, 431 South Dearborn St., Chicago.

The Municipal Engineers of the City of New York will hold their 14th annual dinner at the Hotel McAlpin, on Saturday, Nov. 25, at 7 p.m. Tickets sell for $3 each. C. S. Bell is Chairman of the House Committee.

The Alabama Technical Association was formally organized at a recent meeting in Birmingham. The association will include the members of the five national engineering societies. The movement for state organization, according to local press dispatches, was started by H. S. Geismer, Frank H. Crockard, S. H. Lewis, Martin J. Lide, Julian Kendrick, H. M. Gassman, F. G. Cutler, Priestly Toulmin and W. E. Mitchell. The constitution and by-laws have been drawn up and mailed to all members of the national organizations in the state.

The Steel Treating Research Club is the name of a new technical society in Detroit, Mich. Meetings are held in the rooms of the Detroit Engineering Society, 46 West Grand River Ave. The present dues are $6 per year for active members; it is very possible, however, that this rate will be cut in half. An employment exchange is provided for the use of anyone requiring services of men for case-hardening, heat-treating, tool or tool-hardening work, or for chemists and metallurgists. The officers are as follows: President, C. N. Dawe, and the Secretary, H. G. Kiefer.

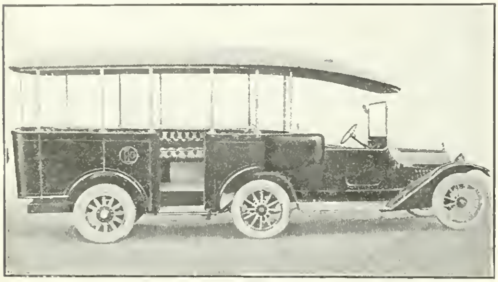
The New England Water-Works Association—The Nominating Committee appointed by President Sullivan met on Oct. 21 and prepared the following list of nominations: For president, Caleb Mills Saville, Hartford, Conn.; for vice-presidents, Carleton E. Davis, Samuel E. Killam, Henry V. Macksey, Frank A Barbour, Percy R. Sanders, Thomas McKenzie; for treasurer, Lewis M. Bancroft; for advertising agent, George A. King, Taunton, Mass.; for secretary, Willard Kent, Narragansett Pier, R. I. The November meeting will be held in Boston, on Nov. 8, at the Hotel Brunswick.

American Society of Mechanical Engineers—The following officers for 1917 have been nominated by the nominating committee of the society: President, Ira N Hollis, president of the Worcester Polytechnic Institute, Worcester, Mass., Vice-Presidents, Charles H. Benjamin, dean of the Schools of Engineering, Purdue University, Lafayette, Ind., Arthur M. Greene, Jr., professor of mechanical engineering at the Rensselaer Polytechnic Institute, Troy, N Y., Charles T. Plunkett, president and secretary of the Berkshire Cotton Manufacturing Co., Adams, Mass; Managers Robert H. Fernald, Whitney professor of dynamical engineering, University of Pennsylvania, Philadelphia, Penn., William B. Gregory, professor of experimental engineering, Tulane University, New Orleans, La., C. R Weymouth, chief engineer of Charles C. Moore & Co., San Francisco, Calif., Treasurer, William H. Wiley, publisher, New York City.

Appliances and Materials

Passenger-Omnibus Trailer

A novel design of trailer-type omnibus has been developed by R. B. Fageol, of San Francisco, and is being exploited by the Fadgl Flexible System, Inc., Hobart Building, San Francisco. One of these "flexible street cars" is shown in the accompanying view—that built for the Pacific Electric Co., of Los Angeles. A trial run of this machine over the Tehachapi Mountains and Mojave Desert (250 mi.) is reported to have been made in 10½ hr. and at a gasoline consumption of less than 1 gal. per 18 mi. The car was put in regular service by the Fresno Traction Co. in July.



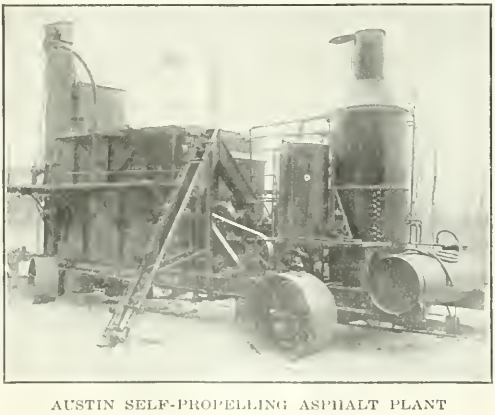
FADGL "FLEXIBLE CAR"

This type of car was designed primarily for use of street-railway companies as a feeder for rail lines. The weight of the bus body is carried largely on the single pair of rear wheels, the forward end being pivoted on any make of car that it is desired to use—even a light Ford. The rear wheels are made to track with the hauling wheels. The body shown seats 15 to 18; a larger size is used for interurban service.

* * *

Self-Propelling Asphalt-Mixing Plant

An asphalt-mixing plant that is portable and self-propelling, to the extent of developing a speed of 1 mi. per hr., has been placed on the market by the Municipal Engineering and Contracting Co., Chicago, Ill. As shown in the accompanying illustration, the machine rests on four steel wheels, the front ones being 40 in. in diameter with 14-in. face, and the rear wheels 48 in. in diameter with 24-in. face. In place of the rear wheels a caterpillar tread may be used. The firebox is built in and forms a part of the main frame. One side is equipped with a furnace for crude oil, the other side with doors and grate bars for burning coal, wood or coke. The drier consists of three drums built into one unit. The largest drum is 68 in. in diameter. Each drum occupies a space 14 ft. by 5 ft. 8 in., and the three are equal to a single continuous drum 4 ft. 3 in. in diameter by 40 ft. long, with 543 sq.ft. of heating surface. The drums revolve at 8 r.p.m. The asphalt-mixing kettle is above the drier and therefore does not require a separate fire. There are two compartments to the kettle. A fluxing tank large enough to hold a half-day's run can be added, or a detached tank on separate wheels may be used. The measuring boxes are one-half batch capacity and are equipped with standard beam scales The mixer is of the two-spindle pug type and is gear driven The mixer discharges into a wagon on the street level, no depressed driveway being necessary.



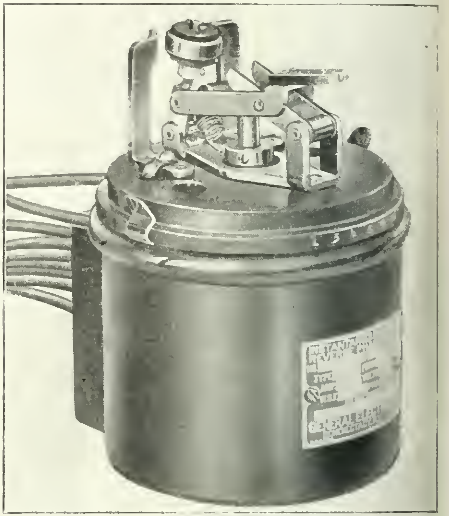
AUSTIN SELF-PROPELLING ASPHALT PLANT

The machine has an overall length of 34 ft. 9 in., a width of 7 ft. 3 in. and an overall height of 18 ft. 9 in. The traveling height with the elevator taken down is 12 ft. The outfi weighs 26 tons. The capacity is rated at 80 cu.yd. per 8-hr day in ½-cu.yd. batches. This is equivalent to 1,200 sq.yd. of 2-in. asphalt surfacing. The machine is known as the Austin asphalt mixer and is made by the Municipal Engineering and Contracting Co., Chicago, Ill.

* * *

Protection Against Accidental Reversal of Motor

A new reverse-phase relay is manufactured in both circuit-opening and circuit-closing styles by the General Electric Co The relay operates on the same principle as the squirrel-cage induction motor; the operating coils correspond to stator, a a hollow aluminum cylinder connected to the contacts analogous to rotor. When a phase is reversed, the plung operates the contact. These relays are furnished for tw phase or three-phase service.



A SAFEGUARD WHEN THE ELECTRIC MOTOR REVERSES ACCIDENTALLY

* * *

Purifier for Lubricating Oil

A new design of purifier or reclaimer for used lubricatin oil is being made by the De La Vergne Machine Co., of Ne York City. The device is in the shape of a double-shell tan the inner compartment containing the oil and the out (annular) serving as a hot-water jacket. The cleanin process consists in agitating the old oil with a solution of special proprietary coagulant, "Oilite." An equal amount hot water is let into the oil from the jacket, a solution of th coagulant (¼ lb. per gal. of oil) is added, and the contents the inner tank are agitated by compressed air or a mechan ical stirrer. Then the mixture is allowed to settle for 10 h The dirt and impurities form a sludge between the clea oil and dirty water. When the connection between inner a outer compartments is opened, the clear oil is automatical discharged.

* * *

Insulating Paint

Two new insulating paints for electrical apparatus a being made by the Union Insulating Co., West Jacks Boulevard, Chicago, under the trade names "Ohmlac" a "Hyblack." They are made from mineral hydrocarbon min in Utah, called elaterite or wurtzilite. This asphaltic ba is combined with nonoxidizing oils and thinned with naphth The paints are claimed to be useful also for protection again gases, acids, alkalies and electrolytic action.

Engineering News

VOLUME 76 NOVEMBER 9, 1916 NUMBER 19

Jacking Up a Viaduct; Buckling Columns Give Trouble

Settlement of the pile foundations under a steel viaduct carrying Riverside Drive across Manhattan Valley in New York City made a very difficult repair job necessary. The work has been carried out successfully, however, and at very low cost, by the Bureau of Highways, Borough of Manhattan, under E. W. Stern, Chief Engineer, and Robert A. MacGregor, Assistant Engineer. A remarkable phenomenon in the course of the job was incipient failure of the lower portions of the columns, as shown in large distortions and web-buckling.

The Riverside Drive viaduct was completed in 1900. A fairly full description of the structure in *Engineering News* of June 8, 1899, pp. 358 to 360, with a double-page inset of drawings, may be consulted with regard to the details. While that article stated that the work was constructed under the Bureau of Highways, with F. S. Williamson as Consulting Engineer, the fact appears to be that a separate organization over which the Highway Bureau had no jurisdiction was in charge of the design and construction, except that the formal countersign of the Bureau of Highways had to be affixed to vouchers. None of the present officials of the bureau were connected with the work, and little or no detail information is found in the files of the Bureau.

The viaduct consists of plate-girder spans about 65 ft. long and one plate-girder span over Manhattan St. about 128 ft. long. In place of diagonal bracing longitudinally and transversely, there is arch bracing. According to the designers' intentions, this arch work was intended to support part of the moving load, or, in other words, to reduce the deflection of the respective plate girders under moving load, but not under dead-load, the arch and girder being merely in contact under full dead-load conditions. The probabilities are that the arches serve principally as ornaments and as bracing, although the bracing effect (in longitudinal direction at least) is seriously reduced by the inadequacy of the bolt connections between arch and girder.

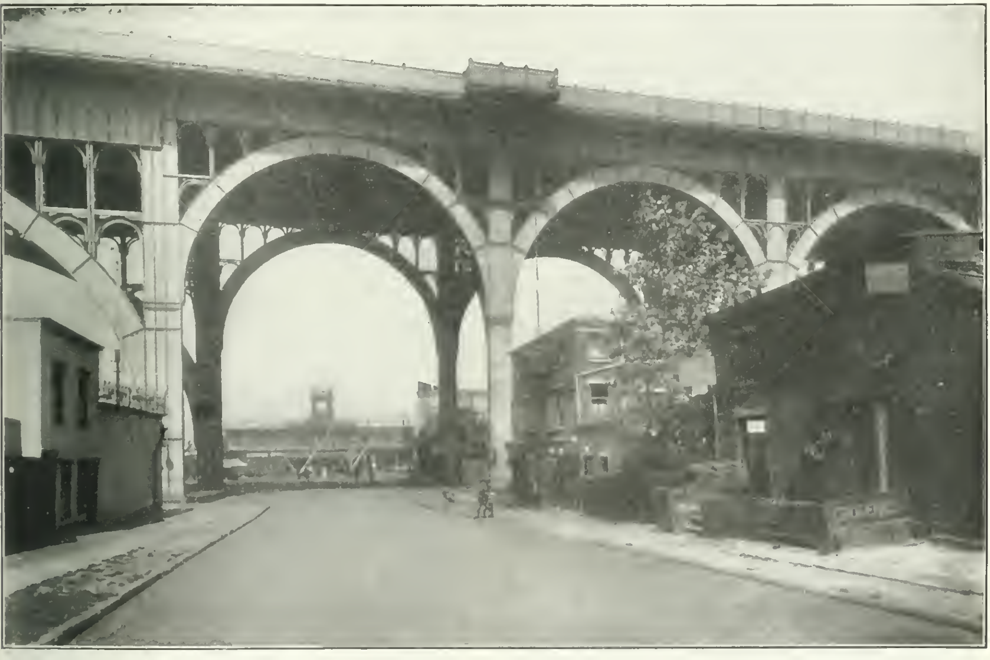
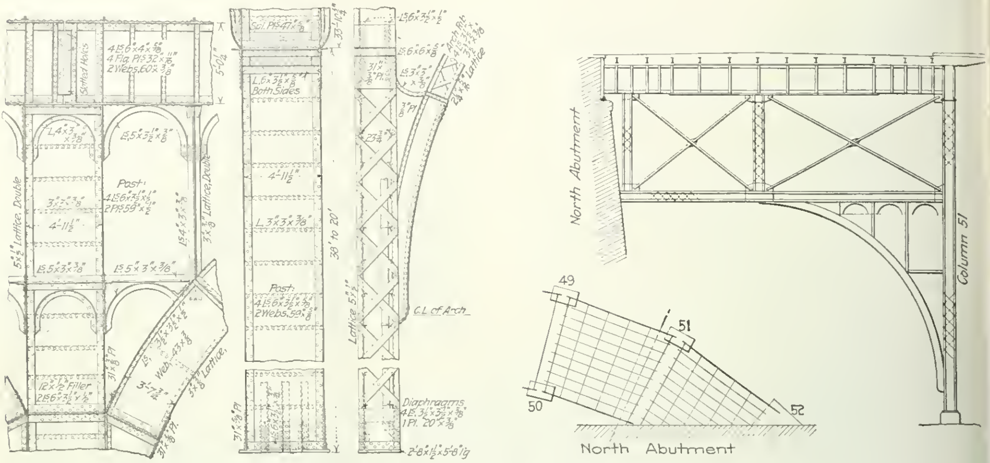


FIG. 1. RIVERSIDE DRIVE VIADUCT, SHOWING TWO OF THE SETTLED BENTS AT THE RIGHT; THE LARGE ARCH IS TO THE LEFT

Some time in 1912 the roadway on the viaduct was seen to show a marked sag in the length of a few hundred feet north of the large arch. Levels were taken on the footings, and it was found that two or three bents had settled, to a maximum of about 7¼ in. Presumably the settlement had existed longer, but maintenance and inspection during the dozen preceding years had apparently not been close enough to give information on the settlement. Plans for repair were made in 1915, and the work was taken in hand during the past summer.



FIGS. 2 AND 3. DETAILS OF RIVERSIDE DRIVE VIADUCT AFFECTED BY FOUNDATION SETTLEMENT

The columns are founded on a concrete spread footing supported by piles cut off about 2 ft. below water level, or 10 to 13 ft. below street level. Each column has 16 piles, giving over 8 tons dead-load per pile.

Why six of the columns should settle and the others not cannot be explained, but the Bureau believes that softer subsoil in the region of settlement is responsible; the location is near what appears to be the deepest part of the geological valley.

In spite of the settlement the engineers of the Bureau decided to rely on the old foundations without reinforcement or other change. This decision determined the general nature of the repair job.

The decision was based on three sets of levels, run respectively in April, 1915, September, 1915, and February, 1916. These showed irregular but not consistent differences; while the later levels showed generally lower elevations, they also showed in a few cases what appeared to be a rising. The conclusion reached was that the differences in levels were to be attributed to indefiniteness of the benches, personal equation of the leveling party, etc., and could not be held to indicate continuation of settlement. It was judged by the engineers of the Bureau that the settled foundations had remained stationary during the ten months of observation and in consequence that it is safe to leave the structure on the old pile foundations, merely jacking up the superstructure to original level.

It can readily be understood that this decision will save a large present outlay. Estimates made for repair with reinforcement of the six settled foundations indicated a cost of $100,000; the method followed is bein carried through for about $11,000.

The columns of the viaduct are designed to carry abo 450 tons total load, but the actual dead-load on them only about 200 tons. All parts of the jacking rig we figured for the 200-ton load. The columns are unusuall large and of peculiar section: A two-rib section wit

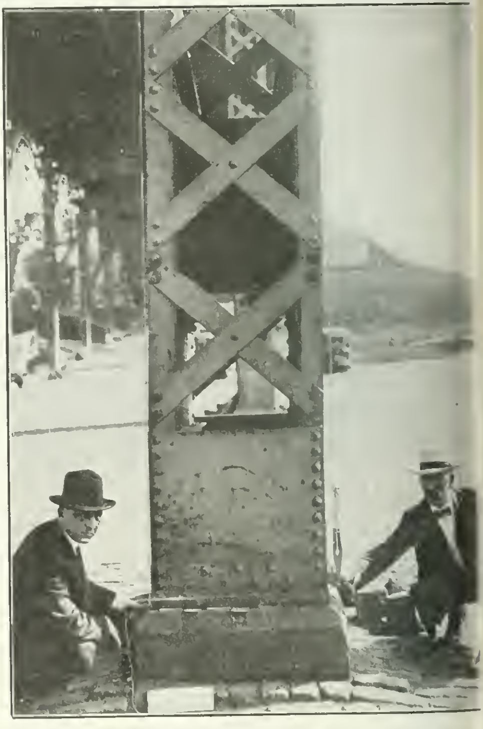
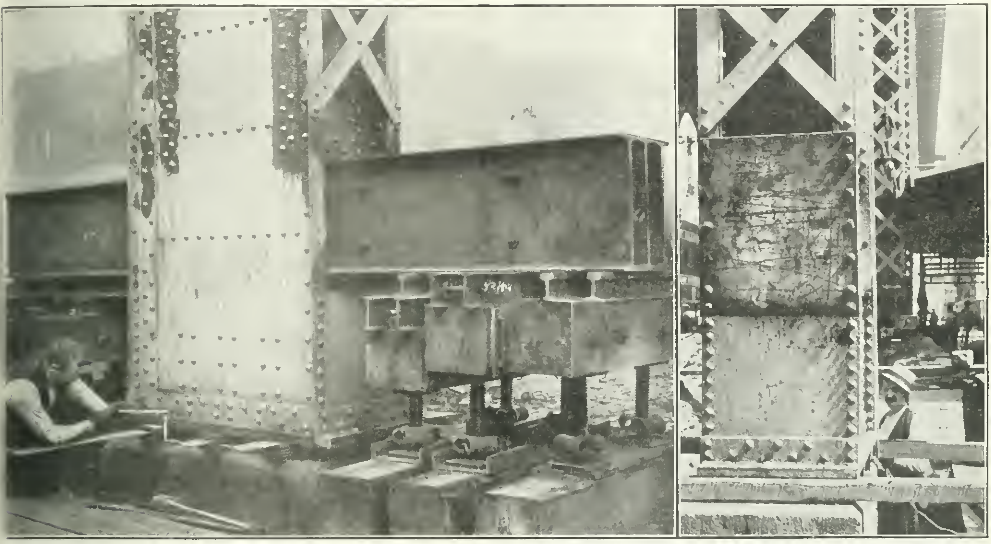


FIG. 4. DISTORTION AS SHOWN BY CHORD-LINE AND PLUMB-LINE (NORTH FACE OF COLUMN 15)

two 59x⅝-in. web plates, four corner angles 6x3½x⅝ in., and inner *horizontal* stiffening angles, the two channel-shaped ribs being latticed on the open (north and south) sides. Two jacking diaphragms were riveted vertically between the two webs, high enough above the base to llow the insertion of a jacking beam. The beam, consisting of three 24-in. I-beams, 16 ft. long, was placed hrough the latticed sides of the columns, bearing upward gainst the jacking diaphragms, and at the outer ends t rested on groups of jacks on cribbing.

This arrangement worked satisfactorily. The cribbing vas proportioned for a soil loading of about 2 tons per q.ft. and was placed in shallow pits about 4 ft. below treet level. Screw jacks were used, of rated capacity 0 tons each. At first four jacks were used under each nd of the triple jacking beam, but later six were placed t each end. The jacking was done on two jacks of ne end at a time, four men working with an 8-ft. bar. t is believed that a lifting force of possibly 75 tons per air of jacks was exerted.



FIGS. 5 AND 6. COLUMN 18 DURING AND AFTER JACKING, SHOWING REINFORCING PLATE AND RESIDUAL KINK

Cast-steel jacks of the type ordinarily used in house aising failed by the threads shearing out of the nuts. acks of forged steel were then employed, with full atisfaction, except that the work was hard and slow. he men made a quarter-turn on one pair of jacks, then roceeded to the next pair and then to the third. It as thought during the work that hydraulic jacks would ave proved more convenient, and amply safe if used with rew jacks as follow-ups. The amounts the six settled olumns were jacked are shown in the accompanying abulation.

West Side		East Side	
Col. No.	Raised, Ft.	Col. No.	Raised, Ft
15	0.094	16	0.581
17	0.418	18	0.598
19	0.386	20	0.466

When the columns were jacked to the desired height r a little above, shims of I-beams or rails were set under them, and the base was then grouted to make a solid mass with the cap stone.

After the first of the columns had been jacked and lowered, it was noticed that the entire base portion for a height of 8 or 10 ft. was buckled into a long S-shape (see Fig. 4). Such bending developed in several of the columns after the jacking, when the shims and wedges were placed under the base. The distorting process was facilitated by the absence of one panel of latticing, where the jacking beam went through the column.

Lateral displacement of the columns complicated the matter. All of the six columns were out of position before work started; three were east of true position by amounts of 1¼ in., 1¼ in. and 3 in. respectively. This condition is attributed to either tipping or lateral shift of the top of the pile group under the column footing, occurring simultaneously with the settlement.

During the jacking the columns moved laterally back and forth, because of slightly unsymmetrical position of the jacks. This kick at times amounted to several inches. In some cases its direction was such as to correct the initial displacement of the column; one column, however, is farther off true position now, after completion of the work, than originally. For the three columns whose

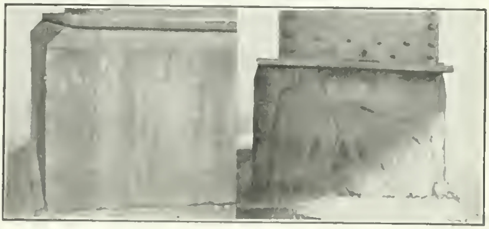


FIG. 7. CRACKED AND SPALLED PIER CAPS ATTRIBUTED TO PRESSURE AND BONFIRES

initial displacement was measured the figures are: Col. 18, before jacking, 3 in. E, after jacking, 2 in. E; Col. 19, before jacking, 1.2 in. E, after jacking, 0.6 in. W; Col. 20, before jacking, 1.2 in. E, after jacking, 3.4 in. E.

For one of the worst cases, Col. 15, a ram was used to bring the column back to true position. When the column was lifted, a plumb line from its top showed the bottom to be 1⅛ in. east, and the cap stone 2⅛ in. farther east; the column had originally been central on the stone. By using a battering ram the column was easily pushed over to plumb, and then the stone was shoved west 3¼ in. to come under the column base. At the two other columns where the ram was tried, it proved ineffectual. Sideward jacking by a kicking jack was resorted to. One of the columns was forced west ½ in. by this means, but the other one could not be moved over.

This latter, Col. 18, shown in Figs. 5 and 6, was seen to have a sharp kink in the base section even before jacking was started; this kink resulted from removal of two lattice bars to admit the jacking diaphragms. An extra tie-plate was put on the sides just above the batten plate at the base (Fig. 6). The kink partly remains, but it is less severe than it was during the work.

Dishing of the Column Webs

Fully as serious as the lateral bending of the columns was the dishing of the column webs, which appeared at the same time. The amount of this dishing on the 59-in. width of the rib was as great as ¼ in. in places. The longitudinal bending, measured at the corner angles, was at the same time as much as ½ in.; thus there was at the worst place a total buckling distortion of the web of over ¾ in. out of its plane, in a relatively short wave. This evidently denoted a very threatening failure of the web plates to do the work of load-carrying that they were expected to do.

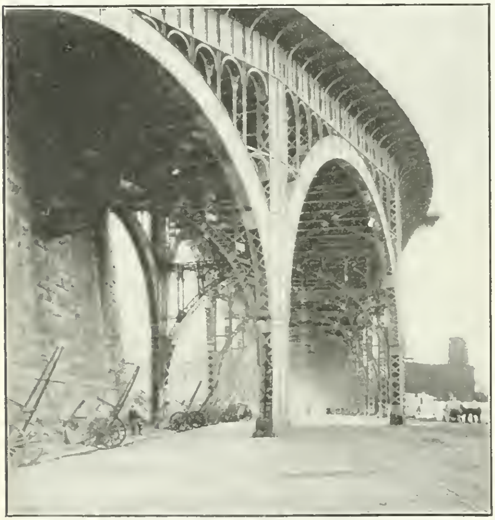


FIG. 8. NORTH END OF VIADUCT; COLUMN 51 IN FOREGROUND

These columns were not highly stressed, but on the contrary, with 100 sq.in. to carry the load of 200 tons, there was not more than 4,000 lb. per sq.in. in the meta if uniformly distributed. But it was quite eviden during the work, that the column bases did not bea uniformly, and therefore probably put non-uniform stre into the columns. Some column bases were clear of th footing cap stones at one side of corner; others ha cracked or spalled the cap stones near one end. Thus th stress in the columns is a doubtful matter. In spite this, the buckling and dishing of the columns is obvious a symptom of constitutional weakness.

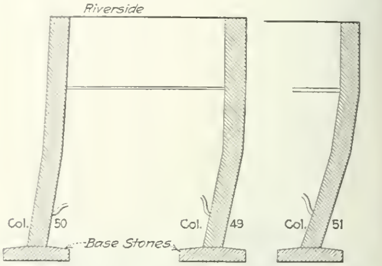


FIG. 9. DIAGRAM SHOWING RESIDUAL BEND IN VIADUCT COLUMNS

Horizontal scale 1 in. = 20 in.

Effect of Settlement and Jacking on the Viadu

The settlement involved only six columns; if oth parts of the viaduct settled, the movement was fair uniform and its amount cannot now be determined.

The marked sag of the structure at the six settl columns did not produce any visible effects in th superstructure, except to shear off numerous bolts co necting the arches to the girders, due to longitudin motion of the arches relative to the girders above the During the jacking such longitudinal motion occurred i even more marked degree, resulting in shearing off mo of the bolts in the connection.

Each longitudinal arch is connected to the girder ov it by eight bolts at the crown. The minor (decorativ arches that fill in the spandrels are similarly connect to the girder by two bolts each. In some instances a eight bolts of the main arch and several of the minor-ar bolts sheared off during the jacking. These same bol had been replaced only a year earlier, having then shear off as the effect of the settlement. No rivets were shear or heads snapped off in the attachment of arches t columns, so far as has been discovered.

Treatment of Column Bases and Footing Caps

The footing cap stones under the jacked columns w remain, except that in two cases the stone was bad cracked and was therefore removed and replaced concrete. The other caps will, however, be banded wit two 6x½-in. steel bands to forestall any cracking te dencies. Later, this banding will be extended to all p of the viaduct.

Vertical stiffener angles 6½ ft. long, three on ea web, have been attached to the sides of the jacked column to take up the dishing and guard against its recurren The base portions of these columns are being inclos in a cast-iron shell 5-ft. high above street, fitting with slight clearance around column and footing cap. Concre filling will be carried up to the tops of these shells.

It is intended to apply this shell treatment to all he columns of the viaduct. Concrete filling 3 ft. high s being put in now. It is found that the base portions re often used to store paper and rubbish, which if set fire exposes the steel of the columns to possibly dangerous eating. Later the concrete filling will be carried up to ear the tops of the columns, as fireproofing and as stiffenng, in view of the uncertain stress distribution in the colmns. The transverse portal or bracing arch is riveted to he side of the column, but is not backed by a diaphragm o transmit the arch thrust to both ribs of the column. Since the arch must exert thrust whenever it performs ny bracing action or other useful effect, the need of ome stiffening to the column at this point is obvious.

ONE COLUMN IS BENT FIVE INCHES OUT OF LINE

Supplementary to the present repair work is some work n the northerly two bents of the viaduct, Cols. 49 and 50 nd Col. 51. The latter is of serious concern in the iaduct.

Column 51 supports the west edge of the viaduct where t swings eastward to its landing on the north abutment the abutment runs parallel to the center line of the iaduct and is situated just east of its easterly edge). he transverse bracing arch and strut from this column re attached at their east ends to the abutment; and s the abutment has moved outward several inches at he top, due to settlement of the forward edge, it forced he column outward near mid-height, forming what ppears to be a permanent bend.

When this condition was discovered, the anchorage of he strut in the abutment was cut. This resulted in ecreasing the bend in the column by ¾ in.; the strut oved east by this amount, and its east end also moved orth 2 in. The residual bend in the column, which s clearly visible, measures about 5 in. (Fig. 8). Steel olsters will be inserted through the pier cap stone to upport the column, and the column will be filled with oncrete.

There is a similar bend in both columns of the pair ext south, Cols. 49 and 50. Their condition is sketched Fig. 9. The treatment here will be the same as for ol. 51. The distortion of this bent is probably due to the ction that pushed Col. 51 over, the effect being transmitted by the rigidity of the buckle-plate floor of the iaduct.

The pier cap stones under many of the columns are racked, and some are spalled (Fig. 7). Bonfires may ave contributed to this, but in some cases at least conentrated pressure of the column base is believed to be ne of the causes. Ice formation in the bolt holes may lso have played a part; the holes in the stones are 3 in.; hile the bolts are 1¼ in.

It is held that the cracks are not important enough justify replacement of the bases. As soon as an ppropriation can be obtained, however, the stones will ll be banded, and the cast-iron jackets placed.

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Streets with Two Driveways and a Central Foot-Walk erve a part of the shop and warehouse district of Toronto, nt There being only a curb between the driveway and the ront wall of the buildings, wagons can be driven or backed lose up to the doorways. The driveways drain to and down heir center lines. Midway in each block a cross driveway ntersects the central walk Poles and wires are placed at he curbs of the central walk.

What Is the Road to Progress in Engineering Education?

By CHARLES A. HOLDEN*

The discussion now in progress in regard to engineering education in large part neglects two fundamental considerations: (a) A recognition of the basic principles common to all engineering problems; (b) the product being turned out—well-grounded men who will continue to be students.

Highway engineering may be taken as an illustration. It involves the following subjects that are common to most engineering work:

Mathematics
Physics
Chemistry
Graphics
Surveying
Earthwork
Drainage
Foundations
Retaining walls
Reinforced concrete
Hydraulics
Bridges
Electricity
Accounting
Specifications and contracts
Correct, concise and forceful presentation
Selection and management of labor
Administration, etc.

Also for a general and preliminary grasp of the subject, it is necessary to consider it from the viewpoint of one of the texts on highway construction. Later, if the engineer becomes enough concerned, intensive specialization is necessary.

In the same way other divisions of engineering activity can be analyzed into a group of subjects that are common and fundamental to all operations. Any one of these subjects may become the major activity in an engineer's life, while the others are minor but often-considered branches. One cannot be termed an *Engineer* who has not the background furnished by the above broad survey. Otherwise he must be denoted a [particular branch] engineer.

The consideration of an educational program always brings one to the inquiry whether the student is to be prepared for his lifework or for one branch of engineering. In the former case he needs a training that will enable him to accept any openings which may be offered him and to adapt himself to his environment. In the latter case there will be many prepared in a particular mold from whom the employer may select a few, while the others will have to enter different work for which they are not prepared and have to suffer the loss incident to the readjustment.

It is frequently two or three years before the young engineer finds a branch of engineering that combines opportunity and congeniality. It is then that with most effectiveness and certainty he can undertake specialization, either in actual practice or at some university.

The futility of too early specialization is illustrated from another angle by the reply to a circular in regard to training highway engineers. The commissioner of a state highway department writes: "I presume there is a lack of trained road engineers for the reason that the type of road building changes so rapidly that it is hard for an engineer to keep up with the times. I would give preference to graduates of a college highway-engineering course, provided they had as much experience as the other applicants.”

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*Professor of Civil Engineering, Thayer School, Hanover, N. H.

The present time demands and the future will more insistently demand men with breadth and depth of vision, who will be able to discern fundamental principles, develop constructive policies and administer those polic consistently and adequately. I know of no one who in a better position than the broadly trained engineer render to this country and this generation the servi that is needed.

* * *

Alignment and Drainage of Rural Highways

By H. E. Bilger*

SYNOPSIS—Description of small details essential to successful highway construction, but frequently neglected. Simple means of rendering grade crossings less dangerous, and the essentials of alignment to insure surface drainage.

The really permanent part of the entire improvement of a rural highway is its alignment, both horizontal and vertical. Hence the alignment merits attention before greater expenditures are made for surfacing work, which at best is of but a relatively temporary character. This statement applies particularly to the level prairie states of the Middle West, where to superficial appearances there seems little choice in the matter of alignment.

In the prairie states the general features of highway alignment as originally established, in most cases, will meet satisfactorily the requirements of modern traffic. These highways as a rule follow the section lines east and west, and north and south, and are straight.

Because of the unusually favorable conditions afforded by the topography and because also of the fact that practically all parts of the country could be utilized for agricultural purposes, a very large mileage of highways was laid out in the states of the Mississippi Valley.

The State of Illinois, for example, has 1.69 mi. of rural roads for each square mile of land area. Likewise Richland County, Illinois, has a corresponding figure of 2.27, the greatest in the state; while Pope County has 0.95 mi., the least in the state.

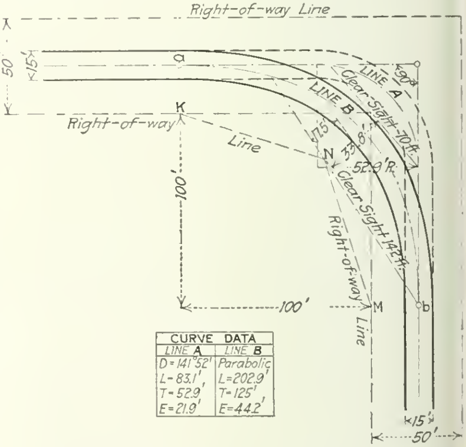
In view of this large mileage of intersecting roads on grades that invite high speed and on a soil that yields its best crops with the worst mud, it is evident that close attention should be paid to *all* details of highway alignment and particularly to those involving drainage.

Small Details of Horizontal Alignment Often Neglected

Marked improvement can be effected in small details that will tend greatly toward the general safety and comfort of the traveling public. For example, at all abrupt angles in the right-of-way, and particularly those approaching 90°, greater safety of travel can be brought about by simply procuring enough additional right-of-way to permit moving the inner fence corner a distance of only 30 or 40 ft. By so doing, the radius of the curve can be considerably lengthened and a much better view provided. Travel is benefited out of all proportion to the cost of the little piece of land. In order that this additional right-of-way at the corner may be utilized to the utmost, it is necessary that all vegetation be kept down and th signboards, if any, be transferred elsewhere.

A typical 90° angle in a highway is shown in the a companying sketch, similar to which there must be mo than 100,000 in Illinois alone. To keep the improv ment at the corner within the 50-ft. right-of-way lir would require a curve having only a 52.9-ft. radi and the clear sight provided for the traveler would only 70 ft.

As contrasted with this, notice the advantages afford by acquiring the piece of land *KLMN* (see sketch), whi contains 0.055 acres and would cost, at the rate of $3 per acre, only $16.50. The longer curve provides an ou look of 142 ft. as against the 70 ft. for the other. the same time it shortens the pavement from *a* to *b* by amount sufficient to save 40.6 sq.yd. for a 15-ft. pav ment—about $70 on a brick pavement and $50 on one concrete, which is about three times a reasonable pri for the land.



RECOMMENDED CURVE FOR 90° TURNS; ILLINOIS HIGHWAYS

In addition to this the right-of-way is not contract at the corner as it is by the shorter-radius curve, so th the 17.5-ft. margin between the inner edge of the pav ment and the property line is preserved for use as an ear road around the corner as well as on tangents. Moreov the land *KLMN* because of its corner location, is practi ally valueless for agricultural purposes.

At all crossroads additional land should be provid by moving the fences back to include the land at the fo corners within the limits of the right-of-way, as proposed in the sketch. This brings the control of the corners within the authority of the road officials, who can have removed all vegetation that obstructs the view of the approaches.

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*Road Engineer, Illinois State Highway Department, Springfield, Ill.

Where there is an angle greater than 45° in the alignment and the improvement at this place is on an embankment higher than, say, 4 ft., there should be provided on the outside of the curve a substantial-looking guardrail painted white, to serve as a warning to traffic.

Improvements at Railway Grade Crossings

In the State of Illinois there are 95,696 mi. of rural highways and 13,198 mi. of steam railroads. As practically all the highways have been located on the section lines, their directions are north and south, and east and west. With comparatively few exceptions the general directions of the railways are also north and south, and east and west, so it becomes at once apparent what a relatively large number of crossings are formed by the railroads and the highways; and considering the practically level topography it is readily seen why 87%, or 17,119, of these crossings are at grade.

Economic conditions do not exist that will at this time warrant the separation of grades on as many as 10% of these crossings in the rural parts of Illinois. Nevertheless, every effort should be made to improve these crossings in a manner that will minimize the accident hazard.

In the vicinity of crossings the improvement should be such as to provide an unobstructed view along the track for a distance of at least 1,000 ft. each way, and this view should be enjoyed along a length of highway extending a distance of at least 300 ft. on each side of the crossing.

It is particularly important that there be provided accommodations for two vehicles to pass with entire safety and comfort at the crossing, requiring never less than 18 ft.; and the highway for a distance of 50 ft. or more on each side of the crossing should be practically level or should at least have a very easy grade, say not steeper than about 2%.

Much destruction of both life and property is caused by motor vehicles taking a run on the steep grades up to the crossing and then stalling the engine on the track. Occasionally two vehicles will make a run from opposite sides of the crossing and upon reaching it find that the highway does not have sufficient width for passing.

Vertical Alignment and Drainage

In establishing the general vertical alignment of the highway there must be carefully considered the construction cost, the serviceability of the road and the practicability of economic maintenance. These three factors will assume varying degrees of importance, dependent largely upon the development of the country contiguous to the road improvement.

The proper alignment for any road is so closely related to such local conditions as topographic features, available funds, etc., that general recommendations might be wholly a misfit when applied to a particular case. It can be safely said, however, that grades should be kept reasonably consistent and closely in harmony with the general topography of the neighboring country, but aside from this there is little justification for expenses incurred in order to obtain grades lower than some 3 or 4%.

To design highway improvements according to a limiting grade fixed for a geographical area even as large as 15,000 sq.mi. is not warranted either by the nature of or by any factors of the highway problem. The whole matter is more of a local issue as regards both the factors of construction and the use of the roads, but in order to make the most out of a given combination of conditions a broad experience in road building is required.

The Most Essential Element in Surface Drainage

The particular feature of a large percentage of the Illinois roadwork commanding attention is the necessity for positive surface drainage of the roadbed by elevating it above the level of the adjacent fields. In order to maintain satisfactorily a road surface in practically level country on other than a sandy soil it is generally absolutely necessary to forestall capillarity by elevating the roadbed.

It is probably true that on more than one-half of the mileage of the roads in the state the traveled way is lower than the general elevation of the adjacent fields, and in a large percentage of these cases the practicable gradient of the side ditches is not sufficient to carry off surface water. This condition is due to the simple fact that formerly highway construction consisted chiefly of fencing off a right-of-way across the prairie without attention to the matter of surface drainage.

In connection with tilling the land for agricultural purposes the under-drainage of the road has been given more consideration than the surface drainage. It has not been fully appreciated that underground drains are primarily for the removal of underground water and that for the removal of surface water these drains cannot be depended upon as more than a 20% substitute for complete surface drainage.

Classification of Soils in Facility of Drainage

With respect to their properties of shedding or absorbing surface water all characters of soil encountered in Illinois roadwork may be assigned to one of the three following classes:

Class 1—Impervious soils, such as the prevailing gumbo throughout the corn belt, or any dense clay or other soil through which surface water will not readily penetrate.

Class 2—Semi-pervious soils, those soils of an intermediate character that evidently are not assignable to either Class 1 or Class 3.

Class 3—Very porous soils, including sand, gravel or loose stone; soils through which surface water will readily penetrate.

In case of doubt as to whether a particular soil should be assigned to Class 1 or Class 2 it should be assigned to the former, and for doubt between Classes 2 and 3 the assignment should be made to Class 2.

How To Deal with Each Class of Soil

Class 1—No matter whether on an elevated tableland or on a low bottom, where the obtainable side-ditch grade is less than 0.4%, not more than 800 ft. of road in one stretch should have the crown of its subgrade (finished crown for earth roads) less than 12 in. above the general elevation of the adjacent land without the limits of the right-of-way, notwithstanding the size of the side ditches.

Exceptions to this rule would be where the highway follows a practically level ridge and the adjacent land drains away from the road on both sides; also, where the highway follows along land that all drains one way. In the latter case, needless to say, cross-culverts should be placed at suitable intervals to carry the water from the higher ditch to natural outlets.

Class 2—Same as Class 1, except that 0.2% should be substituted for 0.4%.

Class 3—The crown of the subgrade should be at least 6 in. above the general elevation of the adjacent land without the limits of the right-of-way.

Notwithstanding the character of soil, where the grade of the side ditches is from 0.4% to 1% an endeavor should be made to keep the crown of the subgrade at least 6 in. above the general elevation of the adjacent fields. With a nonporous soil and an open-ditch gradient of less than 0.4% it is difficult to provide surface road drainage by seeking natural channels located at considerable distances apart. A more effective and more positive practice is to elevate the roadbed by filling from borrow pits to an elevation above the accumulated water level, which under the conditions assumed is the general level of the adjacent fields.

Reduce Speeding Hazards on Vertical Curves

The speed of motor-vehicle traffic requires that other details of vertical alignment be given full consideration. For the most rigid types of Illinois roads, as brick and concrete, parabolic vertical curves should always be used when the rate of change from one grade to another is as much as 1%, and for the more resilient types of roads when the rate of change is as much as 2%. Both the safety and the comfort of travel require these vertical curves, though their proper lengths are dependent upon factors that necessarily must be assumed.

It would be only reasonable to assume that in rural territory automobiles frequently ascend short grades up to 10% at a rate of from 15 to 25 mi. per hr. To come from this speed to a full stop, there should be provided at least 150 ft. If it is assumed that on ascending grades two automobiles are approaching one another, each at the rate of, say, 20 mi. per hr., the vertical curve at the summit should be of such length as to enable the drivers to see one another when they are at least 300 ft. apart.

With the eyes of the drivers 5 ft. above the road surface no vertical curve is required to meet this condition when the change in the rates of the grades is not more than 6.67%. When this change is 10%, however, the curve should never be less than 200 ft. long. Likewise, changes of 13 and 16% would require minimum curves of 292 ft. and 360 ft. respectively. Practical considerations would commonly suggest the use of vertical curves before they would be required to meet this condition, but nevertheless it is well to have in mind reasonable limits within which ordinary practice should be confined.

While the search for the ideal road-surfacing material and the battle for supremacy of certain material interests go on, the local road-building authorities cannot do better than confine their activities to the fundamentals of the highway problem—namely, the establishment of a drainage practice similar to that of the railways and the production of a highway alignment that will properly fit *all* the purposes for which it exists.

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Plans for a Municipal Electric Light Plant for St. Louis, Mo., have been under consideration for 18 months. By a resolution of the Board of Aldermen on Oct. 19, Mr. Hooke, the Director of Public Utilities, was authorized to make additional surveys and estimates for this plant at a cost of $12,500, and to report within a year's time.

Proposed Code for the Sanitar Control of Waterways*

I. There shall be no objectionable deposits at a point in a waterway as a result of sewage or other wast discharged therein.

Note—To prevent such deposits public authorities shou recognize the efficacy of such preventive and correcti measures as the dredging and removing of the deposits befo they become objectionable, the proper location of sewer ou lets and the removal of solids by screening, sedimentatio chemical precipitation and like methods.

II. There shall be no local nuisance created at or i the vicinity of any sewage or industrial-wastes outfal arising from excessive turbidity or the production odors.

Note—To prevent such conditions public authorities shou recognize the efficacy of such preventive and corrective mea ures as the arrangement and proper protection of sewa outlets and all methods of sewage treatment in proper designed plants, including screening, sedimentation, chemic precipitation, oxidation in various types of coarse- and fin grained filters and treatment by the activated-sludge proce

III. There shall be no general nuisance created in waterway due to excessive turbidity or to odors, as result of sewage or other wastes discharged therein.

Note—To prevent such conditions public authorities shou recognize the efficacy of such methods of sewage treatme as are enumerated in the note to Article II, but it will necessary to carry the treatment far enough to meet the f lowing requirements:

1. That dissolved oxygen shall be present in the wate of the waterway at all points and at all times in such quant ties as to prevent the emanation of putrefactive odors.
2. That every municipality or industrial establishme discharging sewage or wastes into a waterway may have i proper share of the dissolved oxygen, subject to the afor said limitation of paragraph 1.
3. That the share of dissolved oxygen of a waterwa which a municipality or industrial establishment may utili at any time, should be subject only to the aforesaid lim tation (stated in paragraph 1), so long as other parties a not utilizing it nor thereby being deprived of its use.
4. That as the size and number of municipalities or i dustrial establishments discharging sewage or wastes in the waterway increases, and the available share of dissolv oxygen for each decreases, treatment methods must be i creased generally and correspondingly, in order that ea party may continue to have the share of the available oxyg to which it is entitled.

IV. There shall be no interference with or undue bu den upon mechanical operation or bacterial efficien of water-purification plants procuring their raw wat from a waterway.

Note—The public authorities should recognize in this cas

1. The efficacy of relocating water-supply intakes a sewer outlets as a means of remedy.
2. The efficacy of such methods of sewage treatment will reduce the quantity or alter the character of either th suspended matter or that dissolved matter, or both, whi may interfere directly or indirectly with the mechanic efficiency and operation of water-purification plants.
3. The efficacy of such methods of treatment as will r duce the number of bacteria that may cause a bacterial burd upon water-purification plants.
4. That since water- or sewage-purification processes c be carried to any desired limit, at least theoretically, share of responsibility that is to be imposed upon the diffe ent sewage-disposal and water-purification plants, with r spect to extent of purification, will obviously depend upon number of legal and administrative considerations of

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*From the report of the Committee on Sanitary Control Waterways, submitted to the Sanitary Section of the Ame ican Public Health Association at Cincinnati, Ohio, Oct. 1916. The members of the committee are Harrison P. Edd chairman, Boston, Mass.; Edwin A. Fisher, Rochester, N. Paul Hansen, Springfield, Ill; Theodore Horton, Albany, N. W. H. Dittoe, Columbus, Ohio. The code was preceded by statement of fundamental principles. The full report w be printed in the "Journal" of the American Public Heal Association (877 Boylston St., Boston, Mass.). Reprints will sent to members of the Sanitary Section about 30 days in a vance of the 1917 convention, at which the code will presented for possible amendment and for adoption.

economic, engineering and public-health nature which properly come within the jurisdiction of central authorities and the courts.

V. There shall be no active (potentially dangerous) bacterial contamination or gross pollution of properly located and authorized shellfish beds.

Note—Public authorities should recognize in this matter five important features:

1. The proper supervision, by competent authority, of the location of shellfish beds and drinking places, and suitable control of shellfish operation.

2. That the gross pollution of shellfish beds by deposits of suspended matter from sewage or industrial wastes can be prevented, and that bacterial contamination of the beds may be avoided, by relocation of sewer outlets.

3. That the gross pollution of shellfish beds by deposits of suspended matter from sewage or industrial wastes can be prevented also by the installation of proper sewage-treatment processes that will remove these solids to the extent necessary.

4. That where shellfish beds are so located as not to be subject to gross pollution and where bacterial protection only will be necessary, this protection can be accomplished satisfactorily by the employment of such methods of treatment as will destroy or remove the bacteria.

5. That since active bacterial contamination and gross pollution of shellfish beds can be prevented by proper location of such beds and by proper location of sewer outfalls and proper treatment of sewage and other wastes, the enforcement of the abandonment or relocation of shellfish beds or of preventive or remedial measures to protect such beds will obviously depend upon a number of legal and administrative considerations of an economic, engineering and public-health nature which properly come within the jurisdiction of central authorities and the courts.

VI. There shall be no active (potentially dangerous) bacterial contamination or gross pollution of properly located and authorized bathing beaches and other bathing places.

Note—The public authorities should recognize in this matter:

1. That notwithstanding the legal rights of riparian owners, in view of our knowledge of the dangers to health arising from bathing in waters contaminated by the bathers themselves as well as from sewage and wastes discharged into them, control is needed both in the selection and authorization of bathing places and of the discharge of sewage and wastes into the waters in which bathing is authorized.

2. That the gross pollution of bathing beaches by suspended matter from sewage or industrial wastes can be prevented, and bacterial contamination may be avoided, by relocation of sewer outlets.

3. That where protection of properly authorized bathing places, from bacterial contamination only, is required, such protection can be secured by such sewage-treatment processes as will destroy or remove the bacteria.

4. That where properly authorized bathing places require protection against gross pollution arising from suspended or other objectionable sewage matters, this additional protection can be secured by the installation of such additional sewage-treatment processes as will sufficiently remove the objectionable matters.

5. That since active bacterial contamination and gross pollution of bathing places can be prevented by proper location of such places and by proper location of sewer outfalls and proper treatment of sewage and other wastes, the enforcement of the abandonment or relocation of bathing beaches or of preventive or remedial measures to protect such beaches will obviously depend upon a number of legal and administrative considerations of an economic, engineering and public-health nature which properly come within the jurisdiction of central authorities and the courts.

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Position-Light Signals on the Pennsylvania R.R.

Signals that use lights only (by day and night), but in which the lights give position indications simulating the positions of semaphore arms, have been in use for about 15 months on the electrically operated section of the Pennsylvania R.R. between Philadelphia (Broad St. station) and Paoli, Penn.—20 mi. All lights are white, since all indications are given by position (Fig. 1).

Each unit or signal consists of a group of incandescent lamps inclosed in casings and mounted upon a board or background. Certain of those lamps are lighted or extinguished in varying the indications. Fig. 2 shows one of the installations on a four-track signal bridge near Ardmore. In this view the eastbound train has just set the top right-hand signal at "Stop," while the signal below shows that there is a train in the second block ahead. In the left-hand signal the top indication is "Proceed, prepared to stop at next signal"; the lower indication shows that there is a train on this track also in the second block ahead. The upper signal (for the first block) gives three indications; the lower signal (for the second block) gives two indications. The blocks here are 3,500 ft. long. The view shows a steam train, but the catenary trolley-wire suspension will be noticed.

Exact and permanent location of the lamps behind their respective lenses is essential for correct reading by the motormen. For this reason bayonet sockets are used in preference to screw sockets. Difficulty was introduced in the beginning by the fact that the lamp makers could not guarantee a uniform distance between the base of the lamp and the filament, and allowance had to be made for a variation of at least $^1/_4$ in. A slotted brass collar is used for adjusting the lamp in position.

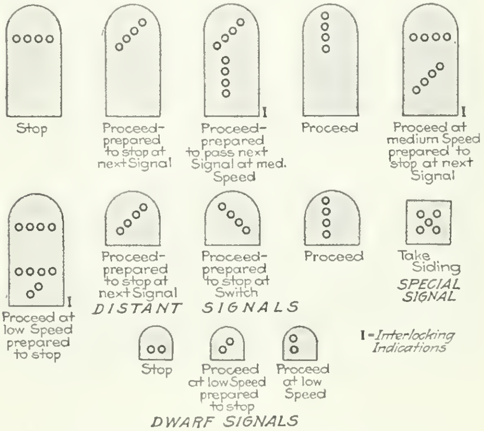
Stop
Proceed-prepared to stop at next Signal
Proceed-prepared to pass next Signal at med. Speed
I
Proceed
Proceed at medium Speed prepared to stop at next Signal
I
Proceed at low Speed prepared to stop
I
Proceed-prepared to stop at next Signal
Proceed-prepared to stop at Switch
Proceed
Take Siding
SPECIAL SIGNAL
DISTANT SIGNALS
Stop
Proceed at low Speed prepared to stop
Proceed at low Speed
I-Interlocking Indications
DWARF SIGNALS

FIG. 1. TYPICAL INDICATIONS BY POSITION-LIGHT SIGNALS ON THE PENNSYLVANIA R.R.

Those marked "I" are for interlocking plants

Although the filament has coils of large diameter, there was trouble due to its attachments not being secure and permitting a drop, or sag, that necessitated refocusing. This defect has been remedied. The lamp has a spherical bulb, and the filament is above the center line.

The first signal was mounted about 25 ft. above the rail, but at a distance of 175 ft. the light was invisible. A special lens was then devised, in which both the lower quarter and the bullseye portion deflect rays downward. This was necessary as the signal bridges are about 29 ft. clear above the rails, and the top light of the vertical row of lamps is over 40 ft. from the rails. The effect is to give practically three zones of light: First, the direct rays, from a distance of a mile or more to within 200 or 300 ft. of the signal; then, overlapping these and to within 40 or 50 ft. of the signal, come the rays deflected downward through the lower quarter of the lens; finally, the image in the mirror reflected through the bullseye. The steps of the lens are painted black to prevent trouble from the reflection of rays of sunlight striking these steps. On curves the same type of lens is used, with the spread-light feature in addition.

The signals are operated with 3-volt current by day and 11-volt current at night. The latter gives good results on foggy nights. It is found that a 12-volt lamp burning night and day at 10 volts has a range of 3,000 ft. or more by day and is not hard on the eyes at night if the signals are a mile or two apart. The first signals had (for each indication) five lights in a row, 12 in. c. to c., corresponding to a 5-ft. semaphore arm. Better results are obtained with four lights 18 in. c. to c., as in Fig. 1. In this illustration the backgrounds appear unduly large, but in construction the second and third rows of lights have their own backgrounds, of various shapes, depending upon the number of indications. This reduces the wind pressure on the structure.

This system is in use for automatic and manual block signals, interlocking signals and dwarf signals. There is also a special "Take siding" signal (Fig. 1). This is mounted by itself on a mast and has a background 3x3 ft., with lights 12 in. c. to c. It is lighted only when giving the indication. In December, 1915, two signals were installed to protect traffic at a signal-track tunnel. These are lighted by the approaching train.

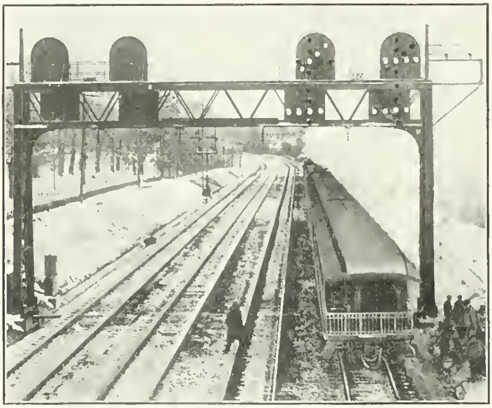

FIG. 2. SIGNAL BRIDGE WITH POSITION-LIGHT SIGNALS ON PENNSYLVANIA R.R. NEAR PHILADELPHIA, PENN.

Results with Light Signals

After a year's experience it is concluded that with the position-light signals the chance of false clear or misread signals is at a minimum, while the number of total failures is greatly reduced. The enginemen are practically unanimous in stating that these signals are more visible than any others at night, in fog and in snowstorms. The close indication (within 150 ft. of the signal) is better than that of the semaphore at night and is as good by day as the semaphore is at night.

The indications are uniform by day and night. With semaphores the indications are by position during the day and by color during the night, and by both during morning and evening periods. Colored-light signals give indications by color only, while position-light signals give indications by position only. Semaphore and colored-light signals are limited to three indications. The position-li t signals can give four indications, thus in many cases eli i- nating advance or other signals required to supplement e semaphore.

These signals are said to have every advantage wl e power from a central plant is available, as where altern - ing-current track circuits are used. They are speci y adapted for distant switch and block signals on bra h lines. The cost of lighting continuously from a prim y battery is prohibitive, but on lines of light traffic the g- nals can be lighted on the approach of a train and ex i- guished after the train has passed. The cost of a typ four-track automatic-signal bridge with signals and fittings (including track circuits) is estimated at $10, as against $10,633 with motor-operated signals, which e about the least expensive semaphore signals on the l With 1,882 lamps in service the lamp renewals aver only 179 per month, or a cost of $16 per year, whicl s about the cost for ordinary repairs to motor-oper d semaphore signals.

This system of signals was developed by the engineer f the Pennsylvania R.R. in coöperation with the Corn g Glass Works and the Union Switch and Signal Co. s several parties had a share in the invention of vari s parts, it was considered advisable to pool the pat s and applications. Licenses under these patents have b n granted to the Union Switch and Signal Co., Gen l Railway Signal Co., Federal Signal Co. and the l l Switch and Signal Co. The foregoing description is c - piled from an article prepared by A. H. Rudd, Signal - gineer of the Pennsylvania R.R., and sent out by the r - way company. In it Mr. Rudd makes the following st - ment:

"My own opinion [of these signals], prejudiced perh s but nevertheless concurred in by many of our people o have had to do with them, is that unless a speed contr s developed, so reliable and dependable as to preclude e necessity of fixed signals, the power-operated signals f the future will be light signals (either position or col , perhaps of several types, superseding gradually the n - able arms now in use."

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Photogrammetry for Taking Topography of Watershed

By Douglas H. Nelles*

Photogrammetry, on this continent at least, has l n made use of principally by governments where large a s were to be mapped in rough, rugged, mountainous regi s. In Canada 22,750 sq.mi. has been mapped by this meth ; and if to this is added the 31,000 sq.mi. mapped by e Canadian International Boundary Commission in Ala t, it makes the total of approximately 53,750 sq.mi. to d

The recent use of photogrammetry for mapping 3 sq.mi. of the Thirty-one Mile Lake watershed, Que , was, however, of an entirely different nature. T s presented a mass of irregular, bush-covered hills from 0 to 1,000 ft. high. Running through the center of e watershed are two main lakes, Thirty-one Mile d Pemichangan, and in between the hills on either side e 101 small lakes.

The Geodetic Survey of Canada had two prim y triangulation stations established in this vicinity, on n the center of the watershed and one on the outside of the southern edge, from which a secondary triangulation was thrown over the watershed, comprising 24 stations. Ten of these stations were in the southern portion of the watershed, containing 93 sq.mi.

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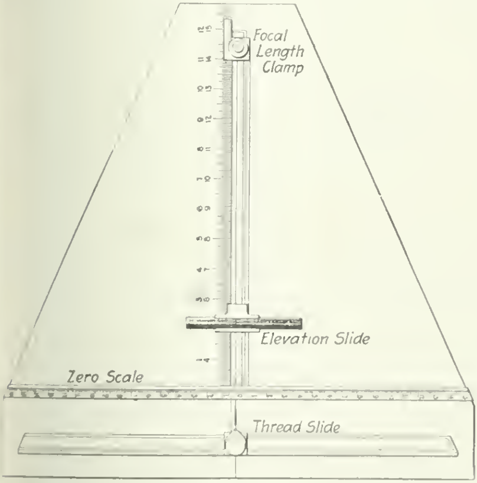
*Ottawa, Ont.

To these 10 stations were tied 83 photo-topographic stations, and from each station was taken a set of photographs forming a panorama of the country that could be seen from each station. Plotting from photographs taken during the summer was not a success, as enough points could not be identified to control the topography. Another set of photographs was therefore taken during Feburary, from which very successful results were obtained.

All the lake outlines, creeks, farms and clearings were surveyed by plane table, and the roads by transit and stadia. All these detail surveys were tied to the triangulation and camera stations. The rest of the topography was filled in from the photographs.

Office Work and Methods

The office routine consisted of computing the positions of stations; drawing a polyconic projection on the scale chosen; plotting triangulation and camera stations; transferring and adjusting the plane-table topography to the map; drawing the horizon and direction lines upon the photographs; identifying and marking direction points; choosing and marking topographic control points on photographs; plotting the photograph traces on the map, as explained later; plotting control points; determining their elevations and finally sketching in contours and other detail.



SIMPLE DEVICE FOR PLOTTING TOPOGRAPHY FROM PHOTOGRAPHS

The ordinary methods of plotting from photographs are generally known and will not be described. In this work a special machine shown in the accompanying illustration was used entirely for taking out elevations. The credit for the original idea of determining elevations by the method to be described is due to W. H. Boyd, Chief Topographer of the Canadian Geological Survey. The machine designed by the writer and made in the Dominion Observatory machine shop, besides giving elevations, measures the focal length of a photograph and plots the photograph trace on the map.

The focal-length clamp has a double action. The larger screw clamps the scale in position. Inside of this screw is a smaller one with a fine steel point on its lower end. The smaller screw serves the purpose of lifting the needle point so that it will not touch the paper when the machine is being used for determining elevations. This point is inserted at the station point when the machine is being used to plot photograph traces or to determine focal lengths.

The focal-length clamp has a vernier with two zeros, one at the forward edge, from which the thread swings, and one opposite the center of the needle point. The vernier reads to 0.01 in. In the center of the forward edge of the focal-length clamp is a small hole in which a fine silk thread is fastened by a wooden plug. The other end of this thread is attached to a spring that serves the purpose of keeping it taut. The spring is attached to a ring placed around the screw of the thread slide. The thread-slide clamp is kept tight enough so that the slide will stay at any position.

Use of Plotting Machine

To determine an elevation: Set the focal-length clamp at the focal length of the photograph, using the line of the zero scale as zero (see illustration). Set the altitude scale of the elevation slide so that the part of it opposite the center mark of the slide will read the altitude of the station plus the height of the camera. Now measure the distance between the control point and the photograph trace and make the distance between the elevation slide (on the focal-length scale) and the zero scale equal to it. Measure the distance of the control point above or below the horizon line and set this distance off on the zero scale above or below the zero. Move the thread to cut the point so obtained, and the thread will also cut the altitude scale of the elevation slide at the elevation of the station.

When working on small scales and in a region of high altitudes such as the Rocky Mountains, points are very often plotted at a distance of from 5 to 15 mi. from the station. This would only be done when nearing the limits of the country controlled by the survey, and in these cases it becomes necessary to take into consideration the correction of curvature and refraction, which is 11.4 ft. for 5 mi., 57.1 for 10 mi. and 129.1 for 15 mi. This is done by computing and plotting a curvature and refraction scale for the particular scale of the map, and so placing it on the machine that the forward edge of the elevation slide will cut it at the proper point each time that it is set. Then to get the true elevation of the control point, the curvature and refraction reading is mentally added to the thread reading.

To determine the focal length of a photograph with the machine, a photograph is selected that has two well-defined points in it, to which instrumental directions have been read from the camera station. These two directions are plotted on the plan. The center mark of the forward edge (bottom in view) of the machine is then placed over the direction line of the photograph; and the distances of the points on each side of it are marked on the edge of the machine with a pencil. The larger the angle between the points the better the results.

The needle point of the focal-length clamp is screwed down at the station and the clamp left loose to slide longitudinally. The machine is then swung around and moved up and down about the clamped needle point until the two pencil points on the edge coincide with the two direction lines on the plan. The machine is then oriented in azimuth, and the reading on the vernier opposite the needle will give the focal length of the photograph to 0.01 in.

If a line is drawn along the edge, it will be the trace of the photograph. If a dot is made at the center mark on the edge and a line drawn between it and the station mark, it will represent the direction line of the photograph.

The photographs were generally enlargements, double the size of the original, and measuring 12 by 8½ in. They were all made the same size, so that their focal lengths were the same; but before being used for plotting, the focal length was checked by measuring the distance between the cone marks that control the location of the horizon and direction lines. All recent surveying cameras have marks placed at a distance apart equal to the focal length, which are photographed upon the negative so that the focal length of any photographic print or enlargement can be measured directly.

PHOTOGRAPHIC SURVEYING WITH AN ORDINARY EASTMAN KODAK

It so happened that a map being plotted under the direction of the writer was found to have what is officially termed "a hole in it"; that is to say, there was a small valley which could not be plotted for lack of photographs. It was known that the valley contained a small lake that had not been surveyed by plane table, so that it was necessary to get accurate information.

An officer of the survey could not be sent to the locality to get the required photographs, so it was decided to ask the superintendent of a fish and game club who lived near the valley to take the photographs for the survey. He understood how to use a kodak, but not a surveying camera, so a No. 4 Eastman kodak was sent to him with a map showing the hills surrounding the valley and the two places from which the photographs were to be taken, together with minute directions for exposure, etc.

In order to use these photographs it was necessary to locate from them the position on the map of the two places from which they were taken and the position of their traces on the map. To do this, a photograph trace was drawn upon a piece of tracing cloth. This was taken to represent the trace of the photograph on the right side of the panorama from one station. The trace of the photograph next to it was then plotted in its proper position by making use of a common object in the overlap of the photographs, and the other three traces plotted in the same way. There were eight known points shown in the different photographs which had been plotted on the map from other sources. Direction lines were drawn through these points on the tracing cloth, which was then placed on the map and the position of the station located by the three-point problem, or in this case an eight-point problem—that is, a position was found for the tracing cloth so that every direction line cut through its respective point on the map. When this position was found, the position of the station point was pricked through on the map and also positions of the photograph traces.

New Formula for the Crown Thickness of Arches

By JOSEPH P. SCHWADA*

The usual procedure in the design of arches requi the adoption of an arch ring to which the rigid analy may be applied. If the arch ring chosen is satisfacto as shown by the analysis, the work is over; but if it not satisfactory, repeated trials must be made until a is found that satisfies the requirement for work stresses. If a certain variation of thickness from cro to springing is adopted, the problem becomes one choosing a proper crown thickness.

This problem has been studied to some extent, and a result a number of empirical rules have been formula for its solution. Application of these rules shows la differences in results, and so will lead one to think t the assumptions upon which some of them are based radically wrong or that they ought more properly to called personal opinions.

The important factors entering into the problem The span and rise of the arch ring, the curvature, thickness at the crown, the relative thickness from crown to the springing, the live- and dead-loads, and amount of temperature variation and unit stresses assu in the design. The number and nature of these variab however, are such as to prevent inclusion of all of th in the same formula, because no rule can be drawn that will include such variables as curvature and temp ture variation; some assumptions regarding them n therefore be made and a formula drawn up accordin

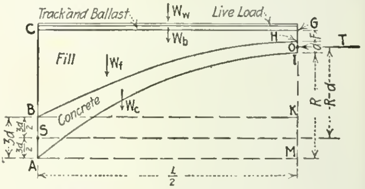


FIG. 1. NOMENCLATURE USED IN ARCH-THRUST FORMULA

With this in view a method is here proposed for determination of the crown thickness of arches. The sumption is made that the vertical thickness at the spr ing is equal to three times the crown thickness. In design of a series of railroad arches analyzed accor to methods followed in actual practice, it was found t when this relation was adopted and the arch axis n to coincide with the dead-load pressure line, satisfac results invariably were obtained. It is further assu that the intrados and extrados curves are parabolas, cause in the design of these arches it was found t though arcs of circles were used, the parabola clo approximated the curves, sufficiently at least for the posed method. A uniform live-load on the whole is assumed, and a temperature variation of ± 20° allowed.

With these assumptions an expression for the cr thrust can be formulated. The depth of arch ring at crown can then be determined by dividing the thrus an average unit crown stress, a stress which has definite relation to the maximum stress in the arch for various spans and ratios of rise to span. In the sketch of a half-arch, Fig. 1, let

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*Instructor in Structural Engineering, University of consin, Madison, Wis.

L = Span of intrados, ft.;
R = Rise of intrados, ft.;
d = Crown depth of ring, ft.;
F = Depth of fill at crown (not including track and ballast or pavement), ft.;
f = Weight of fill, lb. per cu.ft.;
B = Weight of track and ballast or pavement, lb. per sq.ft.;
c = Weight of concrete, lb. per cu.ft.;
w = Uniform live-load, lb. per sq.ft.;
W_b = Total weight of track and ballast or pavement on half-span, lb.;

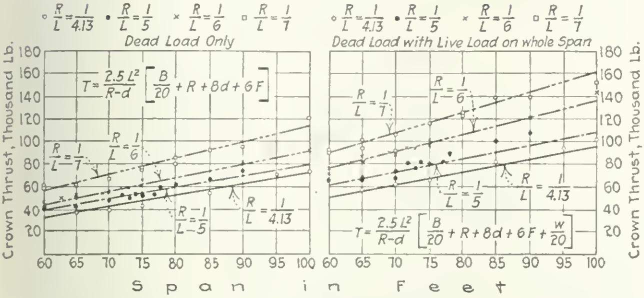


FIG. 2. CROWN THRUST BY FORMULA (LINES) AND IN ACTUAL ARCHES (POINTS)

W_f = Total weight of fill on the half-span, lb.;
W_c = Total weight of concrete on the half-span, lb.;
W_w = Total live-load on half-span, lb.;
T = Crown thrust for full load, lb.;
f_c = Maximum unit stress in arch ring, lb. per sq.in.

Consider a section of arch ring 1 ft. wide and assume the pressure line to pass through O at the crown and S at the springing, and take moments about S; then $T\ (R - d) = \Sigma M$, or $T = \frac{\Sigma M}{R - d}$, where ΣM is the sum of moments of the vertical loads or weights W_w, W_b, W_f and W_c about S. Now the values of W_w and W_b are respectively $\frac{wL}{2}$ and $\frac{BL}{2}$. The values of W_f and W_c can be determined in terms of R, d, L and F by finding the areas of the fill and of the concrete, from the relation between the areas under the parabolas and certain rectangular areas, and then multiplying each area by its unit weight.

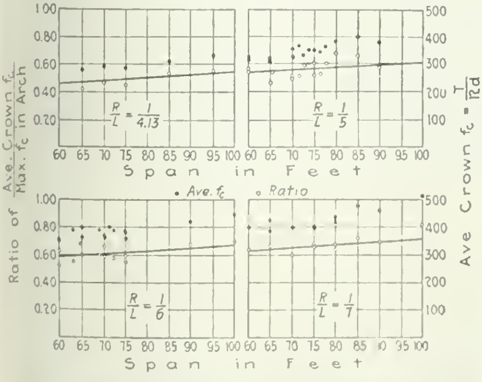


FIG. 3. RATIO OF MEAN CROWN STRESS TO MAXIMUM ARCH STRESS IN ACTUAL ARCHES

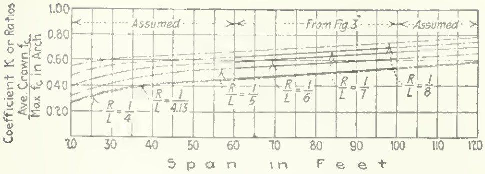
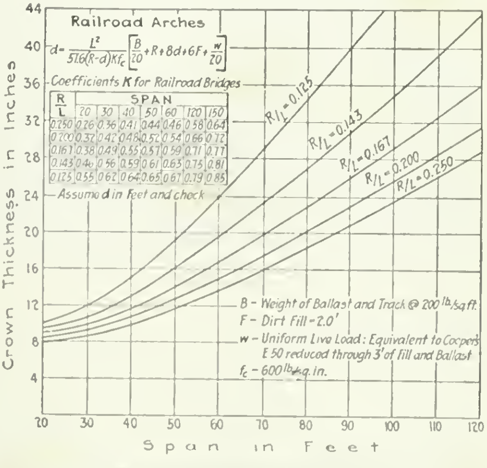


FIG. 4. DIAGRAM OF RECOMMENDED VALUES OF K FOR RAILWAY ARCHES

The area of the fill is equal to the difference between the area of the rectangle $BCGK$ and the area under the parabola BHK. The area of the concrete can be obtained by subtracting the area under the parabola AIM from the sum of the area of the rectangle $ABKM$ and the area under the parabola BHK. The area of the fill then is $(R - 2d + F)\,\frac{L}{2} - (R - 2d)\,\frac{L}{3} = \left(\frac{R}{6} - \frac{d}{3} + \frac{F}{2}\right) L$, and the weight of the fill is $W_f = \left(\frac{R}{6} - \frac{d}{3} + \frac{F}{2}\right) Lf$. The area of the concrete is $\frac{3dL}{2} + (R - 2d)\,\frac{L}{3} - \frac{RL}{3} = \frac{5}{6}dL$, and the weight of the concrete is $W_c = \frac{5}{6}dLc$.

From the same relations between the parabolas and rectangles the centers of gravities of the fill and concrete with respect to AC can be found by statical moments. The distance of the center of gravity of W_f from AC is



R/L	SPAN 20	30	40	50	60	120	150
0.250	0.26	0.36	0.41	0.44	0.46	0.58	0.64
0.200	0.32	0.42	0.48	0.52	0.54	0.66	0.72
0.161	0.38	0.49	0.55	0.57	0.59	0.71	0.77
0.143	0.46	0.56	0.59	0.61	0.63	0.75	0.81
0.125	0.55	0.62	0.64	0.65	0.67	0.79	0.85

FIG. 5. CROWN THICKNESSES AND STRESS COEFFICIENTS OF RAILWAY ARCHES

$$\frac{(R-2d+F)\frac{L^2}{8}-(R-2d)\frac{L^2 5}{48}}{\left(\frac{R}{6}-\frac{d}{3}+\frac{F}{2}\right)L}=\frac{\left(\frac{R}{48}-\frac{d}{24}+\frac{F}{8}\right)L}{\left(\frac{R}{6}-\frac{d}{3}+\frac{F}{2}\right)}$$

The distance of the center of gravity of W_c from AC is

$$\frac{\frac{3dL^2}{8}+(R-2d)\frac{L^2 5}{48}-\frac{RL^2 5}{48}}{\frac{5}{6}dL}=\frac{L}{5}$$

The centers of gravities of W_w and W_b are distant $\frac{L}{4}$ from AC.

With these values, ΣM in the expression $T=\frac{\Sigma M}{R-d}$ becomes

$$\frac{BL^2}{8}+\left(\frac{R}{48}-\frac{d}{24}+\frac{F}{8}\right)fL^2+\frac{dL^2c}{6}+\frac{wL^2}{8}$$

and the expression for crown thrust finally is

$$T=\frac{L^2}{48(R-d)}[6B+(R-2d+6F)f+8dc+6w]$$

In general, the weight of fill is taken at 120 lb. per cu.ft., and of concrete at 150 lb. The value of the thrust T then becomes

$$T=\frac{2.5L^2}{(R-d)}\left[\frac{B}{20}+R+8d+6F+\frac{w}{20}\right]$$

That the assumptions made in deriving the expression for thrust are reasonable assumptions is shown in Fig. 2, by a comparison between the values of thrust according to the expression (shown by the curve) and actual values of thrust determined in a series of railroad arches analyzed according to the elastic theory (shown by the plotted points).

For the arches designed according to the assumed conditions of thickness and curvature, the relation between the maximum stress and average crown stress (determined by dividing the actual full-load crown thrust by the cross-section at the crown) is shown graphically in Fig. 3. The black dots in each case are the average crown stresses, or working crown stresses. The circles are the ratios of these average crown stresses to the maximum stresses anywhere in the arch. That some definite relation exists between these stresses is evident. The curves drawn through these circles may then be said to represent the variation of this ratio for the different ratios of rise to span.

The curves grouped in Fig. 4 provide a means for determining the value of the average crown stress f_cK, in terms of f_c, the assumed maximum stress in the arch. The heavier portions represent this relation as determined from the data and shown in Fig. 3. The lighter portions of the curves, from 100 to 120 ft. and from 60 to about 45, are obtained by producing these lines. A further extension of this relation to the very short spans would result in thicknesses less than would be desirable for practical reasons, and the variation is therefore arbitrarily changed to provide a general expression for all working conditions of railroad arches.

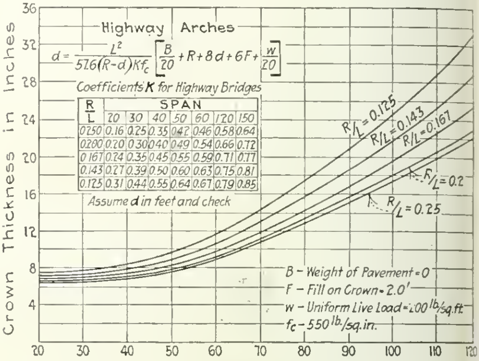
An expression for the thickness at the crown, in feet, may then be derived as follows:

$$d=\frac{\textit{thrust}}{12\times 12\times \textit{average stress}}$$

$$=\frac{T}{144f_cK}=\frac{2.5L^2}{144(R-d)f_cK}\left[\frac{B}{20}+R+8d+6F+\frac{w}{20}\right]$$

$$=\frac{L^2}{57.6(R-d)f_cK}\left[\frac{B}{20}+R+8d+6F+\frac{w}{20}\right]$$

In Fig. 5 is shown the application of the formula for crown thickness to a series of railroad arches for ratios of rise to span from 1/4 to 1/8 and for conditions as noted in the figure. For convenience the coefficients of stres for certain spans are arranged in tabular form. Intermediate values can be determined and the crown thicknes for any other conditions easily obtained.



R/L	SPAN 20	30	40	50	60	120	150
0.250	0.16	0.25	0.35	0.42	0.46	0.58	0.64
0.200	0.20	0.30	0.40	0.49	0.54	0.66	0.72
0.167	0.24	0.35	0.45	0.55	0.59	0.71	0.77
0.143	0.27	0.39	0.50	0.60	0.63	0.75	0.81
0.125	0.31	0.44	0.55	0.64	0.67	0.79	0.85

FIG. 6. CROWN THICKNESSES AND STRESS COEFFICIENTS OF HIGHWAY ARCHES

To adapt the formula for crown thickness to highwa arches a slight change must be made in the value o coefficients for short spans, because of the light loads involved and because of a desire to obtain thicknesses whicl are practical. The coefficients for f_c for spans up to abou 60 ft. therefore differ from the coefficients for the sam spans for railroad arches. For spans over 60 ft. th coefficients are the same. A complete table of values fo highway arches is given in Fig. 6, with an application t a series of highway arches for conditions shown in th figure.

To illustrate the application of the formula to a highway arch assume: Span, 90 ft.; rise, 12 ft.; weight o pavement, 100 lb. per sq.ft.; fill 1 ft.; live-load, 300 lb per sq.ft. unit stress fc, 550 lb. per sq.in. Then k = 0.71. Assume depth at crown to be 23 in. = 1.92 ft According to the expression,

$$\textit{Depth } d=\frac{90\times 90}{57.6\times 10.08\times 0.71\times 550}[5+12.0+15.3$$

$$+6+15]=1.91\ \textit{ft.}=23\ \textit{in.}$$

If the resulting thickness does not check the assume thickness, another trial must be made.

In applying the formula for crown thickness it shoul be understood that f_c in the expression represents an approximate maximum value of stress which one may reasonably expect to obtain if the arch is designed accordin to the rules for curvature and thickness followed in th design of the arches here considered. The maximun value of stress for these arches varied from 575 lb. pe sq.in. to 650 lb. per sq.in., with an average value of abou 625 lb. per sq.in. A value of 550 lb. per sq.in. to 600 lb per sq.in. for f_c is suggested for use in the formula.

Unlined Sewer Tunnel in Rock at Rochester

By Charles L. Raymond*

The Main and Front St. sewer tunnel in Rochester, N. Y., was driven at an average depth of 38 ft. below street level for a distance of 2,200 ft. along Main St. and 1,500 ft. along Front St.

Six working shafts, about 10x12 ft., were located in side streets varying from 20 to 40 ft. in distance from the main line of the tunnel. These shafts were connected by crosscuts to the main tunnel. Six angles were turned on the center line of the tunnel, and three different slopes were used in the grade.

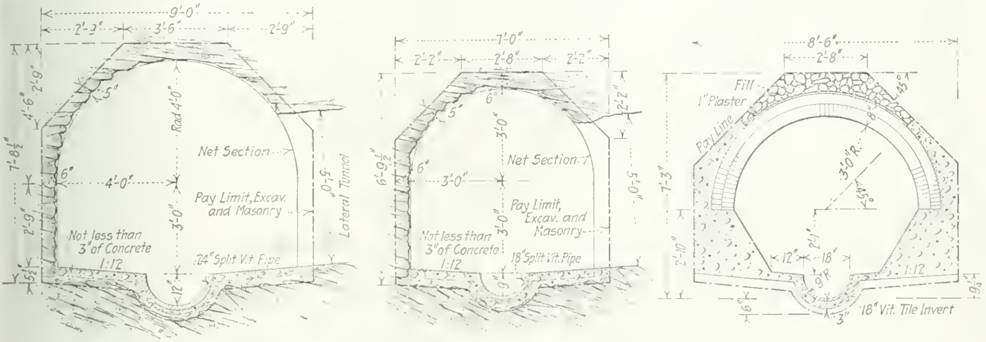


FIG. 1. SECTIONS OF MAIN AND FRONT ST. SEWER TUNNEL

For the engineering work a careful preliminary sur y of all streets concerned was first made. Then a base r offset line 35 ft. south of the center line of Main t. and 19 ft. east of the center line of Front St. was ocated. Points were set on this base line on the center ne of the shafts and crosscuts to the main tunnel. The hafts were then marked out and sunk to the required depth and from temporary points the crosscuts were driven over to the main line.

To carry the survey into the tunnel from the base line two 8-lb. plumb-bobs were hung in the shaft and carefully set in line on the surface. The transit was then taken down the shaft and into the crosscut. Here it was accurately set up in line with two plumblines and this line produced to permanent points set in the roof.

The survey points, in the tunnel roof, were spuds set in a wooden plug driven tight in a 2-in. hole drilled 4 in. deep. Both grade and line were carried on this spud. A theoretical roof grade was carried, and as each new point was set the contractor was given the distance the plug was above or below this grade; since the distance from the grade line to the bottom of the tunnel was constant it was a simple matter for the contractor to carry along the grade.

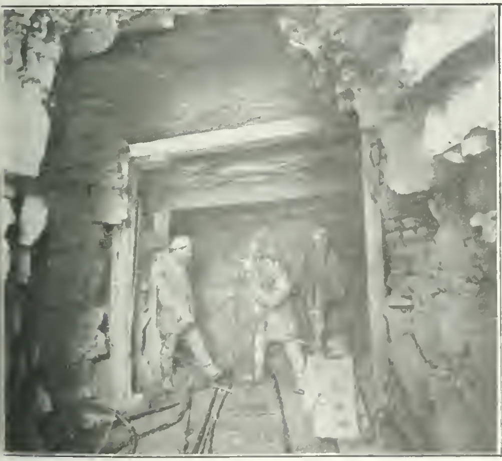


FIG. 2. ROCHESTER SEWER TUNNEL DURING CONSTRUCTION, LOOKING WEST TOWARD ANGLE TO SHAFT 2

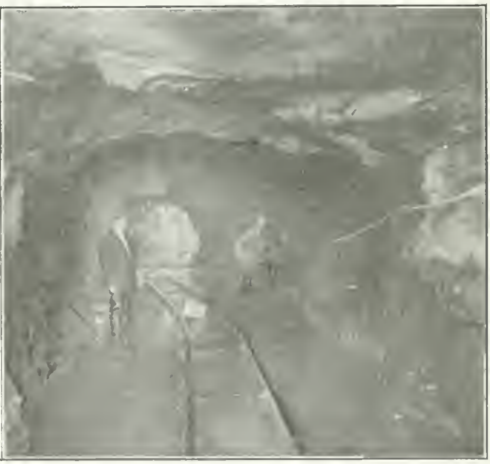


FIG. 3. LOOKING NORTH AT MAIN AND FRONT ST

Some difficulty was experienced at first in keeping numbers on the plugs. Small tin tags were tried and then white paint, but the dust from the blasts and the corrosive effect of the tunnel water soon destroyed both. Then a heavy brass tag with the number stamped deeply into it was tried, and this proved satisfactory.

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*Engineer in charge, Main and Front St. Sewer Tunnel, ochester, N. Y.

All lines and grades carried into the tunnel were checked twice, and some three times.

The tunnel was driven both ways from all six shafts. The greatest error in alignment at the meeting of headings was ¼ in., and the error in grade was less than that. This being well within the allowable error the work was considered satisfactory.

The rock in the greater part of the tunnel was a good, hard limestone. The contractor had an electrically driven air compressor to furnish power for drilling. Pipe lines were laid along the curb of the street through which the tunnel was driven and carried into the tunnel through the working shafts. The Leyner type of drill was found to give the greatest satisfaction; "jackhamers" were used to a small extent in trimming the sides and bottom.

In drilling the heading from eight to ten holes, averaging 6 ft. in depth, were drilled, and these afterward were loaded with from four to six sticks of 60% dynamite. Holes were fired singly except the V-shaped cut in the center, which was fired first.

For the greater part of the work the ordinary fuse was used, it being cut to the required lengths for timing the shots. An average of 25 ft. a week was made in each heading, and at no time was traffic on the street delayed nor serious damage done to property.

There was very little over-breakage in the tunnel. Some occurred at Shaft No. 2 where the rock for about 250 ft. was quite soft, and also a little at Shaft No. 4 at the corner of Main and Front St. The rest of the tunnel had to be trimmed to meet the required dimensions.

Only a little trimming was necessary at Shaft No. 2. Here the roof of the tunnel was good rock, but the sides and bottom contained soft mud seams.

The excavation of rock has been completed, the last headings being holed through on March 3, 1916. The work now carried on is the laying of 18 and 24-in. vitrified tile invert and the placing of the concrete lining in the bottom, also the construction of brick manholes at all the shafts. These manholes will have larger cast-iron covers than ordinarily, for dumping snow.

These manholes are to be connected with all the existing sewers in Main and Front St. Concrete baffles are constructed in the manholes to prevent the sewage, in flowing down, from injuring the bottom.

* * *

Cost of Factory Buildings of Timber and of Concrete

SYNOPSIS—The National Lumber Manufacturers Association has recently distributed as a bulletin a paper by F. E. Davidson, President of the Illinois Society of Architects, presenting a detailed estimate for the construction of two buildings on the same site—one of standard mill construction, the other of reinforced concrete. The paper shows that the cost of the latter building is about 30% more than that of the building of timber construction. The figures given by Mr. Davidson are of much interest; but since they are put forward by those interested in exploiting the use of wood in construction, it seemed desirable to present at the same time a statement of the case from the point of view of those who are well qualified to speak as to the merits of concrete for building construction. T. L. Condron, the designer of the concrete building referred to in Mr. Davidson's paper, has therefore prepared a statement which we print below, following Mr. Davidson's paper.

A Comparison of Concrete and Timber Factory Buildings

By F. E. Davidson[*]

I have as architect designed and superintended the construction of a great many manufacturing plants, both of fireproof construction and of the type known as standard mill. Based upon the actual construction costs, the increased cost of a strictly fireproof manufacturing building is from 25 to 35% greater than the actual first cost of an exactly similar standard mill building. In considering these costs I have included everything necessary absolutely to complete the building ready for the owner's occupancy; that is, the heating, lighting, elevators, power wiring, lighting fixtures, sprinkler equipment, window shades, window screens, etc., are all included in the cost of both types of construction.

It is of course manifest that the actual cost of many of the items of construction will be practically identical for either type of building. I have designed standard mill factory buildings in Chicago that have cost, complete, including all these various items, less than 7c. per cu.ft.; but I have never been able to secure the construction of a fireproof building, including all these items of cost, for less than 11c. per cu.ft., nor do I know of any accurate data showing any lower costs than those noted above.

DEPRECIATION CHARGES AND COST OF MAINTENANCE

When depreciation charges are considered, I have always recommended that a depreciation charge of 3½% per year be charged against a standard mill building and that a depreciation charge of 2½% per year be charged against an absolutely fireproof building.

As to maintenance charges: It is of course evident that as much outside painting, and in fact as much interior painting and calcimining, or whitewashing, will be required for a fireproof building as for a building of standard mill construction. Practically the only thing that wears and must be replaced in a mill building is the finished flooring, and I do not know of any accurate records of maintenance cost of a standard mill building which will average more than three-fourths of 1 per year. Yet, on the other hand, I do not know of any records of the maintenance charges on fireproof buildings which will average less than one-half of 1% per year.

INSURANCE RATING

As to insurance ratings: Every architect and engineer of course knows that a standard mill sprinklered building is given a much lower insurance rating than an absolutely fireproof building if unsprinklered. And even if the fireproof building is sprinklered, the difference in the actual ratings between a standard mill sprinklered factory and a standard fireproof sprinklered factory, with the ordinary occupancy, will only amount to about 10c. per $1,000 per year on the insurable value of the building.

ADVANTAGES OF STANDARD MILL CONSTRUCTION

Thus, considering first cost, depreciation, maintenance and insurance only, the argument is all in favor of the standard mill building. When I refer to a standard mill building I mean a building designed by a thoroughly competent industrial architect, who will inclose all stairs and elevators with brick masonry walls and have the openings to them protected with automatic firedoors, and will have all windows, with the possible exception of street frontages, of sheet metal and glazed with wired glass, with no unprotected vertical openings between any floors in the building. These are items that, more than any others, affect insurance ratings on any building.

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[*] Architect and Engineer, Chicago, Ill.; President, Illinois Society of Architects.

There are in addition to the questions above noted some additional arguments in favor of the standard mill factory building. One of the principal ones that have recently been brought to the writer's attention is the fact that a skilled artisan will not work if compelled to stand on a concrete floor, if he can secure employment at equal wages in a standard mill building. Many owners of fireproof buildings have had trouble in keeping help, due to this reason only, and in some fireproof factories it has been necessary to cover the concrete floor with a layer of asphalt or to place cork carpet or wood thereon, in order to render the factory "habitable."

There is yet another argument in favor of the standard mill building, which in any large city should be given serious consideration, and that is the salvage value of the building itself. We all know that a standard mill building can be wrecked and, if the work is carefully done, all the structural material can be used in another structure, whereas in wrecking a concrete structure there is no salvage. In fact, I have been quoted by one of the largest contracting firms in Chicago a price for the wrecking of a monolithic concrete building which amounted to a trifle more than one-half the original cost of the building. Our American cities are growing so rapidly that it would indeed be a courageous investor, or at lease one blest with a prophetic vision, who could predict as to what particular use a certain piece of property would be best adapted for 25 or 30 years in the future.

A SPECIFIC CASE

The tables that follow represent the lowest proposals received by my office on a building to be erected for Walter E. Olson, of 42 South Laflin St., Chicago. Mr. Olson decided to build an addition to his present factory and at first purposed erecting the addition of reinforced concrete.

With this idea in view, plans and specifications were drawn for a concrete structure, the Condron Co., structural engineer, of Chicago, doing the engineering work. After these plans were made, the owner decided to find out what a standard mill building would cost him, with the result that another set of plans and specifications was prepared by Davidson & Weiss, architects, Chicago, and bids were taken on both sets of plans, which amounted to practically duplicating the contemplated concrete building in mill construction as nearly as it is possible to have uniformity of design between the two types.

The building is 55 ft. 1½ in. by 124 ft. 7½ in. in area, with six stories and basement, and contains 598,477 cu.ft. The story heights are in general 13 ft. 6 in. floor to floor. The typical bays of the building are 18 ft. by 17 ft. 10 in. The structure was designed for a live-load of 150 lb. per sq.ft. in accordance with the requirements of the Chicago building code, which limits the stresses in long-leaf Southern pine to 1,300 lb. per sq.in. in bending and 1,100 lb. per sq.in. in direct compression with the grain.

The floor girders are composed of two 10x18-in. timbers bolted together, and the floor joists or beams are 8x16 in., ocated 4 ft. 6 in. c. to c. The girders are carried on steel post caps of the writer's own design. The floor construction s a 3-in. tongued and grooved flooring finished with a ⅞-in. maple wearing surface.

This building is an addition to an existing factory, and it was necessary to use cantilever foundations for the entire structure. This, of course, is true for either design.

The timber specified in the contract was to be of the select structural grade as per the new grading rules of the Southern Pine Association. The cost to the contractor in this particular building at the site was as follows: Approximately $34.50 per M. for the 18-in. stock and $33 per M for the 16-in. stock.

ESTIMATE FOR STANDARD MILL BUILDING*

xcavation, concrete foundations and brick masonry complete	$15,884
arpenter work complete	14,374
iscellaneous concrete, including fireproof stairs	3,517
tructural steel and miscellaneous iron	7,150
heet metal	138
ut stone	735
oofing	145
lazing	1,365
eel sash	1,436
iredoors	3,360
ire escapes	1,479
ainting	720
lumbing	615
lectric wiring	1,100
lastering	90
Total	$52,138

* Exclusive of heating and sprinkler equipment

On the basis of 598,477 cu.ft. the cost of the building complete, as shown from the total cost given above, exclusive of eating, sprinkler and architects' fees, is 8¾c. per cu.ft. In guring the cubical contents the space from the bottom of he footings to top of parapet wall is included.

For the same building proposals were taken on the monolithic flat-slab concrete design, and the lowest proposals presented were as follows:

ESTIMATE FOR REINFORCED-CONCRETE BUILDING*

Foundations, reinforced concrete, masonry and carpenter work	$55,941
Sheet metal	138
Cut stone	735
Roofing	145
Glazing	1,470
Steel sash	1,936
Firedoors	3,360
Fire escapes	1,479
Painting	790
Plumbing	725
Electric wiring	1,250
Plastering	90
Total	$68,059

* Exclusive of heating and sprinkler equipment.

The cubic contents of the reinforced-concrete design on the same basis as cubic contents for the timber design equal 585,467 cu.ft. Thus the total estimated cost of building, exclusive of heating, sprinkler and architects' fees, would be 11½c. per cu.ft., and the difference in first cost of the two designs, exclusive of heating, sprinkler and architects' fees, is $15,921.

The concrete design was made as inexpensive as possible and provided for the use of high-carbon steel reinforcing material; and in other ways costs were cut as much as possible, in spite of which fact there was a difference of 2¾c. per cu.ft. in the cost of the two types of construction.

In this instance it will be noted that the cost of the concrete structure would have been about 30% more than the cost of the mill building, and this saving to the owner was effected in addition to the advantages he gained in the matter of quick erection, etc. The insurance rate is the same on the standard mill building as it would have been on the concrete structure.

The Case for Concrete

Sir: The bulletin issued by the National Lumber Manufacturers Association, prepared by F. E. Davidson, has just been brought to the writer's attention. As our company is referred to as having prepared the plans for the reinforced-concrete building used in this comparison, we believe you will be interested in some later data from us on this very interesting subject, which show that for a factory building for the Imperial Brass Manufacturing Co. the bids received for the concrete construction ran only 17% above the cost for the mill construction for the same building, or only 4% more than the cost of the mill construction of the building cited by Mr. Davidson.

In all these comparisons the cost of heating, sprinkler and elevator equipment and plumbing fixtures has been omitted; and it is obvious that if the cost of these equipments, which may be assumed at 28c. per sq.ft. of floor surface for either type of building, be added to the cost per square foot shown by the bids received, the percentage of additional cost of concrete over mill construction will be reduced. Making this addition in all cases, the reinforced-concrete construction of the Imperial Brass Co. building is shown to be 14% more than for standard mill construction for the same building, or only 3% more than the cost of the mill building cited by Mr. Davidson.

These comparisons are even more instructive when it is noted that the Imperial building was designed for heavier live-loads per square foot than the Olson building cited by Mr. Davidson; and that the bids for the Imperial building for standard mill construction totaled 11% less per square foot of floor than in the case of the Olson building, showing that our design for standard mill construction meets the requirement for an exceedingly economical structure. Our designs for the concrete construction of both the Imperial and the Olson buildings were identical, so far as type and unit stresses were concerned, and were for flat-slab, or girderless, floor construction. The accompanying table presents in ready form for comparison all the figures on which the foregoing comments are made.

It is perhaps well to state that in the case of the Olson building, made the basis of the comparison by Mr. Davidson, the Condron Co. was engaged as consulting engineer by Mr. Davidson, architect, to prepare the general design for the reinforced-concrete construction of the proposed Olson building, and Mr. Davidson prepared the architectural plans, including the general layout for both the concrete and the mill buildings.

The specifications and general instructions to bidders for both constructions were issued by Mr Davidson. After the concrete plans were started and fairly well advanced, but before bids were called for, the architect informed us that the owner had decided to abandon the idea of a concrete build-

COMPARISON OI COSTS O' M:LL AND CONCRETE CONSTRUCTION

Comparison of Bids for a Factory Building of Standard Mill and Reinforced Concrete	Olson Building		Imperial Building	
Type of construction	Mill	Concrete	Mill	Concrete
Total floor areas, sq ft.	44,500	45,000	74,000	74,000
Masonry (brick, stone and concrete)...	$20,256	$56,766	$31,097	$80,000
Ornamental and miscellaneous iron, etc.	11,989	4,839	13,250	
Carpentry. . .	14,374		23,500	..
Steel sash, glazing, painting, roofing, etc.	3,804	4,479	6,069	6,883
Plumbing (drainage)	615	725	1,536	1,669
Wiring*.....	1,100	1,250	1,830	2,060
Totals of bids received...	$52,138	$68,059	$77,282	$90,479
Per sq.ft. of floor areas.......	$1 17	$1.51	$1 04	$1 22
Relative costs per sq.ft	100%	129%	89%	104%
Relative costs per sq.ft		...	100%	117%
Adding 28c. per sq ft. of floor area to cover cost of sprinkler, heating and elevator equipment and plumbing fixtures	$1 45	$1 79	$1 32	$1 50
Relative costs per sq.ft	100%	124%	91%	103%
Relative costs per sq.ft	. .		100%	114%
Per cu.ft. of building	8½c.	11¼c.	8c.	9⅛c.
Relative costs per cu.ft	100%	132%	94%	107%
Relative costs per cu.ft	.	.	100%	114%
Adding 2c. per cu.ft. of building to cover cost of sprinkler, heating and elevator equipment and plumbing fixtures	10½c.	13¼c.	10c.	11⅛c.
Relative costs per cu.ft	100%	126%	95%	106%
Relative costs per cu.ft	.	.	100%	112½%

*Estimates of wiring only.

ing and to build of "mill construction." We suggested that since the concrete plans were so far advanced it would be interesting and perhaps instructive to get comparative bids.

This was done, and the results have proved interesting; but we think they are not especially instructive. The column spacing was modified in making up the mill design, changing the spans from 21 ft. 0 in. (concrete design) to 17 ft. 10 in. (mill design).

At the time the bids were called for on the Olson building, the plans for the Imperial Brass Co. building were underway in our office, and in this case the owner desired bids on both concrete and mill construction. The Imperial building was to be an addition to a standard mill building located in the same neighborhood as the Olson building. After the bids were received the owner decided to have the addition built of standard mill construction, notwithstanding the small difference in cost. Doubtless one of the factors in arriving at this decision was the greater ease in tearing down a mill building, provided it was found desirable to change the character of the improvement within a comparatively few years.

Attention has been called to the objection of skilled artisans to working upon concrete floors instead of wooden floors. As you doubtless know, many reinforced-concrete buildings are provided with maple wearing surfaces to obviate this very objection, but it is worth while to remember in this connection that the Ford Motor Co., with several hundred acres of floor space devoted to factory purposes and employing many thousands of skilled artisans, has adopted concrete construction for all its buildings and has used on all its later buildings cement finish floors rather than wooden wearing surfaces. This is also true of practically all the automobile factories throughout the United States, and there seems to be a growing preference for concrete floors over wooden floors, especially in machine shops. The trouble with working on concrete floors is largely imaginary in buildings that are heated. It is true that, in unheated buildings, stone and concrete, being better conductors than wood, are cold to the feet and therefore unpleasant to work upon.

The equipment of buildings with sprinklers seems to the writer to be quite as important in concrete construction as in mill construction, because the contents of buildings are usually not fireproof, even if the building construction itself is fire resisting. We have seen serious conflagrations spread throughout so-called fireproof buildings, fed only by the inflammable contents. In these cases the fires would have been almost insignificant had the buildings been equipped with sprinklers.

With reference to the "prophetic vision" necessary to know what kind of building will be required in any locality in the future there is no question that a first-class reinforced-concrete building six or eight stories high with wide column spacing will serve any and all purposes for which buildings may be required so long as men carry on pursuits in structures protecting them from the weather.

The Imperial Brass Co. building that has been referred to, which is now under construction, is 85x125 ft. in area, six stories and basement, and has 74,000 sq.ft. of floor surface. The cubical contents measured in the same manner as adopted for the Olson building are 972,000 cu.ft. for the standard mill construction and 993,400 cu.ft. for the reinforced-concrete construction, the difference in cubical contents being due to the greater depth of foundations for the concrete construction. The typical bays of the standard mill construction are 18 ft. by 16 ft. 6 in. and for the reinforced-concrete construction 18 ft. by 21 ft. 6 in. The structures were designed for a liveload of 175 lb. per sq.ft. in accordance with the requirements of the Chicago building code.

In the standard mill construction the floor girders are composed of two 8x18-in. timbers, bolted together, and the floor joists or beams are 8x16 in. spaced 4 ft. 6 in. c. to c. The girders are carried on steel post caps built up of plates and angles. The floor construction is 3 in. tongued and grooved yellow-pine flooring with ⅞-in. maple wearing surface. The timber specified was select structural-grade Southern pine, according to the specifications for dense Southern pine given in the Southern Pine Association Density Rule Book of Mar. 15, 1916. No. 1 Douglas fir was permitted as an alternate for the above yellow pine.

The reinforced-concrete design called for an 8-in. reinforced-concrete slab supported by flaring column heads, and reinforced-concrete round columns.

The foundations for the mill-construction building are the usual spread type, except that cantilever foundations are required on the side adjacent to the old building.

CONDRON CO.,
By T. L. CONDRON.

Monadnock Block, Chicago, Oct. 21, 1916.

⁂

Southern Rains and Floods of July, 1916, Exhibited

The destructive floods of July, 1916, in the East Gulf and the South Atlantic States are the subject of a valuable special study by Prof. Alfred J. Henry in the *Monthly Weather Review* for August, published Nov. 1. Through the courtesy of C. F. Marvin, chief of the Weather Bureau, we are able to present material from advance proofs of the study and also to announce that "a small number of separates will be available for distribution to engineers who may be particularly interested in the conditions that produced the flood."

The floods were caused by two tropical cyclones. The first of these occurred during the night of July 5-6, passing inland through Mississippi, and was accompanied and followed by almost continuous rain for five days, with extraordinary precipitation in some sections. The second cyclonic storm passed inland over South Carolin the morning of July 14. Before this storm died out "unprecedented rains fell over the eastern slope of the Blue Ridge and also in the valley of the French Broad." The saturated condition of the soil contributed to a probable 80 to 90% runoff and unprecedented floods in both the Tennessee and Atlantic drainage areas.

The study by Professor Henry includes detailed rainfall figures for the two storms for many stations and also 20 maps and diagrams, mostly rainfall maps, bu including a few hydrographs or river-elevation diagrams Four rainfall maps of most general interest are reproduced here as Figs. 2 to 5, and some cumulative rainfall diagrams as Fig. 6.

Fig. 2 illustrates an "island" of heavy precipitation in southeastern Mississippi, the most notable of three such islands in the storm of July 5 to 8. Professor Henry states that there is no explanation of these islands.

Taking the whole area covered by the storm of Jul 5 to 8, 1916, the records show that during a singl 24-hr. period more than 8 in. of rain fell on an area o 4,945 sq.mi. and more than 4 in. over 17,582 sq.mi. Hig records in three states for 24 hr. were: 12.7 in. at Alag Ala.; 10.8 at Eufala, Ala.; 9 at Ozark, Ala.; 9.9 at Blakely, Ga.; 9 at Fort Gaines, Ga.; and 10.8 in. at De Funia Springs, Fla.

Taking up high records for the second of these cycloni storms, farther east, from 8 to 10 in. of rain was recorded

July 14 at five North Carolina stations. The climax occurred later and is thus summarized by Professor Henry:

> Beginning during the afternoon of July 15 and continuing for 24 hr. the rains in the mountain districts of North Carolina were extraordinarily heavy. At a special orchard station maintained at Altapass in the southeastern corner of Mitchell County, N. C. (altitude 2,625 ft. above mean sea level), an actual measurement of 19.32 in. of rain in 24 hr. was recorded in an 8-in. standard rain gage. The measurement was made at 6 p.m., July 16, 1916. According to the observer, J. S. Bowen, between 2 p.m. Saturday and 2 p.m. Sunday, July 16, the rainfall amounted to 19.32 in. as measured on the 16th, and about 2.90 in. of the rainfall measured on the afternoon of the 15th fell after 2 p.m. of that day; hence the 24-hr. rainfall, 2 p.m. 15th until 2 p.m. the 16th, was about 22.22 in.

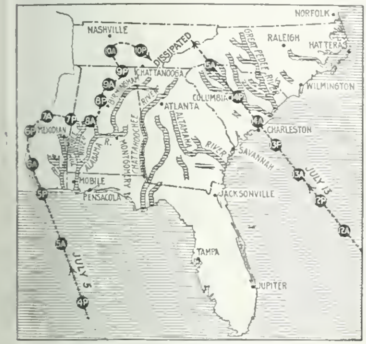

FIG 1 - PATHS OF HURRICANES AND OVERFLOW AREAS ALONG SOUTHERN RIVERS

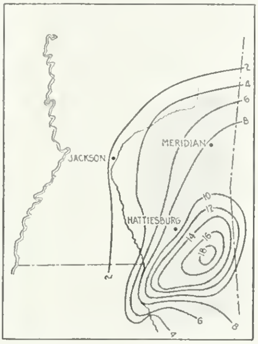

FIG. 2 - PRECIPITATION SOUTHEASTERN MISSISSIPPI, JULY 5-8, 1916 INCLUSIVE

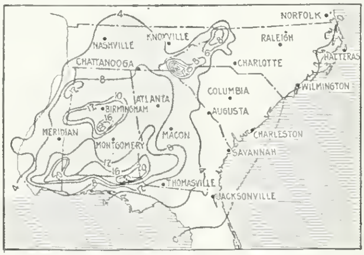

FIG. 3 - PRECIPITATION JULY 6-13, 1916, INCLUSIVE

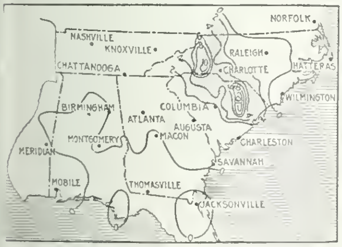

FIG. 4 - PRECIPITATION JULY 15, 1916

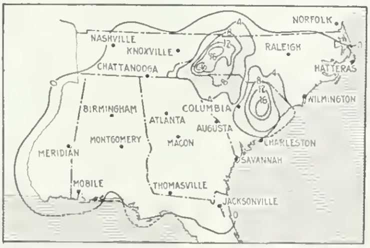

FIG. 5 - PRECIPITATION JULY 14-18, 1916, INCLUSIVE

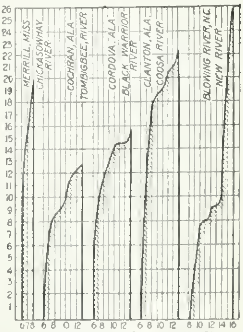

FIG 6 - CUMULATIVE PRECIPITATION FOR VARIOUS DATES AND LOCALITIES

RAINFALL IN THE EAST GULF AND SOUTH ATLANTIC STATES DURING TWO CYCLONIC STORMS IN JULY, 1916

The highest hourly rate of precipitation mentioned by Professor Henry is 5.21 in. per hr. at Mobile, Ala., July 8, 1916. This continued for 25 min., "and appears to be he greatest fall for 25 min. in August" ever recorded on n automatic gage, though a rate of 6.36 in. continued for 0 min. was visually observed at Jupiter, Fla., Aug. 21, 893. Details of hourly rates for July 5 to 8, 1916, are iven in the report for Mobile and Montgomery, Ala., Ieridian, Miss., Birmingham, Ala., Atlanta, Ga., Chattaooga, Tenn., and Asheville, N. C.

The cumulative precipitation for six stations, on as any rivers, is shown graphically by Fig. 6.

Flood conditions are reviewed by Professor Henry. As he storm progressed upstream, "we have the rather nomalous situation of a river being in flood in its lower eaches before the headquarters have reached the flood tage." Also, "the flood stage was naturally long-drawnt by reason of the advance of the rains in a direction irectly opposite to that of the course of streams." Highater marks were greatly exceeded at many places.

The exact loss of life as a result of the floods caused the two storms is unknown, but is placed at 80 persons, most of whom were drowned in the streams of North Carolina. The estimated property loss totals \$21,724,000, divided as follows: Buildings, roads, bridges, culverts, etc., \$4,918,000; crops not gathered, \$11,606,000; livestock and movable farm property, \$811,000; suspension of business, loss of wages, etc., \$1,939,000; railroads, in roadbed, bridges, trestles, culverts, etc., \$2,450,000.

As to the likelihood of similar storms in the future Professor Henry says:

> Unfortunately, our present knowledge of the underlying causes of cyclonic storms, their distribution in time and space, is so indefinite that any discussion thereon must be largely speculative. It may be said, however, that the floods in Mississippi, Alabama and Georgia were due almost wholly to a single long-continued rainstorm which was closely associated with the passage inland of a tropical cyclone. Likewise, the floods of the rivers in the coastal plain of South Carolina, especially the Great Pee Dee, were due to the movement inland of a single tropical cyclone. The floods in the streams originating in North Carolina were due to the torrential rains of the 15th and 16th coming at the close of a period of heavy rains that were associated with the first, or Alabama, storm. Tropical cyclones do not, as a rule, synchronize as did these two, and on that fact we would base our belief that a repetition of the storms of July, 1916, is not probable more than once in a century at least.

It seems hardly necessary to advise those desiring the full paper on these great storms to lose no time in applying to the Weather Bureau, Washington, D. C., for a copy.

⁂

Electric-Automobile Fire-Fighting Equipment has been generally adopted by the City of Paterson, N. J., replacing horse-drawn apparatus. After a study of motor apparatus in use elsewhere, it was decided that the readiness hill-climbing power, simplicity of operation and general reliability dictated use of electric traction in that city. It is reported that there will be required six tractor-drawn (two-wheel front drive) steam pumping engines, five combination chemical engines and hose wagons and one four-wheel-drive aërial truck. Battery-charging apparatus will be installed in each engine house.

Six-Post Water-Tower Tank

SYNOPSIS—The design and erection at Wheaton, Ill., of a steel water tower and tank having a total height of 173 ft. are described.

An elevated water tank of 200,000-gal. capacity, with a six-post steel tower, is being built for the municipal water-works at Wheaton, Ill., to replace an old 138,000-gal. standpipe. The tower is 138 ft. high from the concrete footing to the horizontal ring girder, and the height to the top of the tank is 172 ft. 6 in. The tank is 28 ft. in diameter and 35 ft. high in the cylindrical portion. It has a segmental bottom 14 ft. deep, connected to a 48-in. riser pipe, and is covered by a conical steel roof.

The tower has a batter of 1 in 12 and is divided into four stories or bays by three courses of horizontal struts. The columns are of box section, each composed of two 15-in. side channels and an inner 18-in. cover plate, with double lacing on the outer side. They are made in four lengths of about 38 ft. The horizontal struts are pairs of channels with top and bottom lacing, except that at the ends the channels are brought together and riveted to connection plates on the columns. Each panel has two adjustable diagonal tension rods, set up by turnbuckles and having welded loop ends fitted to 2-in. pins in the connection plates. The loops are double, straddling the plate and engaging both ends of the pins. The connection plates at the bottom are on the outside of the columns; the others are riveted to the sides—that is, to the webs of the channels.

Near the tops of the columns are outside brackets to carry the ring girder, above which the column is extended about 8 ft. by four 6x4-in. angles, which are riveted to the bottom course of the side of the tank. Large reinforcing plates are placed between the backs of the columns and the tank plates.

The tank has five courses, 7 ft. high, with each course outside of the next course below. The plates are 87 in. high and 15 ft. long, with double riveting in the vertical seams and single riveting in the horizontal seams. All seams are made with lap joints. The thickness is 3/8 in. for the segmental bottom and the lowest course of plates, 5/16 in. for the second course and 1/4 in. for the other courses. At the top are brackets carrying a circular channel supporting the 5-in. channels forming the rafters of the conical roof, which has 1/8-in. plates. The roof projects about 18 in. beyond the tank and fits close against its upper edge, so that there are no openings by which birds can enter.

At the base of the cylindrical portion of the tank is a ring girder with a 1/4-in. horizontal web plate 41 in. wide, having radial stiffeners on the under side. The inner flange is a single angle riveted to the tank shell; the outer flange is a 6-in. channel having its lower flange riveted on top of the web plate. The hand railing around this girder consists of steel angle stanchions and top rail, with two diagonal bars in each panel.

About 18 in. below the top edge of the tank is an inside Z-bar ring that serves as a stiffener. On the cover is a swivel trolley for a painters' platform. The top of it is attached to the apex of the roof in such a manner as to allow it to revolve, and its lower end supported by means of a pair of 3½-in. flat-tired wheels between a pair of angles. This frame carries an outside bent plate having a hole for a clevis or stirrup to which the tackle of the painters' platform is hooked. The overflow is a 3-in. pipe leading out through the top course of the tank and carried down one of the columns.

The 48-in. riser is of 1/4-in. plates in 5½-ft. courses, with single-riveted circular and vertical seams. At the top is a domed cover with a telescopic expansion-joint connection to the 12-in. pipe entering the tank. The bottom is flat, with a 12-in. opening for the pipe connection to the mains and a 6-in. opening for the pipe from the service pumps. A 10x16-in. manhole is provided in the lowest course of plate. With the large body of water in a riser of this size no frost-protection covering is needed.

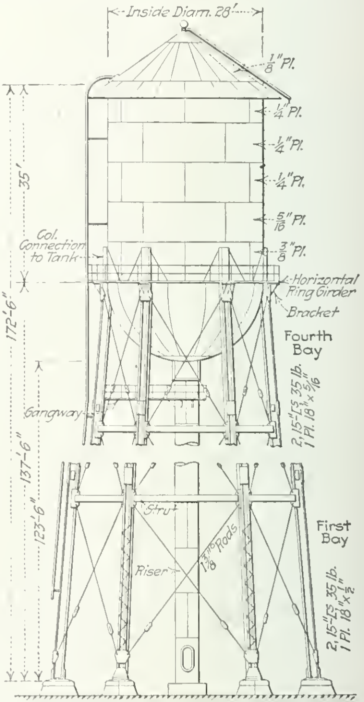

FIG. 1. DESIGN OF SIX-POST WATER TOWER WITH 200,000-GAL. TANK

To give access to the expansion joint, there is a gangway from the column carrying the ladder to the riser pipe. Around the riser is a horizontal ring girder 4 ft. wide, supported by brackets on the riser and forming a platform. The gangway has a floor plate 16¾ in. wide resting on the bottom flanges of a pair of channels and stiffened by transverse angles across the bottom of the plate and channels. Hand-rail stanchions are riveted to the backs of the channels. In this gangway, and in the ring girders and the Z-bar stiffener, holes are made in the horizontal web plates to provide drainage.

The foundations consist of six heavy concrete footings or piers for the columns, and a central pier for the 4-ft. riser. The site is on a good gravel formation, and the pressure of the base of the piers upon the soil averages 2,770 lb. per sq.ft. The column piers are about 8½ ft. high, 5x5 ft. at the top, which is inclined so that the columns will be perpendicular to it. In each pier there are two 1⅞-in. anchor rods, with 2¾-in. upset ends. The anchor rods are inclined 1 in 12 and have the upper ends incased in 3-in. pipe sleeves 24 in. long, into which the rods are grouted after final adjustment. The size of the piers was not governed by he bearing, but was made to comply with a specified actor of safety of 1½ on uplift.

The central pier is 8 ft. square and 9 ft. deep. It has a chamber for the pipe connections and a valve on 6-in. blowout pipe. The top of the pier, over the hamber, is reinforced with steel rods. There are 22½ u.yd. of concrete in each column pier and 18¾ yd. in he central pier. The concrete is a 1:3:5 mix (made with stone), except that for the caps of the column piers it is 1:2:3. It was made in a mixer of the continuous type, and the concrete for each pier was poured in a continuous run.

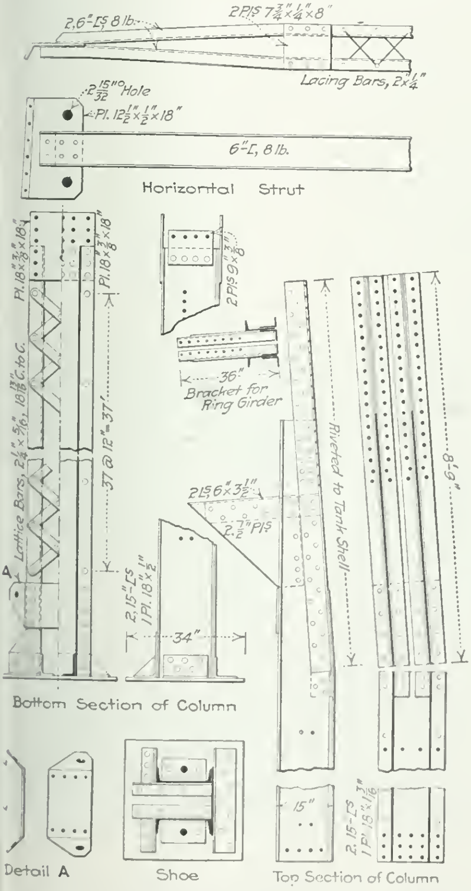

FIG. 2. DETAILS OF COLUMNS AND STRUTS OF WATER TOWER

The tower and tank are of openhearth steel conforming to the specifications of the American Railway Engineering Association. The live-load on the roof is taken at 30 lb. per sq.ft., or 200 lb. concentrated at any point. The wind pressure is taken as 30 lb. per sq.ft., acting on 66% of the diameter of the tank for its full height. The steel was given one coat of paint at the shop and one field coat after erection.

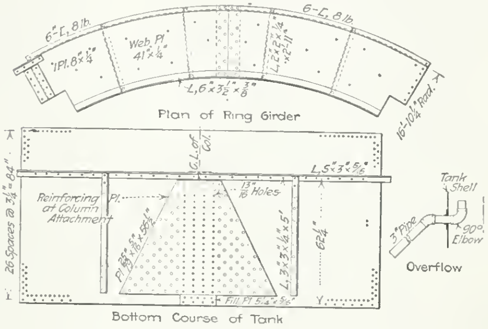

FIG. 3. RING GIRDER AND BOTTOM COURSE OF TANK SHELL

Showing reinforcing plate at column connection

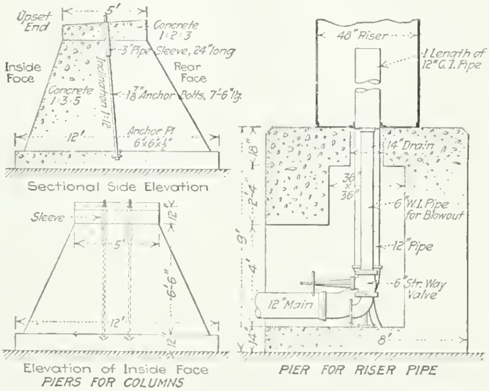

FIG. 4. FOUNDATION PIERS FOR WATER TOWER

ERECTION OF WATER TOWER

The erection outfit was very simple. A light timber A-frame sufficed to raise the tower. It was just high enough to enable the tackle to be hitched above the middle of a column length, the column thus swinging free and being guided into position by guy lines. For the upper bays the A-frame was placed upon each line of struts in turn. With the tower completed, including the ring girder and the bottom course of the tank (to which the heads of the columns are attached), the next step was to place the segmental bottom. Two or three rope tackles were attached to the top of the tower, operated by a team or a hand winch for heavy hoisting, and by hand for adjustment of the parts.

Two of the bottom plates were hoisted into place and bolted to the tank shell, and then the bottom disk or circle plate (with pipe connection) was hoisted. With the aid of the tackles hitched to the circle plate and the ends of the two bottom plates the parts were brought together so that erection bolts could be fitted. The other bottom plates were then placed without difficulty. A platform composed of a few loose planks was used in this part of the work.

The tower and tank bottom were erected in this way without any riveting, all parts being connected by service bolts. The riveting was started on the column splices, working upward, and was completed before proceeding to finish the tank. All riveting was done by hand. The A-frame mentioned above was utilized to support the riveters' platform. It was placed horizontally with the wider end lashed to one of the struts and the narrow end attached to one of the ropes from the top of the tower. For riveting the tank seams a steel cage was used carried by long bars which were hooked over the top of the shell plates.

This structure was designed by L. J. Ruddock, City Engineer of Wheaton, Ill. It was built and erected by the Memphis Steel Construction Co., of Greensburg, Penn. The material was inspected at the shops by Robert W. Hunt & Co., of Chicago. The cost was $8,843 for the steel tank and tower and $1,071 for the concrete foundations.

* *

Activated-Sludge Novelties at Hermosa Beach, Calif.

By A. M. Brosius*

SYNOPSIS—A diffuser wheel in the bottom of each tank draws air and sewage down through a central foam chamber to the bottom of the tank, from which both pass upward. Air under 1 lb. pressure will also be admitted to each central pipe.

Among the assets of the cities and towns on the southern California coast are the fine bathing beaches. It is therefore unadvisable, for æsthetic reasons, to discharge sewage into the ocean adjacent to these beaches without its having been treated to a high degree.

On account of the most available site for the Hermosa Beach sewage works being located within the city limits, it was necessary to select a method of treatment that would be unobjectionable to the near-by property owners, and the activated-sludge process was recommended.

In view of the fact that the porous plates used as air diffusers in some of the activated-sludge plants have caused more or less trouble by clogging with oil and dust, an effort was made to develop a method of air diffusion that would obviate this difficulty, and a series of experiments covering a period of several months were made for this purpose.

The experimental plant (Fig. 1) includes a circular wooden tank, 5 ft. in diameter, with an available water depth of 9½ ft. This tank has glass portholes at 1, 2, 4 and 5 ft. above its bottom. Diffusers of various designs were tried out, both with and without compressed air being supplied to them.

The experiments resulted in the adoption of a diffuser wheel, similar to an impeller of a centrifugal pump, revolving on a vertical shaft. This wheel is in the bottom of the tank, 4 ft. from one side, and at the lower end of a vertical galvanized sheet-iron pipe, 7½ in. in diameter, which extends about 3 in. above the surface of the water when the depth of the water is 9½ ft. In the side of the pipe is an opening 6 in. square, the center of which is 1 ft. under water. This opening is provided with a gate so that the amount of water entering the pipe can be controlled. It was found that the water as it enters the pipe forms a foam with the air in the top of the pipe, which may be designated as the foam chamber. The action of the impeller draws this foam to the bottom of the pipe and throws it out approximately horizontally, thereby diffusing the air uniformly throughout the contents of the tank, the diameter of the bubbles ranging from ⅛ t $^1/_{100}$ in. or smaller.

It is believed that under ordinary conditions of sewage flow sufficient air will be drawn down the vertical pipe without supplying air under pressure. It was considered advisable, however, to provide a blower for the Hermosa Beach plant (Fig. 2) for furnishing air to the foam chamber under a pressure of about 1 lb. This was done in order that the air may be more readily measured. The air pressure is maintained practically uniform by a trap

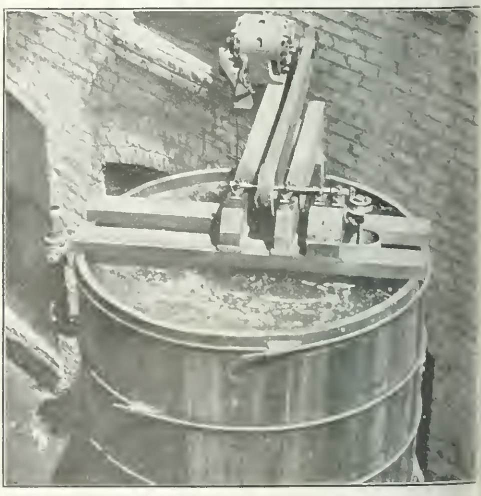

FIG. 1. EXPERIMENTAL AIR-DIFFUSER TANK AT HERMOSA BEACH, CALIF.

The tank contains clear water. The only air diffuse through it is being drawn down the vertical pipe and throw out by the centrifugal action of the diffuser wheel in th bottom of the tank in the sewage inlet channel, which enters one side of the foam chamber, and by an elbow pointing downward, which enters the foam chamber on the opposite side, the head on the lower end of the elbow being slightly less than the head in the trap.

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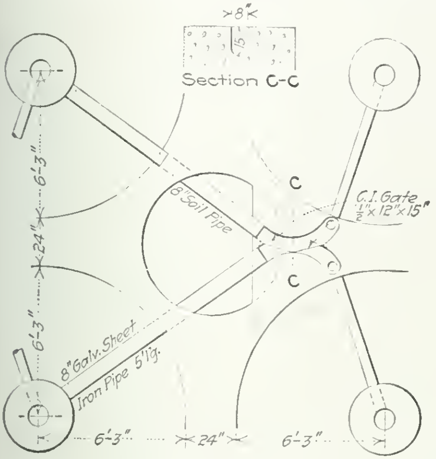
*Consulting Engineer, Hollingsworth Building, Los Angeles, Calif.; formerly Principal Assistant Engineer, Baltimore Sewerage Commission.



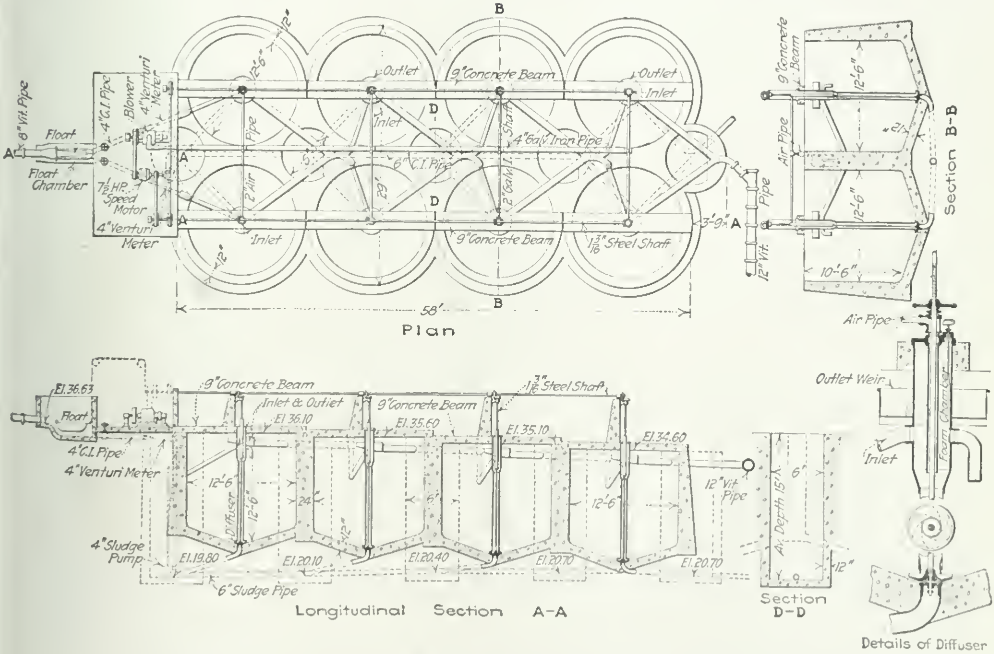


FIG. 2. DETAILS OF ACTIVATED-SLUDGE PLANT PROPOSED FOR HERMOSA BEACH, CALIF.

The operation of the Hermosa Beach plant may be briefly described as follows: After the sewage passes through grit and screen chambers, it enters a float chamber where the movement of a float is communicated through a cable to the brush-shifting device attached to a variable-speed motor. In this way the speed of the motor is controlled by the volume of sewage flow. The sewage on leaving the float chamber enters the foam chamber in one of the first pair of tanks adjacent to the machinery room. There are four pairs of tanks 12½ ft. in diameter, with a maximum water depth of 12 ft. The tanks adjacent to the machinery room may be used for activating the sludge, or as aërating tanks.

On the assumption that the sludge has been properly activated in one tank, the sewage, mixed with air, is discharged into it at the bottom of this tank by the diffuser wheel. The revolution of the wheel gives the mixed sewage and air a high velocity as it leaves the wheel. The diffuser wheel also gives a rotary motion to the entire contents of the tank, which causes the air bubbles to rise in a spiral path having an angle of about 45° with the vertical. The ratio between the length of the spiral path of the bubbles and a vertical path is approximately 14 to 10. This means that the spiral path of the bubbles in a tank 10 ft. deep would be about 14 ft. long, thereby giving a proportionately longer period of contact between the bubbles and the sludge.

The sewage leaves the tank by a circular weir-like overflow basin in the center of the tank, at the top, and runs through an inclined pipe leading to a double Y-trough between the second pair of tanks, where it may be diverted either in whole or in part to either one, or both, of these tanks. This diversion is accomplished by means of two swinging tongue-like gates in the double Y-trough.

The sewage, upon entering the second pair of tanks, passes into the foam chambers, mixes with air and is thrown out by the diffuser wheel in the same manner as described in connection with the first tank. If the volume of sewage flow is large, it may be passed similarly through the third pair of tanks. If, however, the flow is small, it would be necessary to pass the sewage through only one or two tanks that are being supplied with air, the other tanks acting as sedimentation tanks. When, however, it is necessary to use four tanks in addition to the first tank, the effluent from the last tanks would be discharged into one of the fourth pair of tanks, which would then operate as the sedimentation tank; and the clarified effluent from this tank would be discharged into the outfall sewer.

It may be desirable to oxidize further the sludge that has accumulated in one of the last pair of tanks. The other one of these tanks is then utilized as the sedimentation tank. The method of sludge aëration is accomplished in the sedimentation tanks by mechanism similar to that in the other tanks.

In the process just described most of the sludge in the first tank will be carried with the sewage through the several tanks and deposited in the final sedimentation tanks. From these tanks it may be discharged onto the sludge beds or returned to the sludge pump in a manhole between the first pair of tanks. The returned sludge is then lifted by the sludge pump and is discharged into one or the other of the tanks of the first pair, preparatory to repeating the cycle of operation.

While one of the first pair of tanks is being used for the purpose of sludge activation and when the sludge in the other tank is in proper condition, this last-mentioned tank would be used as the first aërating tank.

The bottom bearing for the shaft of the diffuser wheel is so designed that it serves as a valve on the upper end of the sludge pipe in each tank. This valve, together with the wheel and vertical pipe leading downward from the foam chamber, may be raised by means of a handwheel operating on the threaded upper end of the diffuser-wheel shaft. In this way the contents of any of the tanks may be drained out through the sludge pipes, whenever necessary, either for cleaning or for repairs.

The Hermosa Beach plant is designed for a maximum daily sewage flow of 400,000 gal., and an aëration period of 3 hr. It is estimated that the power required for a plant of this capacity will amount to about 60 kw.-hr. per 100,000 gal. of sewage treated. The writer's designs for this plant were approved on July 6, 1916, by C. R. Sumner, city engineer, and by the Board of Trustees of Hermosa Beach. It is expected that bids for construction will be received in October and the plant be in operation early in 1917.

The First Complete Railway-Valuation Reports Filed

Great interest attaches to the first complete reports of the valuation of railway companies' property by the Valuation Division of the Interstate Commerce Commission, which were filed at Washington on Oct. 9. The two roads of which the valuation has been completed are the Texas Midland R.R., a line 111 mi. long in Texas, and the Atlanta, Birmingham & Atlantic R.R. in Georgia and Alabama. The Federal Valuation Act required the Interstate Commerce Commission to ascertain for each railway the cost of reproduction new, the cost of reproduction less depreciation, and the original cost to date.

The principal figures for the Texas Midland R.R. under these three heads are as follows:

Road (wholly owned):	
Cost of reproduction new	$2,601,289
Cost of reproduction less depreciation	2,007,708
Equipment:	
Cost of reproduction new	582,071
Cost of reproduction less depreciation	362,940
General Expenditures:	
Cost of reproduction new	176,69
Cost of reproduction less depreciation	138,56
Total (including proportion of line owned jointly):	
Cost of reproduction new	3,382,00
Cost of reproduction less depreciation	2,527,41
Land:	
1,863 acres owned and used for transportation purposes	236,68
76 acres not held for transportation purposes and structures thereon	8,61
Original Cost:	
Original cost of road could not be found.	
Original cost of equipment now in existence	528,87
Original cost of 1,370 acres purchased	68,23
Original cost of 493 acres donated (cost to donors)	43,10

No other values or elements of value were found to exis

The Texas Midland received aids and donations, includin gifts of right-of-way, amounting to $69,885, not includin contributions of Hetty R. Green.

The capitalization of the company since 1908 has consisted of $2,000,000 of 4% mortgage bonds and $112,00 of capital stock. The present capitalization of the road therefore, is materially less than it would cost to reproduce the road in its present condition.

The railway was chiefly owned by the late Hetty R Green, of New York City. Although commonly repute to be the wealthiest woman in the United States, it i evident that it was not through such investments as tha in the Texas Midland R.R. that she acquired her wealth

The accounting division of the valuation force give an extended history of the Texas Midland R.R.; an while it has not been able to ascertain from existing records all the data concerning the financial history, th principal facts may be briefly summarized as follows: I the early '80's the Texas Central R.R. built a line o railroad about 52 mi. long in central Texas. This, wit other railway lines owned by the company, was sold unde foreclosure proceedings in 1891. Mrs. Green owned 75 of the $1,000 bonds that had been issued by the Texa Central, and she took this 52-mi. line of road in exchange for her bonds. This line was incorporated a the Texas Midland R.R., and extensions were built wit money furnished by Mrs. Green. Up to August, 190 she had advanced to the company about $1,750,000. I addition, she had made other cash advances for freigh cars and other requirements, making the total cash advanced to the company by Mrs. Green, according to th report of the accountants, $2,099,140. As far as th books disclose, Mrs. Green had up to June 30, 191 never received directly or indirectly anything from th Texas Midland R.R., except a payment of $115,650 b the construction company that built the road, and interes on the bonds she held amounting to $331,596.

During the entire time from Feb. 26, 1893, when th railway company began business, until June 30, 1914 the entire net earnings of the company, above operatin expenses and taxes, amounted to $1,127,000. From thi amount, $351,000 was paid out in rents for land, buildings and rolling stock, leaving $773,000 balance availabl for payment of interest and dividends. The total amoun of interest accruing on bonds during this period, however, amounted to $1,152,000, leaving a deficit of nearl $380,000, as the total operating results for that time.

Among other interesting facts found by the accountants in delving into the past history of the company i that when the Texas Central R.R. was sold at foreclosur proceedings in 1891 there were outstanding upon it mortgage bonds amounting to $3,399,000, of which Mrs. Gree owned $750,000. The result of the foreclosure sale wa that when the assets were distributed among the bond holders of the company the holder of each $1,000 bond received the sum of $151.37.

ATLANTA, BIRMINGHAM & ATLANTIC R.R.

The Atlanta, Birmingham & Atlantic R.R. is a single-track narrow-gage railway about 634 mi. in extent, lying in Georgia and Alabama. It has been in the hands of a receiver since Jan. 1, 1909. The valuation results are summarized as follows:

Common-Carrier Property:

	Cost of Reproduction of Road and Equipment, Excluding Lands New	Less Depreciation	Present Value of Lands
Owned by A., B. & A. R.R.	$22,716,886	$18,071,950	$1,091,886
Leased to others	170,754	111,366	13,668
Used by A., B. & A. R.R., owned	$22,546,132	$17,960,584	$1,078,218
Leased from others	1,608,866	1,448,226	1,213,195
Total used by A., B. & A. R.R.	$24,154,998	$19,408,810	$2,291,413

Noncarrier lands, present value	$145,203
Other Noncarrier Property:	
Stock in compress and terminal companies (par value)	4,505,000
Rails and track material	36,058
Aids, Gifts, Grants of Right-of-Way and Donations:	Present Value
Carrier lands	$226,080
Noncarrier lands	21,795
Total	$247,875

In addition to the above, certain counties and municipalities donated sums of money amounting to $85,060 for the purchase of right-of-way. No other values or elements of value were found to exist, and the original cost of the property could not be found.

The various items entering into the physical-property valuation of the system are given as follows for that part of the system owned and used by the company:

	Cost of Reproduction of Road and Equipment New	Less Depreciation
1. Road:		
Engineering	$589,503	$589,503
Grading	5,263,885	5,254,891
Tunnels and subways	46,856	43,575
Bridges, trestles and culverts	2,370,728	1,980,705
Ties	999 281	508,347
Rails	2,717,804	2,400,600
Other track material	539,920	372,990
Ballast	381,770	278,343
Track laying and surfacing	716,765	549,166
Right-of-way fences	11,254	5,929
Crossings and signs	173,975	125,529
Station and office buildings	635,614	470,155
Roadway buildings	338,227	239,282
Water stations	134,139	87,949
Fuel stations	58,413	28,497
Shops and engine houses	244,313	169 248
Wharves and docks	678,378	461,616
Telegraph and telephone lines	286	200
Signals and interlockers	7,050	4,825
Power-plant buildings	17,245	13,795
Power-transmission systems	2,715	2,243
Power-distributing systems	8,460	5,715
Power-line poles and fixtures	410	260
Miscellaneous structures	7,145	4,595
Roadway machines	36,751	22,504
Roadway small tools	9 276	4,636
Shop machinery	204,535	143,641
Power-plant machinery	27,001	21,531
Total	$16,221,729	$13,791,270
2. Equipment:		
Steam locomotives	$1,263,647	$942,795
Freight-train cars	2,895 376	1,570,641
Passenger-train cars	399,780	264,357
Work equipment	131,621	84,339
Total	$4,690,424	$2,862,130
3. General Expenditures:		
Organization expenses	$20,912	$16,729
General officers and clerks	125,473	100,378
Law	62,736	50,190
Stationery and printing	20,912	16 730
Taxes	104,561	83,649
Interest during construction	1,215,737	972,590
Other expenditures—general	83,648	66,918
Total	$1 633,979	$1,307,184
Grand total	$22,546,132	$17,960,584

The endeavor of the commission's accountants to untangle the past financial and corporate history of the Atlanta, Birmingham & Atlantic R.R. has not been very fruitful. For five of the companies whose lines make up the present system no records whatever could be found, and the records of the other three companies were incomplete. The accounts of the Atlanta, Birmingham & Atlantic R.R. itself were not so kept, moreover, as to make accurate statements possible.

The present system is the outcome of the schemes of certain Boston and Atlanta capitalists to build railway lines from Brunswick, Ga., to Atlanta and Birmingham, connecting with a steamer line from Brunswick to New York, to Boston. The railway was built, but the steamship line was never operated. The total outstanding capital liabilities of this company amount to $51,571,000, besides which $1,994,000 of receiver's certificates have been issued. Included in the capitalization is $25,000,000 of common stock and $10,000,000 of preferred stock.

As to the results of operations of the company, the accountants find that the total net earnings above operating expenses from the time the present company began operations in 1909 to June 30, 1914, were $4,190,000. During that time, however, rentals and interest on bonded debts have accrued amounting to $8,630,000, so that the company has not only paid no dividends on its stock, but since it has been operated has come short nearly $1,500,000 of earning its fixed charges.

⁂

Engineers as County Managers are urged by correspondents from California in letters published in the journal issued by the American Association of Engineers. One of these correspondents says: "Every county transacts its business through a board of supervisors or county commissioners, and 90% of the members of these boards are farmers who are unfamiliar with the principles of construction and management. The resulting waste is appalling. Members of the board are each engaged in his own private business and give attention to county affairs only at meetings occurring perhaps once a month. A good many thousand jobs will some day be given to county managers, and it behooves engineers and their friends to get busy."

⁂

The Pennsylvania Water-Supply Commission in its annual report states that the incorporation of companies to furnish domestic water-supply has almost ceased in Pennsylvania. Only nine such companies filed applications with the commission during the year, whereas during the five years prior to the creation of the State Water-Supply Commission from 100 to 150 such companies were incorporated annually, including companies for the development of water power. The commission received during the year 51 applications for the construction of dams and issued 43 permits. It received 29 applications for permits for alterations and repairs on existing dams. The commission's engineers conducted 626 field examinations on 348 existing dams and ordered repairs or alterations on 121 of these The commission approved 485 applications for the erection of structures in stream channels, of which 402 were for bridges, 21 for fills and 62 for walls, piers, ice breakers, etc. The commission comments on the disastrous flood at Erie, Penn., on Aug. 3, 1915, in which 34 people were killed and $2,000,000 worth of damage to property was done, and says:

> It is believed that this flood would have passed off without unusual damage had it not been for the restricted condition of the channel through the city. The commission had previously called the attention of the city officials to the obstructed condition of the stream and recommended that a comprehensive plan for its improvement be prepared and submitted to the commission for approval, but nothing was done until after the catastrophe had occurred.

The commission urges legislation empowering the commission to establish encroachment or shore lines along streams in densely populated districts to serve as permanent boundary marks within which no encroachments may be placed and requiring where possible the removal of existing encroachments. The commission is ready to proceed with the construction of the Pymatuning reservoir to regulate the flow of the Shenango and Beaver Rivers as soon as the necessary funds are provided. An appropriation of $1,500,000 for the work, made by the legislature of 1915, was not approved by the Governor on account of insufficient state revenue.

Notes from Field and Office

Concrete reservoir built of steel frame filled in with cement gun—New United States Coast and Geodetic Survey level rod—Test for coefficient of roughness in 22-yr. old pipe—Record forms for concrete contractors—Highway bridge loading diagrams—Concreting plant for railway bridge piers—Putting new piers under old concrete girder bridge

Building Concrete Reservoirs Without Forms

Something new in reinforced-concrete work is the construction of reservoirs and tanks by means of the cement gun without the use of forms. The steel reinforcement is first erected in the form of a self-supporting frame or cage of angles and bars, with the required amount of spiral reinforcing bars (with hooked ends) securely fastened in place. Over this frame is placed a heavy wire netting of triangular mesh, which serves chiefly to hold the concrete in place while setting, but also forms additional reinforcement.

When this entire steel structure is erected, heavy canvas or ducking is stretched over the outside, and upon this (working from the interior) a layer of concrete 1 to 1½ in. thick is applied by means of the cement gun. When this layer has set for a short time, the canvas is removed; and additional layers of dense concrete are applied from both the interior and the exterior. In this way the walls are built up to the desired thickness; and as each new layer is applied before the previous one has set, the result is a thoroughly homogeneous concrete mass. The roof is built in the same way. The surface is finished by floating.

The first structure of this type was built at Cary, Ill., in 1912. This is shown in Fig. 2. It is 18x32 ft. A larger reservoir now being built at Elmhurst, Ill., is illustrated in Fig. 1. This is 36 ft. in diameter and 22 ft. high, with a 6-in. wall, but the lower portion is below the ground. The work is being done by the Dewey Cement Gun Co., of Chicago. Harry L. Emerson, of Chicago, is consulting engineer for the Elmhurst water-works.

One advantage claimed for this type of construction is the reduced cost due to the elimination of formwork. It also produces a very dense concrete and a very tight

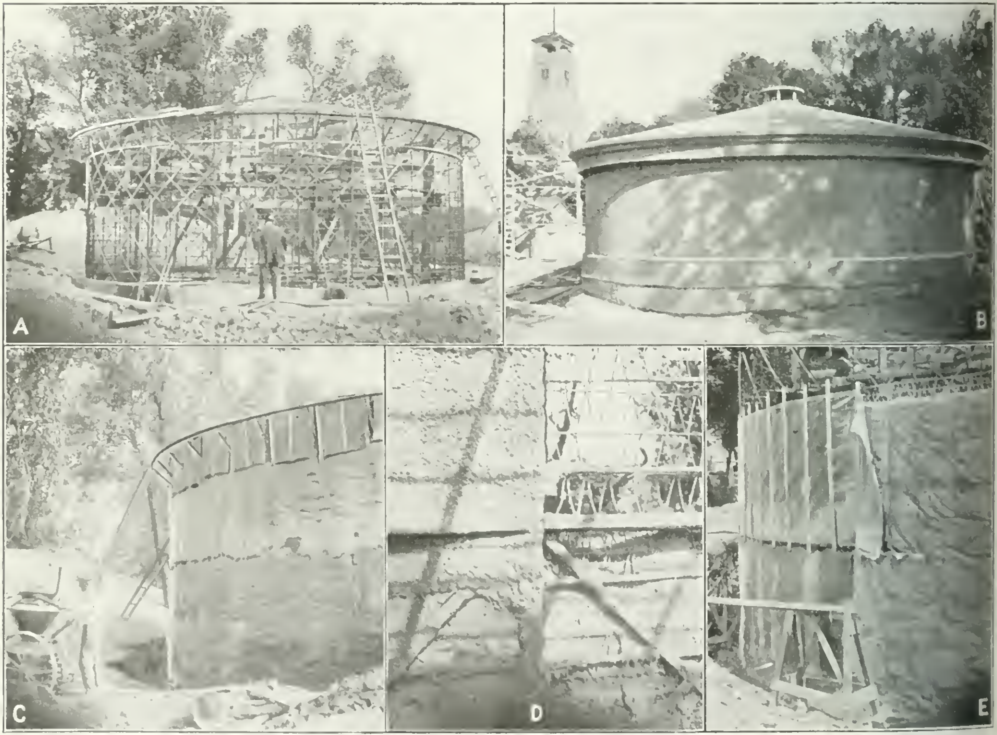
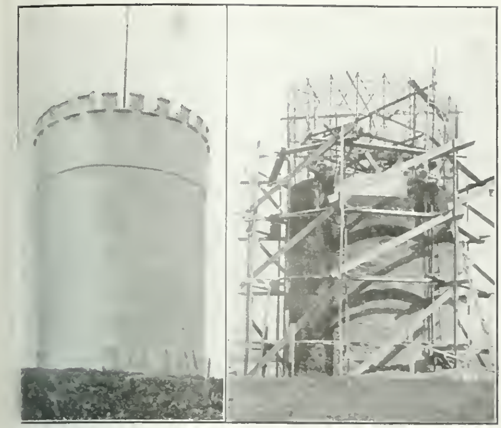


FIG. 1. BUILDING A REINFORCED-CONCRETE WATER TANK BY THE CEMENT GUN WITHOUT USING FORMS; ELMHURST, ILL.

A—The steel reinforcement erected in advance of the concreting. B—The finished structure (only the upper part is above ground). C—Exterior of rough concrete. D—Building up the concrete on the steel. E—Lower course of rough concrete, with canvas in place at the left for the next course above



'IG. 2. REINFORCED-CONCRETE WATER TOWER BUILT WITHOUT THE USE OF FORMS, AT CARY, ILL.

tructure obviating the use of special compounds in the oncrete or placing a waterproof lining. One of the eatures of the work is that cornices of various forms an be built by an expert operator with the nozzle. These re struck off to true lines by means of a sweep and may e left in the rough, or finished to a traveled or floated urface. Successful results in the density and monolithic haracter of the concrete, and also in the appearance of he structure, depend considerably upon the skill of the perator handling the cement gun.

mproved Level Rod Increases Accuracy in Precise Work

By E. G. Fischer*

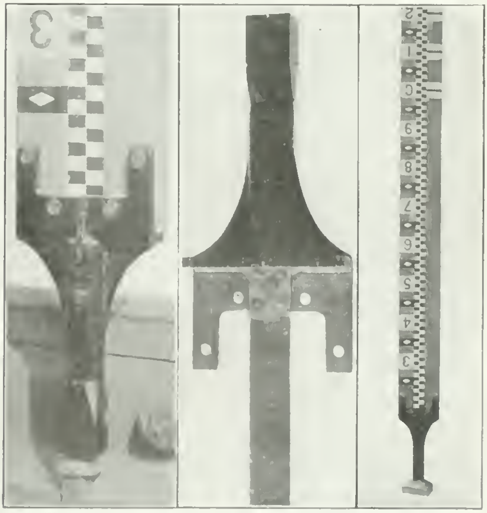
The level rod adopted for use in the geodetic leveling f the United States Coast and Geodetic Survey in 1900, ough contributing materially toward the very great inrease in miles of completed line per unit of time made nce then, had certain shortcomings, which it was thought ould be eliminated by placing the significant part of e graduation on a metal that, besides being structurally nstant as compared with wood, should have a small temerature coefficient.

The rod now in use (which was described in Appendix of the United States Coast and Geodetic Survey Rert of 1899) is made of the best quality of soft white ne, submerged for eight hours in hard paraffin at a perature of about 102° C. The centimeter graduation placed directly upon the wood. Meter spaces of this raduation, defined by fine lines on small silver plugs, rve for occasional checking of the absolute length of e rod. The temperature coefficient was found to be iformly 0.000004 per degree Centigrade, which is the me as that of soft white pine not treated with paraffin. While tests, such as keeping a completed rod submerged r a day or two in water, proved that wood so treated constant as regards moisture conditions, it was found at the rods were subject to variations in length, which n be referred only to changes in cellular or even molelar structure, incident to periods of rest, of jarring and vibrating while in the field, protracted periods of high or low temperature, etc. These variations were of sufficient magnitude to require the measuring of the meter spaces before and after each season's work, and at frequent intervals in the field.

The new Coast and Geodetic Survey geodetic level rod consists substantially only of a metal foot (or shoe) to which is fastened securely a strip or band of "Gamma" steel[1] (American invar) carrying the centimeter graduation. The wooden rod, in the face of which this strip is embedded loosely and is free to move vertically, serves only to support the latter in an upright position and to carry the marks and numerals defining the decimeters and meters of the graduation of the strip. The strips are $1\frac{1}{32}$ in. wide, 0.04 in. thick and 122 in. long. Their coefficients of expansion differ slightly, but in the mean amount to 0.000001 per degree Centigrade.

As is seen from the adjoining illustration, the form of the foot differs materially from that of the present standard, which was designed to rest with its spherical lower surface either in the spherical cavity of a foot plate or pin, or, as more than 95% of the geodetic leveling is done along railways, directly upon the top of the rail. Only the greatest care could prevent errors due to instability of the foot plate. Long series of observations made with the rods supported upon the top of the rail showed errors caused by irregularities in worn rails.

The search for a more perfect support ready at hand at any place and free from these objections led to the selection of the track spike. To suit this support the lower surface of the foot was made a plane normal to the rod. The spikes being in close proximity to the rail, the brass casting holding the hardened-steel shoe was made to extend upward sufficiently to permit facing the rod in any direction, when leveling along tracks with the heaviest and therefore highest rails. For leveling away from railroads, a heavy foot pin with convex top surface is used.



NEW UNITED STATES COAST AND GEODETIC SURVEY PRECISE-LEVEL WORK

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*Chief, Instrument Division, United States Coast and Geodetic Survey, Washington, D. C.

[1] A nickel-steel alloy with very low thermal coefficient, made by the Midvale Steel Co.

This method of placing the rod was tried out during the past season and was found to eliminate certain systematic errors that, no doubt, were due to habitually placing the rod differently with respect to the width of the rail when facing forward and backward.

The foot of the rod is of red metal for a height of 10 cm., with a shoe 5.5 cm. high of 1⅛-in. square steel, the lower end of which is hardened, made plane and polished. The "Gamma" steel strip is fastened to the red-metal foot by means of a stout screw, and its unvarying relation to the hardened-steel plane is secured by four steady-pins.

The wooden part of the rod is of soft, light white pine 1⅛ in. thick and 4¼ in. wide. It is not treated with paraffin, but oiled and varnished for protection against wear and decay.

The "Gamma" steel strip is held in its recess by six pairs of thin brass plates projecting slightly over its edges, but leaving it entirely free, so that changes in the wooden support cannot affect the accuracy of the centimeter graduation.

Just above the handle at the rear is embedded a small thermometer, which is shielded by a wooden sliding cover. An adjustable universal level, below the handle, enables the rodman to hold the rod vertical. The weight of the rod is 14 lb.

The bottom of the foot being of hardened steel, and the "Gamma" steel strip being secured to the foot in a manner to make them practically one piece, the index error will have to be determined only at long intervals.

CHANGES IN LEVELING PRACTICE

Heretofore it has been the practice of the precise-leveling party to have one of the two rodmen occupy with his rod all the odd-numbered, and the other with his rod all the even-numbered, turning points, so that each rod was first shown to the instrument on the foresight; then, after the instrument was carried forward and past this rod to the next station, it was turned on its support for the backsight.

This involved at each change of instrument station the carrying forward of the rear rod past the forward rod, past the level in its new station, to the next turning point; or in other words, a distance of two turning-point intervals. By thus alternating successively the relations of the rods to the instrument accumulated errors due to uncertainties as to their lengths were reduced to a minimum.

The lengths of the new rods being known quite accurately at all times, one of them can be kept in the position to the rear and the other forward of the level for several miles at least before it is necessary to exchange them in order to avoid accumulating errors due to remaining slight uncertainties as to rod lengths. This method will save considerable time.

⁂

Roughness of Steel Pipe After 22 Years' Service

By W. L. Reynolds*

A Kutter's formula coefficient of roughness, *n*, of 0.00938 has been found for a 22-yr. old 16-in. (outside diameter; inside diameter, 15.5 in.) lap-welded steel pipe at Glenwood Springs, Colo. The line was built in 1888 by the Glenwood Light and Water Co., to bring water to the town for domestic uses and power. The pipe was like that now made by the National Tube Co.

A valuation of the plant was made in 1910, and it was necessary to determine both the carrying capacity and condition of this line. The following data are from a test then made to determine the coefficient of roughness.

The conditions for such an examination were exceptionally good. Three wood-stave tanks of about 90,000 gal. capacity each are direct connected to the upper end of the line. These tanks are supplied by a flume. When the test was made, the supply was cut off and the quantity of water that passed through the pipe was measured directly by recording the difference in the water surfaces. At the power house the line branches into lines supplying the wheels and the distributing mains. A gage that had recently been compared with a standard gage was used in recording pressures at the power house. The line is free from sharp curves and well below the hydraulic gradient, being under nearly 200 lb. per sq.in. pressure most of its length. A physical examination showed the pipe to be very smooth on the inside and little corroded on the outside.

TEST DATA, GLENWOOD SPRINGS STEEL-PIPE LINE

Time (Total, 25 Min.)	Water-Surface Readings, 0.0—Water-Surface with Tanks Normally Full	Water-Surface Elevations Referenced to Power-House Nozzles—0.0	Pressures at Power House, Lb.	Power-House Pressures Reduced to Head in Feet
3.14	660.00	460.00	199.6	....
3.14	1.46	458.54	154.6	....
3.16½	2.75	457.25	147.1	....
3.19	4.08	455.92	142.1	....
3.21½	5.25	454.75	141.6	....
3.24	6.35	453.65	141.1	....
3.26½	7.50	452.50	141.1	....
3.29	8.60	451.40	140.6	....
3.31½	9.69	450.31	140.6	....
3.34	10.81	449.19	140.1	....
3.36½	11.89	448.11	140.1	....
3.39	13.02	446.98	139.6	....
Averages	11.56	452.60	142.6	328.6

Volume was measured from three wood-stave tanks at head of the line. Diameter at 3.14 (time), 27.9 ft.; at 3.39, 29.4 ft

Volume of water used, cu.ft.	22,364
Average velocity, ft. per sec.	11.38
Velocity head ft.	2.0
Entrance head loss, ft.	3.0
Average friction head loss, ft.	128.4
Slope to overcome friction, %	0.02061
Hydraulic radius, ft.	0.322
Coefficient C	139.6
Coefficient n	0.00938

At the head end of the line included in the length of 6,229 ft., there is 640 ft. of spiral riveted steel pipe varying in diameter from the 16-in. pipe to 24 in. at the connection with the tanks. Of course, the presence of this larger-diameter pipe would have a tendency to give a lower friction factor than the actual when the whole length was considered as of 15.5-in. inside diameter. To overcome this error, I have recomputed for a value using a total length of pipe of only 5,589 ft., or in other words I have assumed there was no friction loss in the spiral pipe. In this assumption $S = 0.02297$; $C = 132.33$, $v = 11.38$, as before; $r = 0.3225$, as before. By substituting in Kutter's formula, as before, I found a value of n of 0.00975. Therefore the correct value evidently is between 0.00938 and 0.00975. Either value is below that which is usually given for new steel pipe and perhaps only about one-half the value one would expect to find in a pipe after 22 years of service.

A check on the value obtained by this test appeared when 20.3 sec.-ft. of water was allowed to flow through the pipe and the loss as indicated by the power-house gage corresponded very closely with the computed loss.

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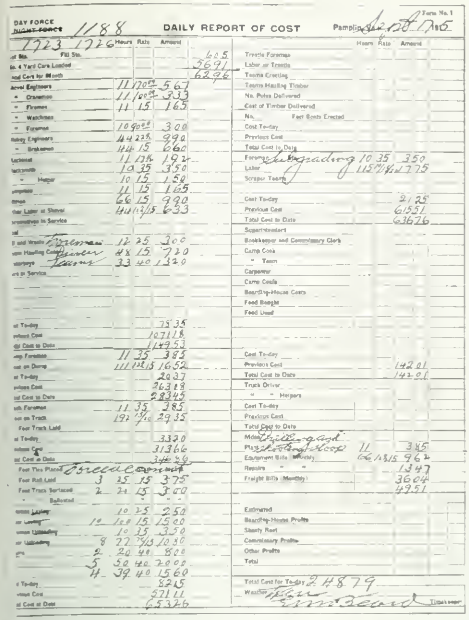
*Glenwood Springs, Colo.

How Two Contractors Keep Daily Record of Job



DAY FORCE
~~NIGHT FORCE~~ 1188 DAILY REPORT OF COST Form No. 1
Pamplin Sept 17 1915

1723 1726	Hours	Rate	Amount	
ut Sta. Fill Sta.				605
o. 4 Yard Cars Loaded				5691
ard Cars for Month				6296
hovel Engineers	11	170^{00}	567	
" Cranemen	11	100^{00}	333	
" Firemen	11	15	165	
" Watchmen				
" Foremen	10	90^{00}	300	
inkey Engineers	44	22½	990	
" Brakemen	44	15	660	
echanic	11	17½	192	
lacksmith	10	35	350	
" Helper	10	15	150	
umpmen	11	15	165	
tmen	66	15	990	
ther Labor at Shovel	44	12/15	633	
ocomotives in Service				
al				
l and Waste Foreman	12	25	300	
eam Hauling Cost Driver	48	15	720	
aterboys Teams	33	40	1320	
rs in Service				
st To-day			7535	
evious Cost			107118	
tal Cost to Date			114953	
mp Foreman	11	35	385	
or on Dump	111	13/15	1652	
st To-day			2037	
evious Cost			26308	
tal Cost to Date			28345	
ck Foreman	11	35	385	
or on Track	192	15/10	2935	
Feet Track Laid				
st To-day			3320	
evious Cost			31366	
tal Cost to Date			34686	
Feet Ties Placed Bridge Concrete				
Feet Rail Laid 3	25	15	375	
Feet Track Surfaced 2	20	15	300	
" Ballasted				
mon Laying	10	25	250	
or Laying 10	100	15	1500	
mon Unloading	10	35	350	
or Unloading 8	72	15	1080	
ms 2	20	40	800	
5	50	40	2000	
4	39	40	1560	
st To-day			8215	
evious Cost			57111	
tal Cost to Date			65326	

	Hours	Rate	Amount
Trestle Foreman			
Labor on Trestle			
Teams Erecting			
Teams Hauling Timber			
No. Poles Delivered			
Cost of Timber Delivered			
No. Feet Bents Erected			
Cost To-day			
Previous Cost			
Total Cost to Date			
Foreman Subgrading	10	35	350
Labor	115	14/15	1775
Scraper Teams			
Cost To-day			2125
Previous Cost			61551
Total Cost to Date			63676
Superintendent			
Bookkeeper and Commissary Clerk			
Camp Cook			
" Team			
Carpenter			
Camp Costs			
Boarding-House Costs			
Feed Bought			
Feed Used			
Cost To-day			
Previous Cost			14201
Total Cost to Date			14201
Truck Driver			
" " Helpers			
Cost To-day			
Previous Cost			
Total Cost to Date			
Mdse Drilling and			
Plant Shooting Hoop	11		385
Equipment Bills (Monthly)	66	1⅜/15	962
Repairs " "			1347
Freight Bills (Monthly)			3604
			4951
Estimated			
Boarding-House Profits			
Shanty Rent			
Commissary Profits			
Other Profits			
Total			

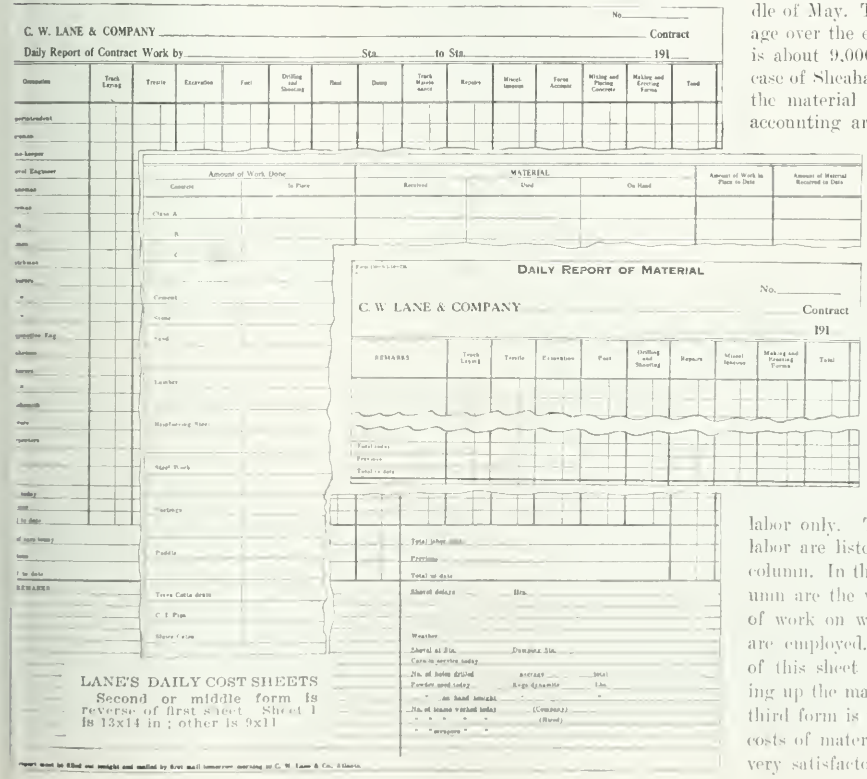
Total Cost for To-day 24879
Weather Fair
Emm Beard Timekeeper

SHEAHAN'S DAILY COST SHEET (8½x11¾)

The first form herewith shows how J. J. Sheahan, of Roanoke, Va., keeps tab on the cost of a contract. The figures shown are a day's record on the low-grade line of the Norfolk & Western R.R., between Burkeville and Pamplin, Va., in 1915. Such a sheet is filled out for each shift and handed to Mr. Sheahan, if he is on the work, or forwarded to him. If the foreman or superintendent has any special remarks, he writes them on the back of the sheet, upon which there is no printing or ruling.

C. W. Lane & Co., of Atlanta, Ga., uses two daily cost sheets, one each for labor and material, as shown. At foot of Sheet 1 is a reminder: "This report must be filled out tonight and mailed by first mail tomorrow to Atlanta."

Both these contractors are now working on the new second-track grading of the Southern Ry. between Central, S. C., and Cornelia, Ga., and are using here their respective methods of keeping track of costs. Lane's section is 5.5 miles long, and 8 shovels are at work on it. He uses large standard-gage locomotives to haul 12-yd. air-dump cars. Mules and 2-yd. wagons handle from one shovel (revolving). The section is 22% complete. Sheahan has a part of the Rinehart & Dennis section, and his plant comprises two shovels, six dinkeys, sixty 4-yd. dump cars, two well drills and two hand hammer drills. Work started about the middle of May. The total yardage over the entire 50 miles is about 9,000,000. In the case of Sheahan's form, both the material and the labor accounting are on one side of the sheet, and that not only is the day's total cost worked out but that this figure is expected to be added to the previous total cost in order to obtain the total cost to date. Sheet 1 of Lane's system is for labor only. The classes of labor are listed in the first column. In the heading column are the various classes of work on which the men are employed. The reverse of this sheet is for following up the material and the third form is to be used for costs of material and works very satisfactorily.



No.
C. W. LANE & COMPANY Contract
Daily Report of Contract Work by Sta. to Sta. 191

Occupation	Track Laying	Trestle	Excavation	Fuel	Drilling and Shooting	Haul	Dump	Track Maintenance	Repairs	Miscellaneous	Force Account	Mixing and Placing Concrete	Making and Erecting Forms	Total
perintendent														
reman														
me-keeper														
ovel Engineer														
aneman														
reman														
ch														
men														
atchman														
borers														
"														
"														
comotive Eng														
akeman														
borers														
"														
acksmith														
ters														
rpenters														
today														
ous														
l to date														

of cars today
tous
l to date
REMARKS

report must be filled out tonight and mailed by first mail tomorrow morning to C. W. Lane & Co., Atlanta.

Amount of Work Done		MATERIAL			Amount of Work in Place to Date	Amount of Material Received to Date
Concrete	In Place	Received	Used	On Hand		
Class A						
B						
C						
Cement						
Stone						
Sand						
Lumber						
Reinforcing Steel						
Steel Work						
Footings						
Puddle						
Terra Cotta drain						
C. I. Pipe						
Stone Cetoo						

Total labor today
Previous
Total to date
Shovel delays Hrs.
Weather
Shovel at Sta. Dumping Sta.
Cars in service today
No. of holes drilled average total
Powder used today Kegs dynamite Lbs.
" " on hand tonight " "
No. of teams worked today (Company)
" " " " " (Hired)
" " scrapers " "

DAILY REPORT OF MATERIAL
No.
C. W. LANE & COMPANY Contract
191

REMARKS	Track Laying	Trestle	Excavation	Fuel	Drilling and Shooting	Repairs	Miscellaneous	Making and Erecting Forms	Total
Total today									
Previous									
Total to date									

LANE'S DAILY COST SHEETS
Second or middle form is reverse of first sheet. Sheet 1 is 13x14 in.; other is 9x11

Proposed Motor-Truck Loads for Highway Bridges

By O. W. Childs*

Not many years ago bridges on rural highways were designed for a uniform live-load, and but slight attention was given to concentrated or wheel loads. Later, traction engines were assumed to be the critical loads for the floor; and still later, road rollers were used for the same purpose. Today, motor trucks are usually considered to be the bogy of the highway bridge.

Large motor trucks equal in weight the heaviest traction engines or road rollers, travel at much greater speeds and have a wider range of travel. These considerations indicate that motor trucks are the proper form of concentrated loads to specify in the design or investigation of highway bridges.

Specifications as to concentrated loads for highway bridges vary considerably. This is inconvenient and causes indefiniteness in judging the comparative capacities of structures. Traction engines, road rollers and motor trucks, with varying wheel and axle spacings and various distributions of loads to the wheels, all give different results even when the total weights of the different vehicles are the same. It is very desirable to use some standard type of concentrated load.

A typical truck of a varying weight serves conveniently for this common standard; when other loads, as road rollers or traction engines, must be considered, their effects may be readily expressed in terms of equivalent typical trucks.

A typical truck is herein assumed to have two axles spaced 10 ft. on centers, with the two wheels on each axle spaced 5 ft. on centers. This truck covers a space 9 ft. wide by 20 ft. long, symmetrical about the truck center. One-third of the weight is on the front axle, two-thirds on the rear axle. With this standard size and distribution the capacity may be definitely and simply expressed as the total weight in tons of the loaded truck.

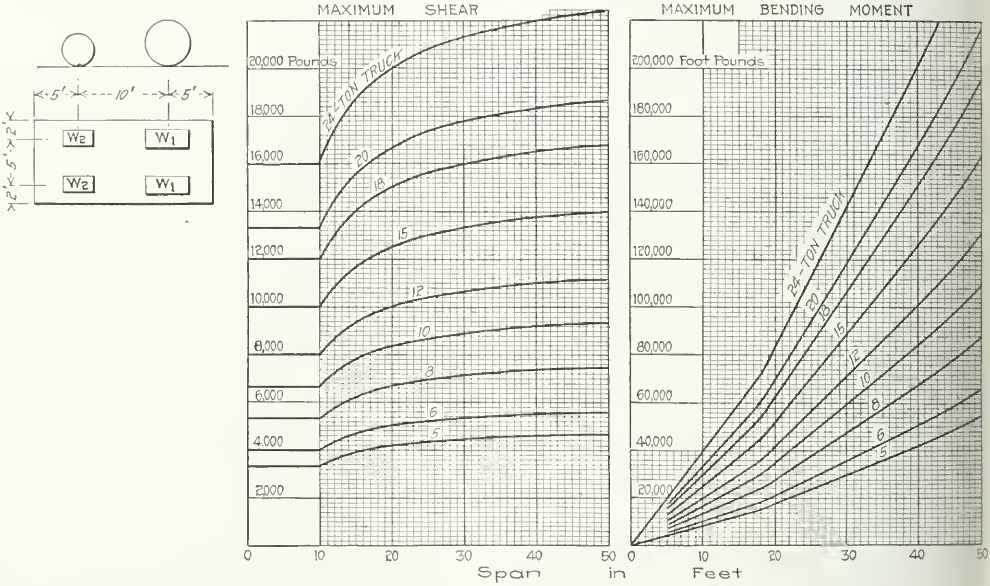
The accompanying diagram of maximum shears and moments covers the range from 5-ton to 24-ton trucks, and spans up to 50 ft. The table for 10-ton trucks may be used for any weight, as the values vary in direct ratio with the weight.

Bridges on improved roads should as a rule be designed for 15-ton typical trucks, but other capacities may be necessary for special conditions. The capacity of an old bridge may be expressed as any number of tons that it may figure to carry on the wheel spacing of this typical truck.

The table and diagrams give static stresses. An addition must be made to these to provide for the effects of impact, which are more serious from swiftly moving motor trucks than from slower-moving road rollers and traction engines. In general this impact allowance should not be less than 30% of the static stress, but it should be varied to fit conditions. The nature and condition of roadway surface and the type of floor system are important factors of impact effect.

Wheel loads will usually cause maximum stresses in the floor system only, but their effect should be provided for in all members where they may cause stress in excess of that of the uniform live-load.

On rural highways only one truck need ordinarily be considered as acting on a bridge, as the roadway is narrow, in most cases. However, two trucks should be assumed as meeting and passing each other whenever the roadway is wide enough to permit this. Truck loads need not as a rule be considered as acting in combination with uniform live-load. Centrifugal force and braking effects should be taken account of where special conditions render this advisable.



PROPOSED TYPICAL MOTOR TRUCK, AND DIAGRAMS OF MAXIMUM MOMENTS AND SHEARS

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*Bridge Engineer, Office of Public Roads and Rural Engineering, Washington, D. C.

MAXIMUM SHEARS AND BONDING MOMENTS FOR TYPICAL TRUCKS

Values for two wheels on one side

	10-Ton Truck			10-Ton Truck	
pan, Ft.	Shear, Lb.	Moment, Ft.-Lb.	Span, Ft.	Shear, Lb.	Moment, Ft.-Lb.
5	6,666	8,333	28	8,810	54,325
6	6,666	10,000	29	8,852	56,791
7	6,666	11,666	30	8,890	59,259
8	6,666	13,333	31	8,926	61,740
9	6,666	15,000	32	8,958	64,201
10	6,666	16,666	33	8,990	66,675
11	6,970	18,333	34	9,018	69,150
12	7,222	20,000	35	9,048	71,627
13	7,436	21,666	36	9,074	74,005
14	7,622	23,333	37	9,100	76,584
15	7,778	25,000	38	9,124	79,094
16	7,918	26,666	39	9,146	81,546
17	8,040	28,333	40	9,168	84,048
18	8,148	30,000	41	9,188	86,511
19	8,246	32,294	42	9,208	88,993
20	8,334	34,721	43	9,226	91,477
21	8,412	37,154	44	9,244	93,965
22	8,486	39,594	45	9,260	96,451
23	8,552	42,040	46	9,276	98,946
24	8,612	44 488	47	9,292	101,424
25	8,668	46,942	48	9,306	104,012
26	8,718	49,401	49	9,320	106,400
27	8,766	51,833	50	9,334	108,889

⁂

Bridge Piers Built Quickly by Effective Plant

The second-tracked Southern Ry. will cross the ugaloo River in South Carolina on a deck girder bridge nsisting of five 100-ft. spans on two cellular concrete utments and three concrete piers. The concrete work s been carried on with efficiency and vigor, with the sult that it is expected that the bridge will be completed months ahead of the contract date. Work started in pril, 1915, and the contract calls for completion by ptember, 1917. On Oct. 1, 1916, one of the abutments Fig. 1) was nearly finished, the excavation for the other as down 20 ft. to rock, and the pier forms were being ected. The foundation pits are dredged out by an angepeel. The forms are very heavy and are intended r use on future contracts.

The concreting plant is designed to minimize manual bor. Crushed stone is transported to the job by a gasone scow from a quarry located a mile or two up the ver; it is unloaded by a derrick and clamshell into bin. The bin is connected to a hopper that discharges to a ¾-yd. Ransome mixer. The concrete is conveyed the forms in buckets on small cable cars on a track. he buckets are lifted off the cars by a derrick and umped. The derrick then replaces the buckets on the rs and they are returned to the concrete-mixing plant.

FORMS UP FOR HOLLOW ABUTMENT OF TUGALOO BRIDGE; A PIER COFFER-DAM

The contract section of the new Southern on which the Tugaloo bridge occurs is held by Winston & Co., under whom the Shiplett Concrete Co. is building the bridge. The headquarters of G. D. Shiplett are on this job. J. O. Parsons, Assistant Engineer, supervises the work for the railway.

⁂

Close Tunnel Cross-Sectioning Widens Clearance

The Sandy Ridge tunnel on the Carolina, Clinchfield & Ohio Ry. is being lined with concrete by the pneumatic method. Before this work was started, a profile was plotted from the final cross-sections taken every 5 ft. through the tunnel. The profile showed the rock outline very accurately. Close examination of the profile brought out the fact that the interior face of the proposed lining could be shifted outward and yet adequate strength secured. Thus a large yardage of concrete was saved and a wider tunnel obtained. A small section of the profile of the tunnel excavation, from which the trimming of the lining was determined, is shown below.

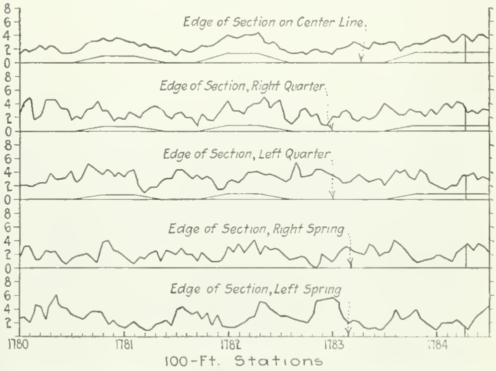

FIG. 1. PROFILE OF TUNNEL EXCAVATION, FROM WHICH TRIMMING FOR LINING WAS DETERMINED

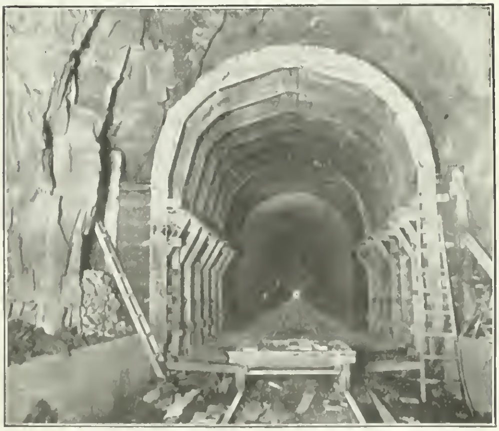

FIG. 2. STEEL FORMS USED TO LINE SANDY RIDGE TUNNEL; NOTE ROCK

The tunnel is 7,804 ft. long and for about one-half its length is through slate and shale formations, which disintegrate upon exposure to air; the remaining half is through sandstone formation badly seamed and broken. Fig. 2 is an interior view of the tunnel, showing a 30-ft. section of steel forms in place. The finished tunnel is 19 ft. wide, 14 ft. 5 in. from subgrade to springline and has a radius of 9 ft. O. K. Morgan, Johnson City, Tenn., is Engineer in Charge.

⁂

Jacking Concrete-Slab Bridge Into Place After Failure

About a year ago an old highway bridge in Monroe County, N. Y., was replaced by a reinforced-concrete girder-and-slab bridge resting on the old abutments. The new bridge is of a novel type that has been used for several crossings in the county. Two girders at the sides rest on the longitudinal arms of a U-abutment and carry a middle floor-beam. The floor slab spans the space between the face walls of the abutment and the floor-beam. The load on the slab is thus being transmitted to the girders through the floor-beam only, as there is no reinforcement connection between slab and girder. This bridge had a span of 15 ft. and a width of 22 ft. inside the girders; the girders were 27 ft. long, extending 6 ft. beyond the face of the abutment at either end.

During the present summer extremely high water undermined one corner of one abutment and, washing out the earth backing there, allowed one corner of the bridge to fall. The whole superstructure, there being a construction joint between abutment and girder, toppled over as a unit toward this corner, crushing the other abutment wall on the same side as the washout and lifting off from the abutment on the opposite side of the bridge.

Examination showed that there was no damage to the bridge itself. A frame was therefore laid across the creek bed and the bridge jacked back into place, as shown in Fig. 1. Once there, it was a simple matter to concrete a new abutment side wall and to repair the face walls, so that now the bridge is doing service as shown in Fig. 2.

The design and repair work were carried out by the office of the County Engineer, J. Y. McClintock, and was in charge of George Wright, Assistant County Engineer.

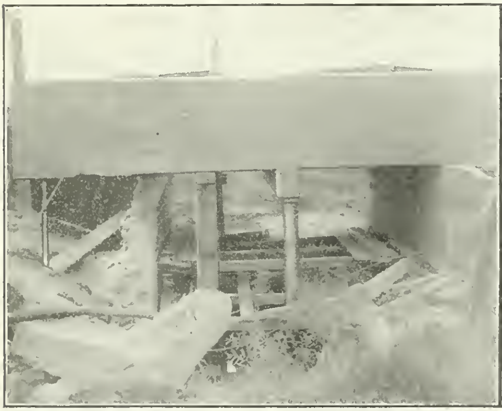

FIG. 1. MONROE COUNTY BRIDGE JACKED UP

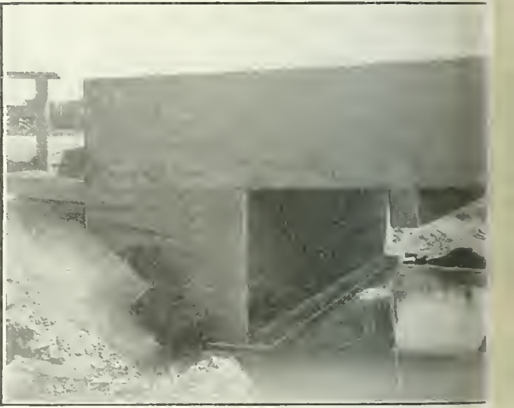

FIG. 2. REPAIRED CONCRETE GIRDER AND SLAB

FINE AGGREGATE

Laying Street Paving by Force Account is favored by tl
Department of Public Works of St. Paul, Minn. In the annu
report of the Commissioner of Public Works, M. N. Goss, f
the year 1915, it is stated that the practical effect of ci
force-account work during the year has been a saving
about 12% over the lowest bids submitted by street-pavir
contractors. The Chief Engineer of the department, O. Clau
sen, says: "The department is in favor of continuing to
paving by city force account for various special reasons a
is splendidly equipped at the present time to lay in an ef
cient and economical manner 20 to 30 mi. of pavement p
season." Mr. Claussen does not favor, however, the syst
in which the city bids against contractors for paving wor
as he considers it unfair both to the department and to t
contractor and predicts that it will eventually be discontinu
In comparing contractors' bids with bids made by the depa
ment for paving work, criticism has been made of the depa
ment because 3% is added to the contractors' bid to represe
the cost of inspection if the work is done by contract. T
extra engineering expense on contract work is certai
enough to account for 3%.

Piledriving Rules of 10 Railways—The general piledrivi
practice on a number of railways is included in the rece
report of the Committee on Modern Methods of Driving Pi
of the American Railway Bridge and Building Associati
The minimum depth of penetration for piles in trestles
usually considered to be about 15 ft., but there are numb
less situations where piles stopped at this depth will
sustain the load. The determination of the proper stopp
place is largely a matter of judgment and experience. For
ulas or rules have been devised to assist the judgment, an
summary of the methods used by a number of railroad co
panies follows:

Foreman's judgment without formulas............ 14 ro
As long as the pile will drive without damage...... 6 ro.
Practical refusal .... 13 ro.
"Engineering News" formula...................... 4 ro.
Special instructions based on investigation and tests. 3 ro

Central of Georgia—3,000-lb. drop hammer with a 20
drop, 1-in. penetration; Bucyrus No. 43, steam hammer, ¼
per blow.

Central of New Jersey—3,000-lb. drop hammer with a 15
drop, 1-in. penetration.

Chicago & Northwestern—3,000-lb. drop hammer, 30
drop, ½-in. penetration. (Above applies to foundation pi
"Engineering News" formula is also used.)

Illinois Central—3,000-lb. drop hammer, 20-ft. drop, ½
penetration.

Michigan Central—3,000-lb. drop hammer, 15-ft. drop,
in. for last 5 blows.

New York Central Lines West—3,200-lb. drop hammer,
ft. drop, ½- to 1-in. penetration.

N. Y., N. H. & H.—2,000-lb. drop hammer, 25-lb. drop, 10
for last 10 blows.

Philadelphia & Reading—2,250-lb. drop hammer, 15-ft. d
refusal; 3,300-lb. drop hammer, 10-ft. drop, refusal.

St. Louis & San Francisco—No. 2 Vulcan hammer, 1
in four to six blows.

Toledo, St. Louis & Western—Penetration of 14 ft. to
ft. Conditions uniform.

Editorials

Will Improvements in Water-Works Reduce Fire Rates?

Bitter complaints have been made at recent water-works conventions that after large expenditures have been made at the insistance of the Fire Underwriters and with the lure of lower water rates no reduction of rates follows. Perhaps with this in mind, Dabney H. Maury, Chicago, in a report on possible improvements to the water-works of Wilmette, Ill., concludes as follows:

> A large part of the cost of the improvements herein contemplated would be incurred for fire protection. No one will profit more directly, nor to a greater extent, from these improvements than will the fire underwriters, and they should bear their share of the cost. It is therefore recommended that these gentlemen be asked to state definitely, in advance of any expenditure for these improvements, what reduction they will make in insurance rates if the standards of service hereinbefore specified be established in Wilmette.

This seems an eminently fair question to put to the Fire Underwriters. Cities or property owners are subjected to penalties right and left for alleged, and doubtless real, deficient fire protection. What more natural than to expect that the fire-insurance rates will be lowered when a hundred thousand or a million dollars have been spent by a city on strengthening the fire service of the water-works? Perhaps rates are lowered oftener than is credited to the insurance men, but no one speaks out in meeting and says so at water-works conventions.

The fact is that the feeling most commonly exhibited at the water-works conventions is that the fire-insurance men continually cry "Give, give," to the water-works men and seem unwilling to give anything in return except what the water-works men regard as arbitrary rules with unwarranted penalties thrown in for full and running-over measure.

The outcome of Mr. Maury's suggestion to the Wilmette Village Trustees will be watched for with interest. Perhaps it will show that the Fire Underwriters are more willing to go halfway than the water-works men commonly believe.

Six Commandments of Sanitary Disposal of Sewage

Six short sentences comprise what may well be termed the Six Commandments of Sanitary Disposal of Sewage, recently submitted as a proposed code by the Committee on Sanitary Control of Waterways of the Sanitary Section of the American Public Health Association. The six rules, together with the committee's explanatory notes, are printed elsewhere in this issue. They deserve the attention of every reader of this journal.

Rarely does a code so clearly crystallize the strong belief of the vast majority of engineers working in an important field as do these six commandments. We therefore expect from engineers no material objection to the code's requirements. That there may be considerable protests to the proposed code we have no doubt, but for the most part they will be in the nature of outbursts from persons with more zeal than knowledge.

It is unfortunate, but true, that popular zeal for the protection of natural waters from pollution—zeal that was long in being aroused—has far outrun knowledge of the real effects of discharging sewage into natural waters, of what is practicable in the way of sewage treatment, and of the relationships of sewage treatment and of water treatment to stream pollution and to each other. The fundamental principles succinctly laid down by the committee in its report and the well-considered notes to each of the six sections of the code provide needful means of popular education on these subjects.

The code and its prefatory fundamental principles, it is hoped, will soon be brought to the attention of the general membership and of the other readers of the "Journal" of the American Public Health Association. So far, good; but this is not enough. The whole report deserves much wider circulation. The cause of public sanitation and sound public economics would be well served and at the same time the American Public Health Association would be given helpful and deserved publicity if the entire report were reprinted and widely distributed for publication and comment in the daily and weekly press of the country.

Road Surfacing Is Not Road Building

Since the beginning of the extensive use of pavements on rural highways the term "road building" seems to have become confused with pavement construction, or "road surfacing." There is a difference. Road building is a much broader term; it includes more than a superficial improvement, in a literal as well as in a figurative sense. The Romans were road builders, and their roads have endured, while modern road surfacings have worn out in a very few years.

The permanent character of the Roman roads was of course attained at too high a cost to be emulated by modern highway engineers, yet there are certain permanent features in everyday modern road building which ought not to be neglected; and there seems to be plenty of foundation for believing that they are neglected, and that a little of the effort and talent being directed to find an ideal surfacing material might well be addressed to some of these simple engineering essentials.

What some of these essentials are H. E. Bilger, Road Engineer of the Illinois State Highway Commission, points out in another part of this issue. Little of this matter is new. In fact, most of it is rather hackneyed, yet it seems that constant reiteration of these principles is necessary to insure consideration.

Tons of literature have gone forth on the necessity of proper drainage of roads, but let this significant sentence from Mr. Bilger's article sink in: "In order to maintain satisfactorily a road surface in practically level country on other than a sandy soil, it is generally absolutely necessary to forestall capillarity by elevating the roadbed above the level of the adjacent fields."

Obvious and platitudinous as this may seem, there is no elementary principle of road building that is oftener violated. Anyone who has traveled over some of the infamous roads of Kansas, Nebraska, Missouri and some of the other agricultural prairie states can vouch for the fact that a great part, if not all, of their troubles is caused by the fact that the roadbeds are troughs in cultivated fields. No amount or kind of surfacing on such roads will cure their real weakness.

It is strange that a practice so universally followed in railway grading should be so often ignored in the parallel practice of highway grading, although behind this neglect of course is the desire to save expense. To raise a 21-ft. roadbed 1 ft. above the level of the surrounding land requires about 4,500 cu.yd. of fill per mile, making an allowance of 10% for shrinkage. Made with wheel scrapers from roadside borrow pits at 20c. per cu.yd., this extra cost would be $900 per mi.—a liberal estimate.

Suppose we go a little farther than Mr. Bilger and suggest a nearer approach to railway practice—an 18-in. fill—making the additional cost not over $1,500 per mi., or 10% of the probable pavement cost, which is not an extravagant expense when the permanency of a $15,000-per-mi. investment is under consideration.

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American Concrete Institute Placed on a Sound Basis

Those connected with the concrete industry who are aware of the difficulties through which the American Concrete Institute has traveled in the recent past will be pleased to learn, in connection with the announcement of the annual convention to be held next February, that the Institute is now in a financially sound condition. Back numbers of the Institute's Proceedings, which have long been withheld from publication for lack of funds, are shortly to be printed and placed in the hands of the members. The delayed volumes Nos. 9 and 10, containing the Proceedings of the conventions of 1913 and 1914, will be printed and distributed to the members before the end of the year. The Proceedings of the convention of 1915 were printed during that year in the form of a monthly journal. Vol. 12, which contains the Proceedings of the convention of last February, has been printed, and is now in the hands of the binders. The cash necessary for publishing all these volumes is already in hand.

The concrete industry owes a debt to the officers of the Institute, headed by President Leonard C. Wason, for the energetic manner in which they have discharged the responsibilities laid upon them. There can be no dissent from the proposition that the Institute has in the past done a very important work for the sound, technical development of the concrete industry. It is the record of that past work, doubtless, which has made possible the campaign that has placed the Institute on a sound financial basis.

The rapid growth of the industry ought to make possible a large accession of membership to the Institute now that it is firmly established as a successful going concern. The President announces that fourteen committees are at work upon subjects in connection with the concrete industry in order to have their reports ready for presentation at the February convention. Under these conditions many new members should join the Institute at ie present time so that they may be either able to attend d take part in the February meeting or entitled to rec ve the report of its proceedings.

⁂

Successful Train-Braking wi h Electric Motors

Saving the power generated when a train runs d n a grade and utilizing that power to help the train p another grade has been a dream of inventors ever s the early days of the railway era. The inventio of the electric motor and its application to railway ser e seemed to open the way for the possible realizatio f this dream, since the electric motor is capable of ac g both as a motor and as a generator.

In the November "General Electric Review," J J. Linebaugh, of the General Electric Co.'s railway d traction engineering department, reviews the progres f regenerative electric braking. The problem may s n easy to the engineer unfamiliar with electrical des ; but while a great many different combinations of fi s, armatures, motors and control have been invente o make possible regenerative electric braking, none of t e combinations have until recently been found practic e with the direct-current railway motor.

With the three-phase alternating current the induc n motor used can very readily be adapted to ele braking on steep grade lines, and such a system s been in operation for many years on some of the Al e lines of the Italian state railways. The three-p e system has been strongly urged as preferable to the di - current system in the electrification of steam railway n account of this advantage.

The principal installations of electric braking in s country on alternating-current installations have n in connection with the electrification of the wes n division of the Norfolk & Western Ry. and on e electrified section of the Great Northern Ry. through e Cascades tunnel, the former on the split-phase and e latter on the three-phase system.

One of the most notable features in connection h the Chicago, Milwaukee & St. Paul's electrificatio f its main line through Montana and Idaho is that ele c braking has been adopted and made successful with e 3,000-volt direct-current system. In fact, the bra g system is claimed to be superior to that used with e induction motor on alternating-current railways. h this latter type of motor as used on the Norfol & Western Ry., for example, electric braking is only o - tive at one uniform speed. In other words, when e train is running down grade and the motors are a as generators, the train is held to one uniform s d regardless of changes in the profile and alignment.

In practical railway operation, however, it is o n desirable to make large variations in speed when run g down grade, and the direct-current motor employe s a generator permits this. The control adopted on e St. Paul lines allows the motors when used as genera s to be operated either in series or parallel. With e flexibility thus secured it is possible to do effective ele c braking over a wide range of speeds. Mr. Lineba h submits cards of braking effect from a freight locom e at speeds of 8 to 35 mi. per hr. and from a passe er locomotive at speeds of 15 to 65 mi. per hr.

The success of this electric-braking system is claimed to be due to the commutating pole motor used, which, with its thorough internal ventilation, can stand without injury the heavy overloads due to fluctuating line voltage, and also to the simple form of control that was worked out by the General Electric engineers just before the St. Paul contract was let.

It is evident that if regeneration is used, all the apparatus on the locomotives and in the substations, etc., must be capable of operating inverted. Not only must the motors on the locomotives act as generators, but the generating equipment in the substations must invert; and if motor-generators sets are used, the direct-current generators must operate as motors and the synchronous motors as generators. They must be capable of doing this instantly and as often as required without affecting reliability or successful operation in any way.

The electrical machinery installed on the St. Paul system has been designed to meet these requirements. When a train is descending a heavy grade and feeding current back into the line, that current is utilized in the propulsion of trains on other portions of the line. Under the rare conditions when more power is being returned to the line than is required by other trains, the surplus power is available for other demands over the wide network of lines fed from the power houses that supply current to the railway. This returned power is in fact credited to the railway company.

On the electric-braking system used on the Norfolk & Western Ry. the power house supplies current to the railway alone, and it was necessary to install large water rheostats to turn excess current into heat, when the railway is returning energy to the power house instead of drawing from it.

The profile of the electrically operated line of the St. Paul shows grades of 2% as a maximum, while there are long stretches of 1.7% grades, and three mountain summits are crossed at elevations of 5,678 ft., 6,350 ft. and 4,200 ft. The electric motors are used as brakes only in descending the steeper grades. On a grade of less than ½% there is little or no surplus of power over that required to overcome the train resistance. On grades of 0.6% one-half the locomotive is used to generate power. It will be understood that the air brakes are regularly used for stopping and holding trains and as an auxiliary for regulating speed when the electric motors are acting as generators.

The great advantage of the electric-braking system in securing the safe handling of trains on long heavy grades will be obvious to every railway man who is familiar with the precautions necessary for the safety of trains on such grades with air brakes alone. The St. Paul is sending trains of 3,000 to 3,500 tons' weight behind the tender down these mountain grades, often with a single locomotive.

It will be readily understood that, with electric braking, the train is bunched against the locomotive in descending a grade, and the common difficulty with broken draft gear due to unequal action of air brakes, varying profile, etc., is eliminated. Of equal importance is the elimination of overheated wheels and brake shoes, with the resultant liability to accident.

These practical advantages in the operation of trains on mountain grades are probably more important than the saving in power by the use of the motors as generators although the power saving is considerable. Mr. Linebaugh states that in descending a long 2% grade a train will return to the line about 60% of the current that would be required to haul it up the same grade. In actual service the power saving varies of course with the grades operated over. On eastbound St. Paul trains between Deer Lodge and Three Forks the power returned to the line is about 25% of the power drawn from it. On trains in the reverse direction over the same division 7% is the proportion returned. On the entire 220 mi. between Deer Lodge and Harlowton the power returned by all trains both ways is about 14% of the total current consumption.

The foregoing summary of what has been actually accomplished with electric braking presents facts of interest and importance to every railway engineer. Numerous problems of economic railway location may require revision in the light of these facts. Just as the application of mechanical power to road vehicles has radically revised standards of road construction, so the introduction of electric motive power and regenerative braking may cause a new answer to be given to old problems.

To take a concrete example, engineers are generally familiar with the extensive line revision carried out by the Delaware, Lackawanna & Western R.R. a few years ago, west of Scranton, Penn., at a cost of about $12,000,000, by which 40 mi. of new railway were built to save 327 ft. of total rise and fall with a reduction also of maximum grades and of curvature. It is at least within the possibilities that the introduction of electric motive power over this division might have been a much more economical solution of the problem, since it would also have improved operating conditions on the long and heavy grade that still remains on the line west of Scranton.

This is only a typical example of the problems in railway location and relocation where the engineer will need hereafter to take into consideration the fact that the use of electric motive power with electric braking has materially reduced the difficulties and losses in the operation of railways with heavy grades.

How To Use Your Old Canals

For many years a number of American cities have suffered from the nuisance of abandoned canals in their midsts—canals that not only were obnoxious as open sewers, but were worse than useless because their boatless waters took up useful ground in the busy areas of the town. Now several of these communities are finding, or hope to find, a use for these deep water-filled cuts by draining the canal and using the bed for rapid transit or railway lines. In Cincinnati the proposed interurban entrance is on the Miami and Erie Canal there; in Syracuse the old Erie Canal bed will certainly in time become the route of the New York Central through the city to replace the tracks which now are the most disgraceful example of municipal disfigurement in the country; in Rochester the Erie Canal will soon be turned into new channels, permitting the use of its bed for a street railway route. The combined advantages of ridding the city of a nuisance and of obtaining ready made a depressed railway terminal or rapid transit route are of such commanding importance as to recommend the procedure to any city now saddled with an unused canal.

Letters to the Editor

Truck Springs Save Pavements?

Sir—Regarding the editorial on p. 710 of *Engineering News*, Oct. 12, on pavement destruction by motor trucks, it might be interesting to note that agitation looking toward the elimination of springless trucks has been in progress for some time in San Francisco, Calif.

The effect of the efficiency of springs on the impact of heavy loads can be seen very easily, as also the probability of objections to springs that might tend to throw the load out of the container. T. H. Claussen.

Stanford University, Oct. 16, 1916.

[The particular trucks referred to in the editorial mentioned, and in the article on page 691 of the same issue, have springs; but springs to carry 18-ton loads are about as stiff and useless as locomotive springs to save wheel shocks.—Editor.]

⁂

Gravel Covers on Concrete Bridge Floors

Sir—In the issues of *Engineering News* for Sept. 7 and Oct. 12 are letters from C. E. V. and C. E. Nagel respectively, regarding the use of gravel covers on concrete bridge floors. Mr. Nagel makes four categorical statements, which, with your permission, I will reply to *seriatim:*

1. The gravel covering is less expensive than the extra thickness of concrete floor and weighs no more.

The question of the comparative cost of gravel as against that of an extra thickness of concrete is one governed entirely by the cost of each material at the site, which of course varies greatly according to locality; and also with the volume and nature of traffic, by which the required extra thickness of the concrete wearing surface should be determined.

Unless the gravel contains a suitable sand-clay binder and is laid at least 5 or 6 in. thick, experience shows the gravel cover difficult to maintain. The extra weight of gravel cover as against the extra thickness of concrete required calls for a heavier design in the bridge, when load requirements in the design receive the care they should.

2. Troweling the top of the slab is not necessary when a gravel covering is to be placed, making a further saving in cost.

Granted. Neither is troweling required—in fact, it is a detriment—when an asphalt or tar composition is used.

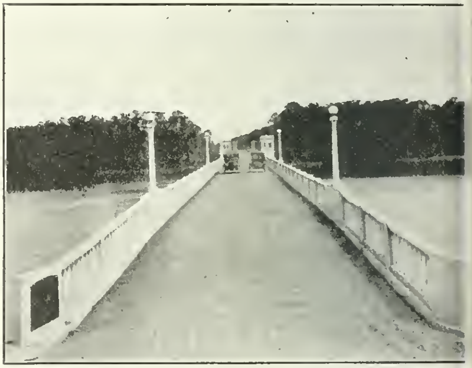
3. Chuck holes at the end of the bridge are avoided where the surface material on the bridge is the same as that on the road.

This contention is justified to a certain extent. If the approach fill is well consolidated, this trouble is minimized; but even then, and with a continuous surface of gravel, chuck holes will eventually develop. It is this feature that has almost entirely governed the writer in using a gravel cover continuous with a gravel road on *short* bridges, as the proportional area of trouble arising from chuck holes relative to floor area on short bri s is great. In short, the continuity of the surfacing terial does minimize this trouble, especially with car n construction of fills.

4. The gravel covering is of great assistance in prop y curing the concrete slab.

With this I cannot agree. The period of curing s most important during the first seven to ten days a pouring. Generally speaking, concrete bridge floors poured some little time before the approach fill is t in; consequently, the placing of a gravel cover is t practicable at such a time. A good curing blanket n be obtained with either earth or sand kept damp, r where the floor is on a level grade, a clay dam at e h end and a few inches of water maintained over the b will be found to give excellent results.

The writer has experienced considerable trouble ca d by the gravel covers washing and raveling from effect f



TAR-CARPETED FLOOR OF CALCASIEU RIVER BRID
NEAR LAKE CHARLES, LOUISIANA

rain. A bridge deck thus covered is also difficult o drain without impairing the condition of the surfac. The writer's experience points favorably to the us f a tar or asphalt composition placed as thinly as sible, with a good blanket of torpedo sand cast on be the composition cools and sets.

Traffic over the concrete deck should first be con ued until the aggregate is exposed and all laitance moved. Good results have been obtained from a tr ment of 0.3 gal. of tar to the square yard. Great should be taken to see that the concrete surface is q clean and dry and that the sand blanket is maintai d until all signs of bleeding have passed.

The writer had a number of concrete bridges trea d about 14 months ago in this manner, and despite a he y traffic the surfacing is still in first-class condition d probably will not require resurfacing for several mo s yet. The Calcasieu River bridge near Lake Charles, cently completed from the writer's plans and speci tions and under his general supervision, receive a wearing-surface treatment of 0.3 gal. of tar per square yard, with a torpedo-sand blanket, at a cost of 47½c. per sq.yd. for approximately 3,200 sq.yd. The treatment was put on by day labor.

The use of a plain concrete wearing surface on bridge floors subjected to light traffic has proved quite satisfactory.

The writer's conclusions stated above have been arrived at from a number of years' experience in the design and construction of concrete highway bridges in many localities under very varied conditions.

F. H. Frankland.

Lake Charles, La., Oct. 15, 1916.

⁂

Busiest City Thoroughfare?

Sir—In *Engineering News* of Oct. 19, 1916, p. 761, L. S. Brodd quotes a police count published by the Chicago *Tribune,* giving extremes of traffic on Chicago streets, as follows:

> On State St., between Madison and Washington St., 11,674 vehicles between the hours of 8 a.m. and 6 p.m. of July 19, 1915, or 1,167 vehicles per hour. On Rush St. bridge, 13,600 vehicles between 9 a.m. and 6 p.m. of July 13, 1915, or 1,511 vehicles per hour.

In *Engineering News* of Sept. 28, 1916, p. 597, it is stated that on Fifth Ave. in New York, at 42d St. 1,119 vehicles were counted proceeding south in the hour between 3:30 and 4:30 p.m.

These figures are represented as maxima for the world. I find, however, in a published report of the Traffic Branch of the London Board of Trade in 1913 that in Piccadilly, the most heavily traveled of all streets in London, 31,335 vehicles passed the Hotel Ritz in 12 hr. This is 2,611 vehicles per hour. The heaviest bridge traffic in London is on London Bridge. The figures are 17,250 vehicles in 12 hr., or 1,438 vehicles per hour. These are much higher intensities of traffic than the figures for either Chicago or New York.

Charles L. Strobel,
President, Strobel Steel Construction Co.

Chicago, Ill., Oct. 24, 1916.

[A traffic census at Fifth Ave. and 42d St., New York, on Oct. 18 by the Fifth Avenue Association showed 17,151 vehicles moving north and south between the hours of 8 a.m. and 6 p.m. This gives an average for the 10 hr. of 1,715 vehicles per hour, which is much more than the Chicago count. Moreover, it must be remembered that 42d St. is almost equally congested, and that every effort is being made to divert traffic from Fifth Ave.—Editor.]

⁂

Combination of Plane Table and Transit for Topography

Sir—In your issue of Sept. 14, 1916, p. 488, is described a system of surveying using a combination of plane table and transit. The undersigned some years ago developed this system almost exactly as described and explained its use in the textbook entitled "Military Topography," written in 1910. The following extracts are from this book, p. 166:

> PLANE TABLE AND STADIA SURVEY WITH TRANSIT USED TO READ STADIA
>
> 163. The transit may be used for reading the stadia and vertical angle when the plane-table alidade has no telescope, by having the transit and plane table set up side by side at each instrument station and about 4 ft. apart to allow the observer to pass between them. The observer sights each rod position through the sighting slits, draws the radiating line, and while he is doing this the recorder is reading the stadia and vertical angle on the rod. The recorder then reads from the computer the true distance and elevation of the point sighted to the observer, who plots them as in the method first described, for plane table with telescope. . . . It is evident that the work can be done much more rapidly by this method than with the plane table alone, because of the more equal division of the labor between observer and recorder. The observer can devote more time and study to the ground and its contouring, and the assistant to estimating distances, slopes and elevations. This method also has the advantage that stadia readings and vertical angles are more rapidly and accurately read with a transit than with a plane-table alidade because of the difficulty of maintaining the large drawing surface of the plane table in sufficiently exact level to give accurate vertical angles. The telescope alidade is heavy and awkward to use and carry from one station to another. In taking readings with it the observer is very liable to lean down on the plane table so that his breast rests against the board. If this occurs his breathing causes the board to move up and down, deranging the reading on the rod. Therefore, always use the transit and plane table where a transit is available.

In reasonably open country this system is in my opinion the most rapid and economical method of taking topography as well as the most accurate of all the available methods usually employed. I was glad to observe that the writer used the plane table as a *plane table* and not as a drawing board for protracting the angle readings taken with the transit.

C. O. Sherrill,
Major, Corps of Engineers, U. S. A.

Ancon, C. Z., Sept. 28, 1916.

⁂

Wood-Block Expansion Joints in Concrete Pavements

Sir—I note with interest what the Michigan State Highway Department concludes about eliminating expansion joints in concrete pavements (see *Engineering News,* Sept. 28, p. 609).

Our experience with the type of expansion joint in use here, covering a period of five years on streets and roads of varying traffic, has been so satisfactory that it should be of interest to your readers.

We use creosoted wood blocks, 16-lb. treatment, sawed out of commercial-size 2-in. lumber in length equal to the depth of the pavement. These 2-in. blocks are placed in a continuous row across the pavement with the tops flush with the top of the pavement and with the grain of the wood vertical.

To prevent the blocks from being hammered down under traffic we place a strip of concrete 6 in. wide and 4 in. deep under the row of blocks. To place them evenly a lath is tacked on each side and nailed to short stakes driven into the ground.

We require the day's work to stop at a joint and space joints about 30 ft. apart. Transverse cracks are practically unknown, and the joints have not needed any attention; even those five years old are in perfect condition. In hot, dry weather the wood shrinks as the concrete expands, and it swells again by absorption as the concrete contracts in wet, cooler seasons.

The cost here is about 10c. per lin.ft. of joint, or about 3½c. per sq.yd. of pavement.

P. L. Brockway,
Assistant City Engineer.

Wichita, Kan., Oct. 13, 1916.

[It should be added that the theory proposed above, that the wood swells in wet weather while the concrete contracts, is contrary to the now generally accepted fact that concrete expansion is caused fully as much by the absorption of moisture as by heat.—Editor.]

The Battle Over the Miami Flood-Prevention Plans

By H. M. Chittenden*

SYNOPSIS—The most important work for river regulation and flood control ever undertaken in the United States (aside from the levees on the Mississippi and Sacramento Rivers) is that now projected for the control of the Miami River in central Ohio. For a month past a court has been hearing the testimony of distinguished engineers on the question whether this work should proceed. At the request of the editors of "Engineering News," Gen. H. M. Chittenden, of Seattle, one of the eminent engineers summoned to testify, has prepared the following summary of the evidence thus far presented for and against the project.

The Conservancy Court of the Miami Conservancy District has been holding a public hearing at Dayton, Ohio, for a month on objections to the official plan for flood protection which was adopted by the directors of the district on May 10, 1916. The hearing has been full of interest throughout and has led to some developments of value to the engineering profession. The following is a résumé of events leading up to the hearing and of the chief features of the Ohio conservency law:

CHRONOLOGY OF PROJECT

1913, Mar. 22-27—Occurrence of the greatest flood in the recorded history of the Miami Valley.

1913, May 27—Fund of $2,000,000 subscribed with which to carry on work of formulating a plan of flood relief for the valley. Fund administered through a Flood Prevention Committee of the Citizens' Relief Commission, an incorporated body.

1913, May 5—Morgan Engineering Co., Memphis, Tenn., engaged to investigate the physical problem and present a scheme for its solution.

1913, Oct. 3-4—Preliminary report by Morgan Engineering Co. on different projects for flood protection, and definite pronouncement in favor of retarding basins.

1914, Feb. 17—Conservancy law of Ohio enacted. (See outline given below.)

1914, Feb. 18—Petition asking for creation of Miami Conservancy District filed in Court of Common Pleas, Montgomery County.

1914, Mar. 26—Report of Special Board of Consulting Engineers. The preliminary hearing on above petition was to have been held Mar. 20, 1914. To assist in presenting its case, a board of engineers, consisting of men who had some special familiarity with problems of this character, was summoned to Dayton. Legal obstacles having indefinitely postponed the hearing, the board, before leaving Dayton, submitted a report upon the plan of flood prevention as so far developed.

1915, June 3—Court of Appeals upheld constitutionality of law. Case appealed to Supreme Court and after a great deal of litigation.

1915, June 4—Supreme Court definitely upheld entire law.

1915, Apr. 21—Attempts to alter or annul conservancy law by legislative action finally defeated.

1915, June 24—District finally fixed at its present size with nine judges constituting Conservancy Court.

1915, June 28—Miami Conservancy District established; E. A. Deeds, of Dayton, H. M. Allen, of Troy, and G. S. Rentschler, of Hamilton, made Board of Directors.

1915, July 7—A. E. Morgan appointed Chief Engineer.

1915, Aug. 4—Board of Appraisers appointed in accordance with Section 26, conservancy law.

1916, Mar. 1—Report of Chief Engineer submitting plan for flood prevention filed with Board of Directors.

1916, Apr. 10 to May 10—Hearings by Board of Directors on plan of Chief Engineer.

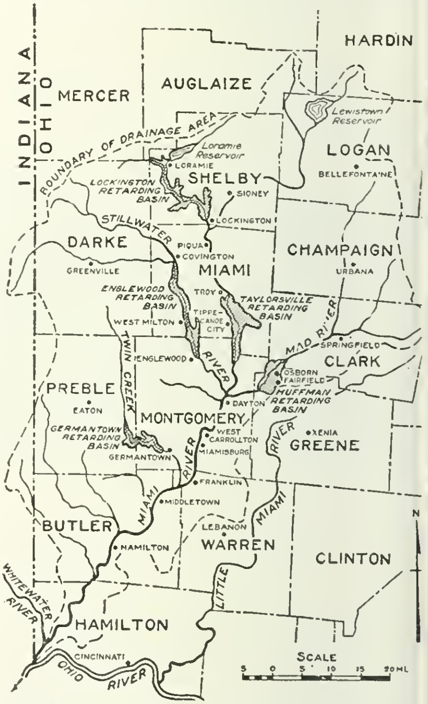
1916, May 10—Plan of Chief Engineer adopted as o plan of district. Objections having been filed with the servancy Court, a date was fixed by the court for a hearing thereon.

1916, Oct. 3—Public hearing began.

Conservancy Law of Ohio

Existing legal machinery being inadequate for proper handling of a problem like that of controllin floods of the Miami, a law was passed by the state le ture authorizing the creation of conservancy district the purpose. The law, which was drafted under Morgan's supervision, is very comprehensive. The of procedure under it, down to the stage which the project has now reached, is given in outline below:

1. Organization of districts is initiated by petition specified restrictions to the Court of Common Pleas of



MAP OF MIAMI RIVER-DRAINAGE AREA, SHOWING POSED DETENTION BASINS FOR FLOOD CONTR

county in the district affected. If the territory shall into more than one county, the court shall consist, f purposes of the act, of the judges of the several counti shall sit in the courthouse of the county where the or petition is filed.

2. Before a district can be organized, the court mus a public hearing at which all objections may be heard. favorable finding by the court the organization of th trict is decreed. The decision of the court is subject usual judicial appeals.

3. Within 30 days after the decree incorporating th trict the court shall appoint a board of three directors specified qualifications, terms of service, etc.

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*Brigadier General, Corps of Engineers, U. S. A., retired.

4. Among other details of organization the Board of Directors is required to appoint a Chief Engineer.

5. The Board of Directors must forthwith cause to be prepared a plan for carrying out the purposes of the district. Before the plan is adopted the board must hold a public hearing. After the hearing the board may adopt the plan, which then becomes the official plan of the district, subject to modification as provided in the next section.

6. If objections to the plan are filed with the Conservancy Court within a specified time, the court must itself hold a public hearing and pass upon the question raised. In case of rejection of the plan a new plan must be prepared. In case of reference back for modification the hearing shall be continued. In any case it is contemplated that a plan will be finally adopted. It is this hearing by the Conservancy Court which is now in progress.

The Official Plan

Although quite a complete description of the plan has already appeared in *Engineering News* (Apr. 6, 1916), the following condensed summary of it, together with the accompanying sketch map, will contribute to the convenience of readers.

The plan is a very carefully worked-out combination of reservoir control and of channel improvement. By neither method alone could the problem be solved. The cost of protection against a flood like that of 1913 by channel improvement exclusively would have been absolutely prohibitory. On the other hand, reservoir sites were not available that would control the discharge of such a flood so that no channel improvement through the cities and towns would be necessary. But it *was* found possible to secure sufficient storage to reduce the flood discharge to a point where channel improvement was entirely practicable and within a cost for the whole scheme which bore a fair relation to the benefits to be received. The following are the chief features of the final plan:

1. The plan provides for a storm 40% in excess of that of 1913; that is, it is planned on this basis, but as actually developed it will do much more than that. The dams will be perfectly secure against a flood more than twice as great as that of 1913, while the freeboard on the levees through the cities is 3 ft. or more above the estimated flood plane for a flood 40% greater than that of 1913.

2. The reservoir control is to be accomplished by five retarding basins. For several reasons the possible scheme of storing the water for industrial or other use was rejected. The reservoirs will be for flood prevention only. Their functioning will be purely automatic. The outlets are to have no gates, but to remain at all times wide open. The ordinary discharge passes freely. Only in time of freshet will there be any accumulation, and such as does occur, even in great floods, will all run out in a few days. As these floods nearly always occur in the winter or early spring, the basins will be free of water during the crop season and practically as useful for cultivation as at present.

DATA PERTAINING TO DAMS FOR FLOOD CONTROL OF MIAMI RIVER

	Germantown Dam	Englewood Dam	Lockington Dam	Taylorsville Dam	Huffman Dam
Average elevation bed of river	723	768.0	876	759	777
Average elevation valley floor	730	782.0	885	770	785
Elevation of spillway crest	815	876.0	938	818	835
Elevation of top of dam	830	892.5	954	837	850
Maximum elevation of water surface for a flood like 1913.......	805	862.0	936	815	830
Same for 40% greater flood	815	876.0	940	820	835
Same for twice as great a flood	824	887.0	948	832	846
Area submerged in a flood like 1913, acres	2,950	5,350.0	3,600	9,650	7,300
Maximum amount of water stored in a flood like 1913, acre-feet	73,000	209,000.0	63,000	152,000	124,000
Length of crest of dam, ft	1,210	4,660.0	*6,400	*2,980	*3,340
Thickness of dam at average elevation of valley floor, ft	650	740.0	410	390	380
Length of outlet conduit ft	520	725.0	15	40	40
Number of conduits...	2	2.0	2	4	3
Total sectional area of outlet conduits, sq ft	182	2140	158	1,116	705
Maximum discharge of conduits in 1913 flood, sec ft . ..	9,340	11,000.0	8,630	51,300	32,600
Same for 40% greater flood	10,000	12,000.0	9,000	55,000	35,000
Same for twice as great a flood	16,100	26,500.0	18,100	79,100	48,400
Length of spillway crest, ft	55	100.0	72	132	100

*Including spillway crest.

2. There are to be five of these basins. Their names and locations are shown on the map. One is above Piqua; four are above Dayton; all are above Hamilton. With almost incredible pains the problem of balancing these reservoirs so as to prevent undue flooding in certain cases, yet so to control the outflow of all as to insure the desired restriction of flood discharge, was eventually worked out. The more important data pertaining to the system are given in the accompanying table.

3. Through the cities or villages of Piqua, Troy, Dayton, West Carrollton, Miamisburg, Franklin, Middletown and Hamilton, channel improvements will be made to carry a flood flow, as regulated by the basins, 40% in excess of 1913. These improvements will vary to suit the particular case and will include channel rectification, dredging, levees, slope paving, etc.

4. The execution of the plan will involve considerable relocation of roads, railroads and other facilities, public and private, and the acquisition, either by easement or fee, of considerable areas of land.

Such, in briefest summary, is the official plan. The object of the present hearing by the Conservancy Court at Dayton is to consider objections that have been raised to the plan.

Routine of the Hearing

The Conservancy Court consists of nine judges, one each from the counties of Hamilton, Butler, Warren, Preble, Montgomery, Greene, Clark, Miami and Shelby, all of which counties embrace lands within the limits of the district. The judge from Montgomery County, in which the original petition was filed, is presiding judge of the Conservancy Court. Questions before the court are decided by majority vote of those present. The court sits on Tuesday, Wednesday, Thursday and Friday of each week, from 10 to 12:30 a.m. and from 1:30 to 4:30 p.m. It has very properly taken the ground that the nature of the inquiry before it requires some relaxation of the rules of evidence as applied in a strictly judicial trial, and witnesses are given all reasonable latitude in answering questions and explaining their views.

The first session of the court was taken up with organization and with statements by counsel for the district and for the opposition of the general plan of flood protection, on the one hand, and the basis of opposition to it, on the other. The next three sessions were consumed in viewing the sites of the several dams, so that the hearing did not commence in earnest until Oct. 10.

The Conservancy District is represented at the hearing by its legal staff, including Attorneys Orrin B. Brown and John A. McMahon, of Dayton, and John Galvin, of Cincinnati, who are taking active parts in the conduct of the case. Other counties are also represented. The brunt of the work, however, is being carried by E. J. B. Schubring, of Madison, Wis., who has specialized in engineering law and practice, is familiar with engineering technical terms and is admirably equipped for the conduct of a case like this.

The principal attorneys of the opposition are Percy Taylor, of Sidney, representing Miami and Shelby counties; J. A. Kerr, representing Tippecanoe City; F. C. Goodrich, prosecuting attorney of Miami County; and C. L. Darlington, representing Greene County.

Nothing so mystifies an onlooker at the hearing, even one who has kept in close touch with the history of the case, as to try to discover the real basis of opposition to the conservancy plans. That opposition has been strenuous and resourceful from the beginning, but just what it is based on is difficult to say. In Mr. Taylor's opening address, following Mr. Schubring, he professed to disclose the grounds of the opposition, but except for a single reference to the public health of the community the sole ground presented was the lack of safety in the dams. There was no dissent from the proposition that something should be done. "We all want to get together," said Mr. Taylor, "and see what is the best thing to be done for the district." Even cost was not the matter "of prime importance," but safety, and Mr. Taylor continued:

> The fundamental proposition is this, as we see it. Is the plan of protection by retarding basins safe and feasible, or is it not? Now, that is absolutely the crux of the whole situation. Anything else is practically surplusage. Of course, there are questions of local flood protection that ought to be heard and will be heard, but the thing we want to get at is this one matter; everything hangs upon that: Are the dams safe?

Elaborating this idea, the whole system of retarding basins was attacked in general and in detail as essentially unsound and creating an ever present menace to the inhabitants in the valleys below.

Unfortunately this line of attack lacks the essential elements of sincerity. Those who are mainly using it live *above* the dams, except some few below the small basin at Lockington. No complaint worth considering has come from *below* the main dams. There is no pronounced distrust of their safety there, where if anywhere it must exist. It is therefore impossible to accept this argument as the real reason. It is effective, it strikes a popular chord, it plays upon public fears and is a useful instrument in accomplishing the real purpose. Yet what the real purpose of the opposition is and what is the motive back of it are nowhere definitely disclosed.

The writer is convinced in his own mind that it is the desire to escape the burdens of an assessment district, which some fear will be out of proportion to the benefits. Indirectly this idea has cropped out in numerous places. Then there is, or has been, a feeling that the scheme is for the benefit of Dayton, Hamilton and other towns and that the outlying districts will be taxed for their benefit. Finally, the very fact of opposition has gained a certain vogue, enters more or less into local politics, serves to sustain much legal practice, and thus its continuance derives an importance in certain directions which is not to be lightly estimated.

Such is a general view of the situation as nearly as the writer has analyzed it. He has not been able to lay his finger on what he can term a single valid objection. There may be such; but if so they have been covered up under the plausible appeal of safety, which, as already stated, lacks the simplest element of sincerity.

Maneuvering for Advantage

Inasmuch as the hearing was for the sole purpose of considering objections to the plan, it was assumed as a matter of course that the objectors would open the case by the introduction of their own witnesses. Not so. The opposition asked to be allowed to call Chief Engineer Morgan of the Conservancy District as an adversary witness for purposes of cross-examination. After some deliberation the court granted this request, and Mr. Morgan took the stand.

For five consecutive sessions (five days) Mr. Mor n was on the stand undergoing a continuous fusillad of questions. His testimony brought out in the clea st possible light the magnificent work that he and his le staff have been doing during the past three years. T re was no point so obscure, no question so abstruse, no i m of data so unexpected that the required information as not instantly at hand. Friend and foe alike recogn ed his splendid achievement, and his testimony, taken a o-gether, was an education to most of those present. after day the opposition beat itself against this wal of information only to recoil without making the sligh st impression.

Some of these encounters had an element of hu or about them which even the dignity of the courtroom c not suppress. One lawyer, a gentleman of much sole ity, thought he had at last got the witness where he wa him. He had heard the witness state that the ave velocity of flow of the river at the crest of the 1913 f was about 4 mi. per hr. (including the overflow secti), and it seemed to counsel so incredible that he set a it to refute it. At last he found what he wanted. Branc ing a report of the United States Weather Bureau e declared that this authority proved that the velc between Dayton and Hamilton was 17½ mi. per hr. l-lowing is an excerpt from the colloquy that ensued:

> Q. How did it happen that it [the crest of the fl] was two hours after it was here? Was it because of the t that it took it two hours to run from here to Hamil ? (Laughter)
>
> A. Not at all.
>
> Q. And didn't the stream pass down at the rate of mi. per hr.? (Laughter.)
>
> A. If it had, there would be a hole in this valley n y feet deep from here to Hamilton.
>
> Q. I am not asking anything about results. Isn't a fact that that is what it did?
>
> A. It didn't do anything like that.
>
> Q. It didn't do anything like that?
>
> A. Not at all.
>
> Q. Then the Weather Bureau report is not correct?
>
> A. The Weather Bureau made no such statement.
>
> Q. What did they state?
>
> A. I am speaking from memory. The Weather Bu u stated that the crest at Hamilton occurred only about o hours after the crest at Dayton.
>
> Q. Doesn't that mean that it took it two hours to n here to Hamilton? (Laughter.)

Mr. Morgan's testimony fills 620 typewritten pa s. No adequate summary is here possible, and only a b f notice of some of the leading features can be presente

A very complete outline was given of the plan itself d a clear description of building dams by the hydra process. The manner of handling floods during const -tion and of effecting final closure of the dams was g e into at length. Danger of settlement in hydraulic dams was shown to be very slight. The causes of e accident to the Necaxa dam in Mexico were explained, accident being the chief reliance of the opposition in effort to discredit the hydraulic-fill process. Many ea -dam failures were cited, their causes analyzed and sho , in practically every case, to be avoidable.

Mr. Morgan explained in this connection how gre a factor of safety (even bordering on the extreme) d been adopted for the proposed Miami dams. Wave-w , muskrat action and other sources of trouble were sh n to be nonexistent in basins that are empty practically e year around.

The danger of clogging the conduits was pressed by e opposition more than any other one point. Mr. Mor n clearly showed that it amounted to practically nothi g.

He described in detail the form of drift barriers provided in the official plan, showed that ice could never come in volume or size of blocks that would choke the conduits; that the basins themselves were to be kept free of floatable material; that drift of any considerable size brought down from above could only come after a flood had reached a point that would fill the basin well over the conduits, converting them into lakes without current velocity and on which drift would be driven about by the wind and more likely than not be stranded on shores; and that in any case a little intelligent care at the proper time would take care of any drift that might come against the barriers.

But no argument would avail with the opposition. Visions of great sycamores, highway bridges and houses hurled down by a raging torrent into the vortex of these conduits, forming there a close grillage that would quickly be sealed up by haystacks, corn fodder and trash of all sorts, were held up to the court as something absolutely certain to happen if the dams were ever built.

Mr. Morgan went very thoroughly into the matter of channel improvement and, for that matter, into every other feature of the subject. But space permits no further consideration of his testimony here. If the opposition thought to secure any tactical advantage by putting Mr. Morgan on the stand in the first instance, it is difficult to see where it succeeded.

MR. HILL'S TESTIMONY

Following Mr. Morgan, John W. Hill, of Cincinnati, was called by the opposition for direct examination. Mr. Hill had a contract with the three counties of Miami, Shelby and Clark to present their case at the hearing. He was the only engineer placed on the stand on that side of the case. He had prepared a report of over 150 printed pages, which was introduced in evidence, and his own testimony was in elucidation of this report.

Concerning both report and testimony, the most charitable commentary that can be made is that they were unfortunate, whether from a professional point of view or as a contribution to the cause of the opposition. It is true that Mr. Hill's time and resources, as he repeatedly urged, were very limited, and it was not to be expected that he could offset in wealth of detail the elaborate work of the district itself. But the report was not merely weak in this respect; it disclosed a willingness to adjust data to suit the exigencies of the case, and this feature was so manifest as to deprive the report of all claim to public confidence. A few examples will show this general tendency.

Mr. Hill sought to attack the hydraulic-fill method of dam construction on the authority of the late J. D. Schuyler, its most earnest champion, if not the father of the method itself. In doing this he quoted Schuyler's well-known book, but only as already quoted in a trade publication on earth dams put out by the Ambursen Co. As a matter of fact, he quoted Ambursen a good deal more than he did Schuyler, but in a way that left the impression that it was all from Schuyler. At the same time he omitted many citations that he might readily have taken from Schuyler, showing that gentleman's unqualified faith in the hydraulic-fill method.

Bearing in mind the fact that the Ambursen Co. is exploiting on the market a type of hydraulic-fill dam in opposition to the ordinary type (but as yet wholly untried in practice), the utter unfairness of these citations from Ambursen, quite aside from the indefensible course of crediting them to Schuyler, is apparent.

In the very important matter of cost estimates the same policy of unfairness appeared. Unit prices of 12c. and 11c. for excavation were used in the Hill report for working out the cost of his proposed channel improvement, while in revising the estimates of cost in the official plan, where 30c. per cu.yd. is used for the same class of work in the same localities, Mr. Hill increased this 30c. to 75c. and then made comparisons between the two estimates as if they were made up on the same basis. If the same unit price is applied to the Hill estimate that he uses in revising the official-plan estimates, the cost of his channel-improvement scheme will be increased from about $40,000,000 to about $200,000,000.

In estimating the necessary channel improvement through Dayton under his own plan Mr. Hill assumes a runoff for Mar. 25, 1913 (the date of the flood crest), of 105 sec.-ft. per sq.mi. of watershed, a material reduction from the recorded discharge. In another place, estimating probable flood conditions at Hamilton with reservoir control, he adopts for the watershed below the reservoirs a figure of 125.6 sec.-ft. per sq.mi., or the full depth of rainfall as given by him for that date. He assumes the dams to be filled to capacity (which would require a storm more than twice as great as that of 1913); makes no allowance for retardation of basin discharge, but makes it arrive simultaneously with the uncontrolled runoff, and thus deduces a figure of 356,000 sec.-ft. discharge, almost as great as his own estimates below Hamilton (Hill's report, page 12) without any reservoir control whatever. As a matter of fact the controlled flow at Hamilton for a 1913 flood will be between 175,000 and 200,000 sec.-ft.

Passing by these inconsistencies, which abound throughout the report, a feature of Mr. Hill's scientific methods may be noted. He was unable to make a survey of the entire river to determine the cost of channel improvement. He had, however, made such a survey and estimate through Butler County immediately after the great flood. To apply this work to the whole river, Mr. Hill assumes that "nature has demonstrated" that the size of channels is proportionate to the ordinary flood flow; that this flow at any point is proportionate to the area of watershed above it; and that the cost of enlargement is therefore directly proportional to such area and to the length of the particular stretch of channel considered. Thus the excavation in Butler County as found by his survey was 87,000,000 cu.yd.; the channel length, 27 mi.; and the average watershed above, as 3,222 sq.mi. Dividing the yardage by the product of 27 and 3,222, he obtains a coefficient of 1,000, which he applies successively to seven other stretches of the river and thus deduces the channel excavation for the whole stream necessary to carry a 1913 flood.

Mr. Hill's main contention was that channel improvement would answer every purpose and that it was cheaper than the official plan. On this last point he failed completely, and his whole argument was finally whittled down to the single point that such great dams ought not to be built so near large centers of population. Under cross-examination he was unwilling to commit himself absolutely to the proposition that a hydraulic-fill dam could not be made safe. If earth dams were to be built, however, he preferred the old method of spreading and rolling. But he thought that no dams should be built where these are proposed. This was the final result of his report and testimony—a personal dictum rather than a scientific conclusion.

A feature of the opposition's case which obtruded itself on all occasions was the assumption of conditions that could never occur. There is not the remotest possibility of any storm ever filling these dams to the spillways, to say nothing of the crests of the dams. Yet this last impossible contingency was constantly assumed and, by continuous reiteration, no doubt created a feeling that it might possibly occur.

Over and over the opposition insisted upon assumptions that virtually amounted to this: What will happen if a storm occurs of such magnitude as to exceed the power of the dams to resist it? The answer must be that in such a case the dams would fail. This sort of argument no doubt had a certain effect upon some. Its chief virtue was that it shut off all counter-argument.

Additional Testimony

In the minds of most of the attendants at the hearing, the case was practically settled by the testimony of Morgan and of Hill. The opposition, however, called several minor witnesses on purely local features of the plan, and then the district took up its own direct examination.

The first witness called was E. A. Deeds, president of the Board of Directors. In straightforward and simple language Mr. Deeds told the story of the work for flood protection in the valley, in which, from the beginning, he has borne a leading part. His statement of the public purpose back of the whole movement and of the manifold difficulties that had beset the work on every hand made a profound impression upon court and audience alike. There was no cross-examination.

Following Mr. Deeds, Chief Engineer Morgan was called. Although he had gone over practically the whole ground on his cross-examination, it had been done in such a desultory and disconnected fashion that it was considered best to place in the record a consecutive and orderly narrative of the work of his department. The opportunity was improved to bring out certain points passed over on cross-examination. Mr. Morgan is still on the stand at this writing (Oct. 26).

Following Mr. Morgan, several members of his staff will be called on special features of the plan. Then will come the witnesses brought in from the outside. These include T. W. Jaycox, of Denver, Colo., and F. J. Fischer, of Los Angeles, on the hydraulic-fill method; G. B. Massey, of Chicago, on methods and costs of channel improvement; and J. W. Alvord, of Chicago, Prof. D. W. Mead, of Madison, Gen. W. H. Bixby, of Washington, and the writer, upon the general features of the plan as a whole. The object in presenting this rather formidable array of testimony was apparently not so much because it was considered necessary for the purpose of this hearing, as it was to make up as complete a record as possible in the event of an appeal from the findings of this court.

Comment

Viewing the case as a whole, it well illustrates what the writer has often remarked: The greatest obstacles that the promoters of public work have to overcome are not those of nature, but of man. Nature is sometimes a stubborn adversary, but she always acts in the open, without subterfuge or indirection. But human ignorance, prejudice and self-interest are handicaps of a different character. Ignorance is least important, because it may yie to instruction. Prejudice—that is, prejudgment of a case and then sticking to it regardless of facts—is imm ably worse. But self-interest is the most insup obstacle of all. Public measures are judged by their on the private pocket-book, and the rarest phenom in the world is a willingness to subordinate pe interest to the public welfare.

It is obstacles like the foregoing that the Boa Directors of the district have been and are still called upon to overcome. The engineering probl well worked out. No such thorough investigatio ever before made of an engineering problem. The the work to date is something over three-quarters million dollars. Even the Panama Canal is n exception.

The engineering staff is ready to proceed with con tion. But months and perhaps years must yet be in this exasperating struggle with purely ar obstacles. It is important that the people of the who really want protection, understand this situat it is. Any further delay in proceeding with the exe of the work will not come from the merits or deme the plan itself, or any lack of preparation to procee solely from an intangible opposition such as is des above. From the point of view of the physical pr the work ought to be entirely completed within th five years.

* * *

Water Meters Give Remarka Results at Redondo

By Edward R. Bowen*

During the summer of 1916, meters were instal all services of the Redondo Water Co. at Redondo, This company serves about one thousand cons The decrease in the consumption of water resulting from the installation of meters is striking, as is by the accompanying tabulations from the superi ent's monthly reports.

REMARKABLE EFFECT OF WATER METERS, REDONDO,

	June		July		Augu	
	1916 Metered Service	1915 Unmetered Service	1916 Metered Service	1915 Unmetered Service	1916 Metered Service	15
Time pumps operated, hr.	304½	923	325½	985½	336	94
Amount of power consumed, kw.-hr.	11,430	33,240	12 560	34,930	12,930	35.6
Amount of water raised, gal	13,183,700	40,105,400	14,201,000	42,822,000	14,654,200	4 59
Amount of power consumed per 1,000 gal., kw.-hr.	0 8670	0 8288	0.8844	0 8157	0 8823	
Cost of pumping per 1,000 gal., dollars	0 0171	0.01336	0 01687	0 01328	0 01665	0
Amount per capita per day pumped, gal	109 86	334.21	114 52	345.34	118.18	
Rainfall during month, in.	0	0	0	0	0	
Amount received from consumers per 1,000 gal., dollars	0 1598	0 0472	0.162	0 0484	0.1725	0

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*Engineering Offices of J. B. Lippincott, Central B Los Angeles, Calif.

Criticisms of Toronto-Hamilton Concrete Road Answered

The recently constructed concrete pavement of the Toronto-Hamilton highway in the Province of Ontario, Canada, has just been made the subject of unfavorable criticism by R. C. Harris, Commissioner of Works of the province. A considerable number of longitudinal cracks and raised joints were reported in August, 1916, less than a year after most of the pavement had been laid. The condition of the pavement was of peculiar interest because apparently every effort had been made to insure a first-class job, and the question naturally arose whether concrete was a suitable paving material for the extreme climatic conditions of eastern Canada.

The chief engineer of the Toronto and Hamilton Highway Commission, H. S. Van Scoyoc, was asked to make a personal inspection of every slab and joint in the 162,841 sq.yd. of concrete pavement laid in 1915, and his report to the commission, an abstract of which is given herewith, contains some interesting information on defects of this pavement and their probable causes. A general summary of the results of Mr. Van Scoyoc's inspection follows:

GENERAL SUMMARY OF CONDITION OF PAVEMENT

SLABS

Total number		2,076
	No.	%
Uncracked	1,751	84 3
Slightly cracked	243	11 8
Total	1,994	96.1
Cracks need filling	82	3 9

JOINTS

Total number		2,071
	No.	%
Satisfactory	1,994	93 9
Need chipping	85	4 1
Need chiseling	42	2 0

SUMMARY; WORK DONE SUBSEQUENTLY TO OCT. 15

SLABS

Total number			654
% of total number laid in 1915			31 5
	No.	%	% of Total Laid in 1915
Uncracked	526	94 9	30 0
Slightly cracked	95		39 1
Need filling	33	5 1	40 2

JOINTS

Total number			654
% of total number laid in 1915			31 5
	No	%	% of Total Number Laid in 1915
Satisfactory	548	83 9	28 2
Need chipping	65	10 1	76 4
Need chiseling	41	6 0	97 6

SURFACE DEFECTS

Total number of square yards	162,841 = 1,465,569 sq ft
No of holes noticed	1
Size	4x4 in = 16 sq in = 0.11 sq ft.

Chief Engineer's Conclusions

The summary shows quite conclusively that the trouble developed in those sections laid after Oct. 15. It is open to serious question if any work should be done in this locality after that date. The temptation was great last season, both on account of the extremely wet weather earlier, which had delayed progress, and the unusually mild weather, which continued well into November. Careful construction succeeded in preventing any injury to the surface by the frost, but it appears that the work was not so fortunate so far as joints were concerned.

The explanation of the trouble is believed to be that concrete expands not only with an increase of temperature, but also with an increase in the quantity of moisture it contains. It contracts not only with a decrease in temperature, but also as the excess water used in mixing dries out. Ordinarily, concrete is laid in warm weather. It contracts in setting up and in addition contracts with the cooler weather during the winter months. The slabs shorten more than enough to provide for the increase in length with the rise in temperature during the following summer.

In this case the concrete laid late did not dry out, on account of the low temperature. A very wet fall was succeeded by an extremely wet, cold spring. The warm weather came suddenly, and the concrete expanded before there had been the usual contraction. Even with these conditions it is believed that there would have been no noticeable trouble if the joints had been vertical.

All the joints that have been chiseled through are more or less inclined from the vertical. In practically every case this inclination is in the direction in which the mixer was working. The only exceptions that have been found up to the present have been on the steeper grades, where the tendency of the concrete is to flow down hill, and in the joints made at the end of a day's work, where there was probable lack of care.

It is quite possible that wider joints would have lessened the trouble, but in this connection it should be added that to have increased the thickness of joints to ½ in. would have entailed an additional expenditure of more than $5,000 for materials alone. It is to be anticipated that the maintenance of a wide joint would be greater than that of a narrower one. In this case a small part of the $5,000 will put the joints in such shape as to cause no serious inconvenience to travel.

The longitudinal and other cracks have been tarred on the approximately 7 mi. from Oakville Bridge to the Blue Dragon at a cost of less than $25 for materials and $175 for labor. This includes any tarring that has been done on the joints as well. Four or five more barrels of tar were required for the remaining work.

Mr. Van Scoyoc further states, in a communication to the editor, that less than 1% of the total number of slabs required attention from cracking—a condition which compares favorably with concrete highways of any extent that have come under his personal observation or knowledge. He says that there was reason for criticism regarding a limited number of joints, more particularly during the early summer; but this condition, however, to a large extent, righted itself, and a very limited amount of repairs has removed grounds for this complaint.

⁂

The New Pier at Cristobal, Canal Zone, although not quite completed, has been put to use for unloading cargoes to relieve the pressure for more handling space at the other two piers, Nos. 8 and 9, and Dock 10. The new pier, No. 7, is 1,035x212 ft. Of the 237,300 sq.ft. of floor space, 155,000 is inclosed and roofed. The pier is carried on 212 steel cylinders 6 ft. in diameter and 125 ft. long, with tops at water level. They were sunk by open dredging and filled with concrete in which are embedded steel rails for carrying girders for the floor system, composed of continuous steel stringers with 11-in. concrete slabs. The shed is of steel framework with concrete walls and cement-tile roof, the 21,000 pieces of tile being furnished by the American Cement Tile Manufacturing Co. Pier 7 has no depressed railroad tracks running the whole length through the middle, as is the case in Piers 8 and 9, but it has a railroad track running outside along the walls, for handling freight. In the construction of the shed 2,200 tons of steel was used. The total cost of the pier is $1,120,000. With its completion there will be available at Cristobal 581,150 sq.ft. of floor area in the new concrete dock and pier system at the Atlantic terminal of the canal, of which area 118,180 sq.ft. will be inclosed. To provide for the still larger demand expected within the next few years, preliminary work has already been begun and the contract let for the steel cylinders for another concrete pier of the same size as No. 7, to cost about $1,500,000 and to be completed within two years.

News of the Engineering World

Transit Head for Pittsburgh

Major Armstrong, of Pittsburgh, Penn., on Nov. 6 sent to the City Council for confirmation as Rapid Transit Commissioner the name of Edwin K. Morse. The position, which pays $8,000 per year, was recently created by an ordinance which directs the commissioner to make a transit survey of the city and to recommend a solution of the transit problem. A budget is ordered as soon as possible. Mr. Morse is a Pittsburgh engineer who has devoted most of his attention to bridge work. He was born in 1856 and graduated from Yale in 1881. His early professional experience was in bridge shops and in 1887 he went to Australia to erect the superstructure of the famous Hawkesbury Bridge there. Since his return in 1889 he has resided at Pittsburgh and has had charge of the construction of a number of the bridges in that district.

⁂

Bethlehem Steel Co. To Spend $60,000,000 on Extensions

The Bethlehem Steel Co., in a circular signed by its President, E. G. Grace, under date of Oct. 30, announces that it will expend approximately $60,000,000 in the next four years in extending the steel plant which it purchased from the Pennsylvania Steel Co., and in diversifying products. The circular says:

> Additional blast furnaces will be built at both Steelton and Sparrows Point. The finishing mills at Steelton will be enlarged and extended and new lines of products added. At Sparrows Point advantage will be taken of its exceptional position as a point for manufacturing material for export; and besides the improvements and extensions, to the existing rail mills, there are in course of erection mills for the manufacture of merchant bars, rods and sheets, a general commercial line of plates and a complete tin-plate mill.

⁂

Easton-Allentown Concrete Road Open for Traffic

The 8-mi. concrete road completed this season between Easton and Bethlehem, Penn., was formally opened with appropriate ceremonies on Thursday, Nov. 2. The celebration was in charge of the William Penn Highway Association of Pennsylvania and the Portland Cement Manufacturers Association, with the coöperation of some of the civic and social organizations of Easton and Bethlehem. Special trains were run from New York, Philadelphia and Harrisburg, bringing over 1,000 guests. An automobile parade with nearly 1,500 vehicles in line went over the new road from Easton to Bethlehem. Here a barrier across the road was removed by the guest of honor, Governor Brumbaugh of Pennsylvania, assisted by two young ladies, while a third broke a bottle of champagne upon the road surface. Luncheon was served at Oak Park, a resort midway between Bethlehem and Easton. Addresses were made by Governor Brumbaugh, Congressman Henry J. Steele and W. D. Uhler, Chief Engineer of the Pennsylvania Highway Department.
ernor Brumbaugh announced that he would ur
passage by the next legislature of a state appropria
$5,000,000 to build concrete roads in Pennsylvan
Chief Engineer Uhler stated that the policy of th
Highway Department hereafter would be to spe
state money only for roads in which concrete wa
either for the entire road or for the foundation.
of work in the construction of the road have be
scribed in past issues of *Engineering News*. The
road received high commendation from the many h
engineers who examined it, about the only criticisr
being that its width, 16 ft., is too narrow for fas
mobile traffic. It is probable that the remaining
to be built next season from Bethlehem to Allento
be 18 ft. wide.

⁂

Los Angeles May Be Its O Contractor--If

By an amendment to the city charter of Los A
Calif., approved by popular vote on Oct. 24, the
authorized to make various street improvements
day-labor or by the contract plan, as it sees fit, a
to assess the cost of the improvement upon eithe
ting property or upon an improvement district
specific work that may be so done and assessed
construction or reconstruction in any public stree
or other public place, or in any right-of-way owned
city, of sewers, drains, water or gas mains, and li
conduits for transmitting electric energy, and othe
mains, lines and conduits, or other public improve

Ordinances providing for such improvements ar
liable to suspension for a period of not less th
months on protest by owners of half the frontage a
unless meanwhile a majority of the frontage petiti
the improvement; but such protests will not be e
as regards sanitary sewers or certain minor improv
adjacent to similar existing adjacent improvemen

A restrictive "if" on the day-labor plan is inclu
the charter amendment, as follows:

> No improvement to be paid for by special assessme
> be made by the city by the direct employment of la
> purchase of materials, under the authorization of th
> division, unless the city shall have been requested s
> by a petition signed by the owners of a majority of th
> age to be assessed for such improvement, or unless
> time of receiving bids for the construction of such i
> ment the city shall have submitted a sealed bid and b
> lowest responsible bidder; provided, that should any
> improvement provided for in this subdivision be ad
> to be let by contract and the bids for the same be,
> opinion of the owners of a majority of the frontag
> assesed for such improvement excessive, then upon
> tion to the council by the owners of such majority of f
> duly made within 20 days after such bids have been r
> all bids may be rejected and the city may proceed to co
> the proposed improvement by the direct employment
> and purchase of materials.

The vote (unofficial) on the amendment was
for to 22,150 against.

ENGINEERING SCHOOLS

Harvard-Technology

A fellowship for research study of asphaltic materials and their uses, to be known as the "Clifford Richardson Fellowship," has been established in these associated institutions. The appointment of the incumbent of the fellowship and the choice of subjects for investigation, as well as the disposition to be made of the results of such investigations as may be undertaken, are to be decided by the institute faculty or the joint committees of the university and the institute having control of engineering work. The funds were provided by the Barber Asphalt Paving Co., of Philadelphia.

University of California

As part of its course in mining engineering under Prof. Frank H. Probert, the University of California has started construction of the "Lawson Adit," an 1,800-ft. tunnel into the Berkeley Hills, starting just east of the Hearst Memorial Mining Building. The object of this work is to familiarize the students with all the mechanical processes of mining, and classes will be held in the underground workings.

University of Tennessee

The University of Tennessee has organized its extension courses for the benefit of shop employees and others who may be benefited by practical courses in mechanic studies. This is the second year of this work. The classes are held at Memphis, the largest city in the state, under the direction of Prof. Charles E. Ferris, dean of engineering. The total cost is $5 and in some instances 60-day notes are accepted in payment. Thomas H. Allen, consulting engineer, is assisting. The Memphis Engineers' Club is coöperating. The State Manufacturers' Association last year paid part of the cost. Correspondence courses are also given.

Massachusetts Institute of Technology

The first of the dormitories at the site of the new Technology buildings in Cambridge have been opened. These are cream-colored buildings in the Florentine style, located a little below the educational group facing the Charles River Basin. The group is L-shaped in plan with a tower in the angle, and forming a block of six independent houses, each with its own entrance, stairway and party walls. The latter are pierced by fire doors to be unlocked only in emergencies and after breaking a glass guard. The two end houses have been assigned to two fraternities which have desired to experiment with quarters in the blocks about the campus. These houses have different layout from the others—each having a kitchen, dining room and two large living rooms. The restaurant and Students' Union, serving the regular dormitories, are temporarily located in the basement—pending construction of the Walker Memorial Building. Student government will rule these dormitories, there being a faculty committee having general supervision of such matters as sanitary inspection, maintenance, etc.

University of Illinois

The College of Engineering of the University of Illinois is to have the benefit this year of an Advisory Board for the Railway Industries of Illinois, which upon the recommendation of the dean and the approval of the president of the university, has recently been appointed by the trustees. The presidents of five of the larger railroads centering in Chicago, and having their administrative offices in that city, have consented to serve as the members of this Advisory Board. The Department of Railway Engineering is soon to receive a modern high-power superheating locomotive for use during the fall and winter under the direction of Professor Schmidt.

Initial steps have been taken and authority has been received from the president and the trustees of the university, which provide a foundation for the establishment within the College of Engineering, in coöperation with the State Public Utilities Commission of Illinois, of an Electrical Standards Laboratory to which the public service corporations of the state can send any piece of apparatus to be checked and corrected.

NOTES

A Gravel-Bank Cave-In killed five men at Barton, Ala., Oct. 24. The men were taking out material for roadwork and were buried by the fall of several tons of gravel.

A Mine Explosion at Marvel, Ala., on Oct. 22 caused the death of every man in the mine of the Roden Coal Co., except one—17 men. The one who escaped was a pumpman in one of the upper headings. All the men killed had gone into the mine to install a new electric-feeder cable. Open lights were used, but up to this time the mine had not been considered gassy. The United States Bureau of Mines mine-rescue car was sent to the scene of the explosion, but by the time it arrived gas helmets were no longer necessary.

Three Adjoining Brick Buildings Collapsed on Portland St., Boston, Mass., Oct. 26. The original failure appears to have been in a six-story brick structure at 21-37 Portland St. In falling, it brought down the two adjoining buildings, a one-story and a three-story structure. The six-story building was unoccupied and was being remodeled. The collapse occurred about 8 p.m. During the day about 50 workmen had been employed on the remodeling. No lives were lost, but the loss in property is stated to amount to many thousand dollars.

A Boston Surface Car Jumped an Open Drawbridge killing 50, on the evening of Nov. 7. The car, jammed with passengers from South Boston, Mass., smashed through the gates in front of the open draw in Summer St. and plunged into Fort Point Channel. Press dispatches state that the accident appears to have been caused by the absence of a red lantern on the guard-gate and the fact that the electric arc lamp that usually illuminates the bridge was not lighted. A floating crane was installed at the open span, and divers went down to the wrecked car, which they reported was standing on end on the bottom. The motorman and conductor escaped death by jumping. They have since been arrested on technical charges of homicide.

The Breakage of a Locomotive Driving Axle, which caused a train accident on the Southern Ry June 7, 1915, has been investigated by the Division of Safety of the Interstate Commerce Commission. Examination of the broken axle was made by James E. Howard, Engineer-Physicist, and it was ascertained that the cause of the fracture was an area of metal at the surface of the journal which contained chatter marks and short incipient cracks made by the roughing cut in the lathe during the machining of the forging from which the axle was made. It appeared that the finishing cut was not deep enough to take off all the metal which had been injured by the roughing cut. Defective workmanship on the axle is further indicated by the fact that the length of bearing of the axle in the wheel-seat was from $\frac{1}{2}$ to $1\frac{3}{4}$ in. long, instead of bearing for the whole length of 8 in. in the wheel-seat as it should have done. Two other fractures had started in the wheel-seat which would soon have caused failure of the axle had it not broken in the journal.

Paving By Day Labor in the City of Minneapolis, Minn., amounted to 108,000 sq.yd. in the season just closing. This is approximately 25 mi. of streets. Three-quarters of the total was creosoted wood-block pavement for which the city has become famous. E. R. Dutton is assistant city engineer in charge of paving.

Railway-Electrification Work on a large scale is planned by the Great Northern Ry., according to reports from the State of Washington. The company has planned to alter to electric traction all its lines in the State of Washington, at an estimated ultimate cost of $16,000,000 to $20,000,000. It is stated that the water-power sites where current will be generated to operate the lines have already been chosen.

The Panama Canal during the first two years of its operation, from Aug. 15, 1914, to Aug. 14, 1916, was used by 2,097 ships, with an aggregate net tonnage (Panama Canal measurements) of 7,046,407. These vessels carried 9,031,613 gross tons of cargo. During the second year of operation the canal was closed for nearly six months, which reduced the amount of traffic through it nearly one-half. The total tolls collected were $5,102,000 in the first year and $2,310,000 in the second year.

A Municipal Ocean Steamship Line has been recommended to the mayor and council of Los Angeles, Calif., by the Chamber of Commerce. It is stated that Los Angeles exporters have gone to great expense in extending the city's trade, but find themselves handicapped by conditions over which they have no control. The city charter, adopted by popular vote, allows the city to engage in the shipping business, and the Chamber of Commerce suggests that a start be made by building two wooden ships at a cost of not over $150,000.

A National Conference to discuss uniform state legislation covering the construction of boilers has been called by the Industrial Commission of Ohio, to take place at Washington, D. C., during the week beginning December 4. It is probable that the Boiler Code of the American Society of Mechanical Engineers will be the basis for discussion at this meeting. It is stated that the City of Philadelphia is about to adopt a new boiler ordinance based on the A. S. M. E. Code to replace its old rules regarding boiler construction, which are said to have been in existence since 1868.

The Union Railway Station buildings in St. Paul, Minn., were condemned by the State Fire Marshal, R. W. Hargadine, on Oct. 20 and ordered to be removed within six months. The order was issued on the ground that the buildings were dangerous to human life and surrounding property. Plans for the construction of a new station by the St. Paul Union Depot Co., of which W. C. Armstrong is Chief Engineer, have not yet been agreed to by all the roads concerned. The plans for a new station first prepared have been objected to by S. M. Felton, President of the Chicago Great Western R.R., on the ground that the plan of operation of the track system would be prohibitively expensive.

Municipal Ownership of the electric light and power distributing systems of Los Angeles is likely to be realized in the near future. Negotiations have been in progress for months between the city authorities and the three companies distributing electric current within the city limits. The city has offered the companies $10,000,000 for their distributing systems and the steam plant of the Los Angeles Gas and Electric Corporation. The companies have offered to sell the property at $13,691,000. The city also offers to purchase power from the companies for 5½ yr. at 0.85c. per kw.-hr. The companies ask for a 10-yr. power contract from the city, during which time the city would purchase power from them for half its requirements at $33.17 per hp. The city is already at work paralleling the companies' distribution systems, but this work will of course be stopped if an agreement is effected for the sale to the city of the existing lines.

Reduced Rates for electric current have been offered to the Public Service Commission for the First District of the State of New York by the New York Edison and United Electric Light and Power Co., and would apply to the Borough of Manhattan and part of Bronx, beginning Jan. 1, 1917. The maximum tariff in both the general lighting-rate and power schedules is reduced from 8 to 7½c. per kw.-hr. until July 1, 1917, after which time it is further cut to 7c. The right is reserved to restore the 8c. maximum if unforeseen conditions adversely affect the companies' financial status. This is reported to mean a revenue reduction of $1,750,000. Similar reductions had previously been ordered upon the associated Brooklyn Edison Co., and this offer was the outcome of conferences between the Public Service Commission, the city administration and the companies. The change is acceptable to the city government and it is expected that it will be formally accepted by the Commission.

The Hudson Bay Railway enterprise has been under investigation by the Canadian Government Railway Commission, which heard at Ottawa the testimony of W. A. Bowden, Chief Engineer of Construction in the Department of Railways and Canals. The theoretical advantage of the Hudson Bay route is the saving in transportation cost on grain exported to Europe. The distance from the principal grain-raising centers in the Canadian Northwest to Port Nelson c
Hudson Bay is practically the same as the distance fro
Winnipeg to Fort William at the head of Lake Superior. Tl
sailing distance from Port Nelson to Liverpool is substantial
the same as from Montreal to Liverpool, and it was con
puted that the saving in the transportation cost by reason
the shorter land journey would be from 5c. to 12c. per bush
of wheat. Mr. Bowden further said: "The information v
had when we started the work has proved very unreliab
during the five seasons we have been working. For e
ample, our information was that Hudson Bay would be op
to navigation about the first of July. The fact is it is n
open until the last of July or the first of August. The da
when navigation was closed by ice was not fixed in th
early information. However, ordinary tramp steamers ha
left Port Nelson on Oct. 23 and gone through without dar
age. A Government tug went through on Nov. 1, but the i
would have damaged a tramp. The grain shipped in Augu
by this route would have to be what was left over from tl
previous year's crop. New grain could be shipped in Septen
ber and October.

PERSONALS

L. D. Heilly has been appointed Manager of the Ambrid
plant of the American Bridge Co., succeeding F. T. Cadmı
who has resigned.

Elmer Folsom and **Milo C. Taylor** announce the formati
of the firm of Folsom & Taylor, Civil Engineers, Peoples Ba
Bldg., Bloomington, Ill.

Francisco Asenjo, Civil Engineer, of Santiago, Chile,
making an investigation of irrigation systems in the We
He is now in California.

Sanford E. Thompson, M. Am. Soc. C. E., Consulting Eng
neer, has established offices and a concrete-testing laborato
at 136 Federal St., Boston, Mass.

G. C. Habermeyer, of Aurora, Ill., has been appointed Ac
ing Engineer of the Illinois State Water Survey, with offi
at the University of Illinois, Urbana, Ill.

Ealy G. Briggs, Assoc. M. Am. Soc. C. E., formerly I
spector, Department of Public Works, St. Paul, Minn., h
been appointed Sidewalk Engineer of the department.

Charles A. Lemmon, formerly Chief Engineer of the But
Anaconda & Pacific Ry., is now Assistant to the General Ma
ager of the Anaconda Copper Mining Co., Anaconda, Mont.

A. Leckie, former Division Engineer of the Arkansas We
ern Ry., at Pittsburgh, Kan., is now Division Engineer of t
Kansas City Southern Ry., at Kansas City, Mo., succeedi
E. M. Basye, transferred.

M. F. Clements, M. Am. Soc. C. E., Assistant Engineer of t
Northern Pacific Ry. at Spokane, Wash., has been promoted
be Bridge Engineer, succeeding H. E. Stevens, who was ma
Chief Engineer, as noted in these columns Sept. 28.

Charles T. O'Neal, formerly Superintendent of the Lehi
Valley R.R. at Buffalo, N. Y., has been promoted to be Gene
Superintendent, with headquarters at South Bethlehem, Pe
He is succeeded as Superintendent at Buffalo by P. J. Flynn

Wendell P. Hall, recently with the valuation department
the Cincinnati, Hamilton & Dayton Ry., at Cincinnati, Oh
has been promoted to be Assistant Engineer in the mai
tenance-of-way department, with headquarters at Cinci
nati.

H. H. Barber, formerly Sales Engineer, and W. B. Gree
formerly Advertising Manager of the Stephens-Adamson Ma
ufacturing Co., Aurora, Ill., announce the formation of t
Barber-Greene Co., manufacturers of car unloaders, wag
loaders, etc., Aurora, Ill.

Edward Ray Weidlein has been appointed Associate I
rector of the Mellon Institute of Industrial Research of t
University of Pittsburgh. He was graduated from the U
versity of Kansas in 1909 and has been a senior fellow
charge of hydrometallurgical investigations at Mellon Ins
tute.

W. H. Vance, recently Engineer of Maintenance-of-Way
the Louisiana & Arkansas Ry., has been promoted to be Chi
Engineer and his former office has been abolished. He is
graduate of the University of Illinois, class of 1899, and w
formerly with the engineering departments of the Peoria
Eastern Ry. and the St. Louis, Iron Mountain & Southern F

J. S. McBride, formerly Valuation Engineer of the Chica
& Eastern Illinois R.R., has been promoted to be Princi
Assistant Engineer with headquarters at Chicago. He is

vil engineering graduate of Rose Polytechnic Institute. He as been continuously in the service of the Chicago & Eastern linois since 1905, when he was appointed an instrumentman construction. He was promoted to be Assistant Engineer 1908 and Valuation Engineer in 1914. He will continue to ave supervision of the valuation work in addition to his new ities.

OBITUARY

William Cooper Cuntz, Assoc. Am. Soc. C. E., General Maner and Treasurer of the Goldschmidt Thermit Co., New York ty, died Nov. 2 at Auburndale, Mass. He was born in Hoken, N. J., 45 years ago. He had been connected with the ldschmidt Thermit Co. since 1910.

James C. Wallace, former President of the American Shipilding Co., of Cleveland, Ohio, died Oct. 31, aged 53 years. started his business career as a machinist in 1881. Six ars later he took charge of the drafting room of the Clevend Shipbuilding Co., of which he became Vice-President and neral Manager in 1893. When this company was merged to the American Shipbuilding Co., in 1899, he became General nager, and in 1904 President.

ENGINEERING SOCIETIES

IERICAN MINING CONGRESS.
Nov. 13. In Chicago, Secy., J. F. Callbreath, Munsey Bldg., Washington, D. C.

RO CLUB OF AMERICA.
Nov. 13. Annual meeting in New York City. Secy., Wm. Hawley, 297 Madison Ave., New York City.

TIONAL COMMERCIAL GAS ASSOCIATION.
Nov. 13-18. Convention in Atlantic City, N. J. Secy., Louis Stotz, 61 Broadway, New York City.

CHMOND RAILROAD CLUB.
Nov. 13. Annual meeting. Secy., F. O. Robinson.

TIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Nov. 14. Convention in Washington, D. C. Secy., W. H. Connolly, Washington.

CIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H. Roth, 1410 W. Adams St., Chicago.

NSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

THERN AND SOUTHWESTERN RAILWAY CLUB.
ov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

Y MANAGERS' ASSOCIATION.
ov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

TIONAL MUNICIPAL LEAGUE.
ov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

ILWAY GARDENING ASSOCIATION.
ec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

RTLAND CEMENT ASSOCIATION.
ec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

The Northwestern Road Congress will meet for the third e, on Dec. 8 and 9 in Chicago. A tentative program has t been issued, and can be obtained from Secretary J. L. ig, Moline, Ill.

The American Society of Agricultural Engineers holds its th annual meeting at Chicago, Dec. 27 to 29. The preinary program has been issued and can be obtained from secretary, D. K. Shedd, Ames, Iowa.

A New York State Industrial Safety Congress is to be held . 11 to 14, in Syracuse, N. Y. at the Hotel Onondaga. Adsses will be delivered on fire prevention, factory sanitation, The New York City office is at 230 Fifth Avenue.

The North Carolina Drainage Association will hold its ual meeting Nov. 22 and 23 in Greensboro, N. C. This is l to be the first time in a number of years that the annual ting of this organization has been held in an inland town city

The Engineers' Society of Western Pennsylvania has taken s toward the purchase of "Solitude", the home of the late rge Westinghouse, in Pittsburgh, and to convert the resice into a memorial. If the project is carried through, it l involve an expenditure of about $400,000.

The Detroit Association of the Members of the American iety of Civil Engineers was organized on Oct 26, and officers were elected as follows. President, Theodore A. Leisen, General Superintendent Detroit Board of Water Commissioners; vice-presidents, Henry C. Ripley and Gale Cummins; secretary, Clarence W. Hubbell, consulting engineer, Detroit, Fifty charter members attended the organization meeting.

The Pittsburgh Association of Members of the American Society of Civil Engineers was organized on Nov. 4 at a meeting held in the rooms of the Engineers' Society of Western Pennsylvania, Pittsburgh. G. F. Davison and R. A. Cummings were continued as temporary chairman and secretary, respectively, and the committee, which reported on the advisability of forming the association, was continued and instructed to draft by-laws, and be ready to report at another meeting to be held in the near future.

American Society of Civil Engineers—The nominating committee has selected the following officers to be voted for at the annual meeting, Jan, 17, 1917: President, George H. Pegram, Chief Engineer of the Interborough Rapid Transit Co. and the Rapid Transit Construction Co., New York City; vice-presidents, George W. Kittredge, Chief Engineer, of the New York Central Lines, New York City; and George S. Webster, Director of the Department of Wharves, Docks and Ferries, Philadelphia, Penn.; treasurer, George W. Tillson, Consulting Engineer of the Borough of Brooklyn, New York City; directors, Alfred D. Flinn, Deputy Chief Engineer of the Board of Water-Supply, City of New York; Lewis D. Rights, Construction Manager of Lewis F. Shoemaker & Co., New York City; William R. Hill, Consulting Engineer, Albany, N. Y.; Arthur P. Davis, Chief Engineer of the United States Reclamation Service, Washington, D. C.; William L. Darling, recently Chief Engineer of the Northern Pacific Ry., St. Paul, Minn.; and R. H. Thomson, Consulting Engineer, Seattle, Wash.

The Association of Railway Electrical Engineers, which deals with train lighting and the general use of electricity for power and light in railway service, held its ninth annual meeting at the La Salle Hotel, Chicago, Oct. 31 to Nov. 3. The attendance was good and there was an extensive exhibit of railway and electrical appliances. In regard to train lighting, a committee submitted recommendations for standards; these have been considered also by the Master Car Builders' Association. Another committee reported on the system of lighting from a plant at the head end of the train, which system is in extensive use and is in general more economical than the individual car system. But where the service requires the frequent making up and breaking up of trains, and diverting cars to other lines, the individual equipment system is the only one that meets the requirement. Other reports related to the rating of lamps used in train service, and arrangement of lamps for lighting freight and repair yards. In relation to power and shop work, the reports dealt with the rating of crane and turntable motors, the use of compressed air in railway shops, and the use of electric welding for various purposes. It was pointed out that the saving in cost due to such welding has been so great that little attempt has been made at scientific management of the work. The time is approaching, however, when it will be necessary to reduce the cost of this electric welding work very materially.

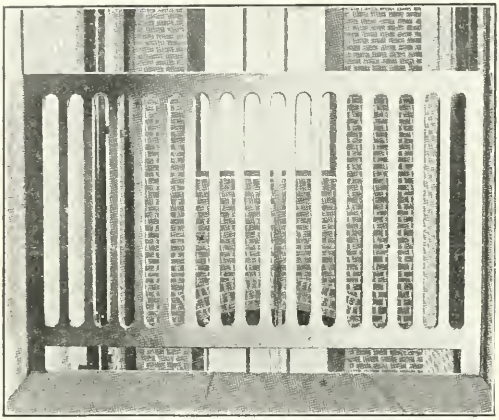
Officers were elected as follows: President, C. J. Causland, Chief Electrician, Pennsylvania Lines; Secretary, J. A. Andreucetti, C. & N. W. Ry., Chicago.

The American Road Builders Association—The annual business meeting of the Association for the election of officers was held in New York City at the Automobile Club of America on Nov. 3. The officers elected were as follows: President, A. W. Dean, Chief Engineer, Massachusetts Highway Commission; Vice-Presidents, Wm. H. Connell, Chief of the Bureau of Highways of Philadelphia; Austin B. Fletcher, State Highway Engineer of California; Prof. Arthur H. Blanchard, Professor of Highway Engineering, Columbia University; for Directors to serve three years, Paul D. Sargent, Chief Engineer of the Maine State Highway Commission; R. H. Gillespie, Chief Engineer of Sewers and Highways, Borough of the Bronx, New York City; T. R. Agg, Professor of Highway Engineering, Iowa State College; B. Michaud, Deputy Commissioner of Highways, Province of Quebec; Fred E. Ellis, Manager, Essex Trap Rock Co.; W. E. Atkinson, State Highway Engineer of Louisiana; Secretary, E. L. Powers, Editor of "Good Roads." At the dinner following the meeting, the retiring President, Col. E. A. Stevens, State Highway Commissioner of New Jersey, acted as toastmaster, and among the after-dinner speakers were Edwin Duffey, State Highway Commissioner of New York; and H. E. Breed, Deputy Commissioner of Highways of New York. Commissioner Duffey stated that under an act of the last legislature, the Commissioner, State Engineer, and Superintendent of Public Works, were given authority to prepare a code of rules for the control of commercial motor vehicles operated on highways within the state with the object of protecting the roads from destruction. The commission has had an engineer at work for some months collecting the information on which to base such a code of rules and will shortly hold a public hearing upon them. They are to go into effect on Feb. 1 next.

Appliances and Materials

Pressed-Steel Elevator Gates

An all-steel freight-elevator gate with the principal member pressed from a single piece of sheet steel is being made by the Paterson-Leitch Co., of Cleveland, under the trade name "Steelite." The gate is as light as a wooden one and much more rigid; it costs but little more. After the main piece is pressed, the mitered corners are welded (oxyacetylene process), and whatever reinforcements are desired are spot-welded. An oak bumper is fastened to the bottom of each leg to cushion the impact and reduce noise. A two-section telescoping gate of similar design is made.



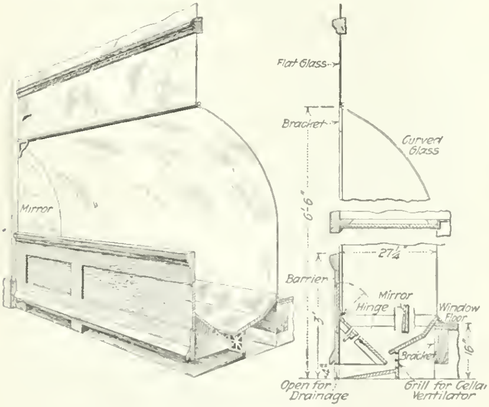
ONE-PIECE PRESSED-STEEL ELEVATOR GATE

With these all-steel gates, are furnished steel-channel guides, steel weight boxes, ball-bearing pulleys, etc., for manual or semi-automatic operation.

* * *

Non-Reflecting Store Window

A store front that clearly discloses the interior and eliminates the disturbing reflections commonly encountered has been developed by the Store Improvement Co., 1804 Finance Building, Philadelphia. This construction, shown in the accompanying sketch, is known as the "shadow-box window." This result is produced by substituting for the usual flat plat glass two plates of glass the width of the window, having the upper, or "awning section" (above the line of vision), o ordinary flat glass and the lower, or "vision section," a ben glass plate set horizontally with the concave side toward th observer. The two plates meet in a plain clamp joint about foot above a tall observer's eyes. A shadow box, or barrier is then placed across the lower front of the window on th building line, with suitable provisions for drainage. Thi barrier may be of any material to harmonize with the building—as stone, iron, wood, kalamein, or iron or bronze grilles etc.

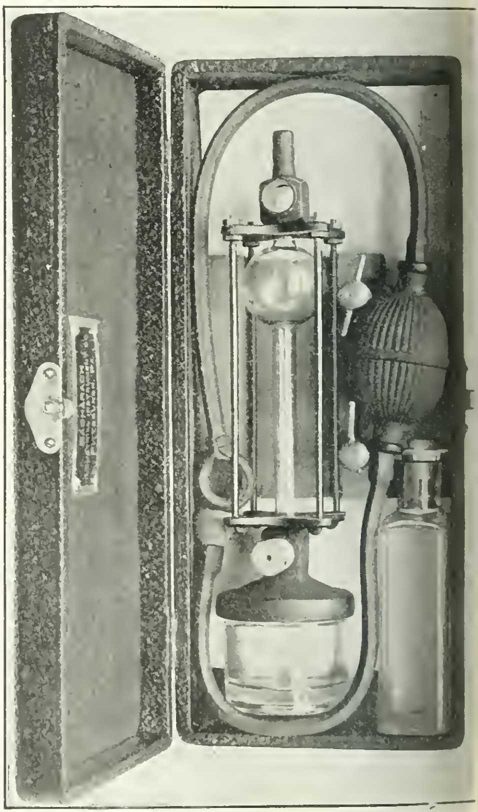


SHADOW-BOX STORE DISPLAY WINDOW

In new buildings the installation of this type of window i easy and comparatively inexpensive—about the cost of goo flat-plate construction. In old buildings the cost is more—and in some cases is prohibitive. Where a window is ver wide, it is usually found best to divide it by mullions int two sections, or into a wide central section and two narrow end sections. Users of this window are obliged first to pur chase a license and then to have the window constructed di rectly by the controlling company or by local contractor under the company's specications.

* * *

Pocket CO_2 Indicator with Replaceable Parts—A pocket CO indicator for use by testing engineers, superintendents an power-plant operators has recently been brought out by th Bacharach Industrial Instrument Co., 14 Wood St., Pittsburgh Penn. It works on the familiar principle of the CO_2 ab sorption by KOH. This instrument is designed for rathe rough usage, and every part can be easily replaced in th event of breakage. It is reported that 17 to 20 analyses pe hour can be made with this instrument. With ordinary car an analysis can be made with a maximum error of 2%. Th reagent is a solution of potassium hydroxide in water. Severa hundred analyses can be made with one charge of the causti The device is compact and portable.



RUGGED CO_2 INDICATOR FOR QUICK TESTS

Engineering News

'OLUME 76 NOVEMBER 16, 1916 NUMBER 20

Famous Yadkin Development Nearing Completion

The much exploited hydro-electric project at the nar- ows of the Yadkin River in Stanley County, N. C., ; now approaching a completed reality, after 15 years f vicissitude and in the hands of the fourth interest hat has undertaken its development. Here is rising a olid concrete dam about 1,400 ft. long, of 217 ft. aximum height and containing 525,000 cu.yd. of concrete. This is the highest overfall-type dam on record nd one of the largest in its concrete yardage. In the ower house immediately below the dam there are being stalled three 31,-)0-hp. generating nits (out of an entual four) iese being by a nsiderable mar- n the largest- pacity single- nner turbines t built. The pos- bility of develop- g a great block electric power the gorge of the adkin River, me 30 mi. south- st of Salisbury, . C., has long een attractive. he first recorded tempt at utiliz- g the fall was omoted by the te George Whit- y, of Pittsburgh. efore actual construction started, the project passed into e hands of the North Carolina Electric and Power ., which created the town of Whitney and built a very ng and expensive cut-stone dam at the head of a 5-mi. retch of canal. This company was caught in the nancial depression of 1907 and was taken over later a French concern, the Southern Aluminium Co., which oposed to establish in that district a large aluminum dustry. This company's plans for the development had en made on radically novel lines, and construction had ogressed steadily (as described in *Engineering News,* ne, 11, 1911) when the European War halted the work.

After about a year's interim the new town of Badin d the industrial site were purchased by the Tallassee wer Co., a subsidiary of the Aluminum Co. of America. nder the new owners the town has been further developed d is rapidly growing toward its eventual population of 5,000. The plans of the hydraulic development have been considerably changed again by the new owners and a practically completed power house and its equipment were abandoned; but the dam, so far as it was constructed, has been made use of.

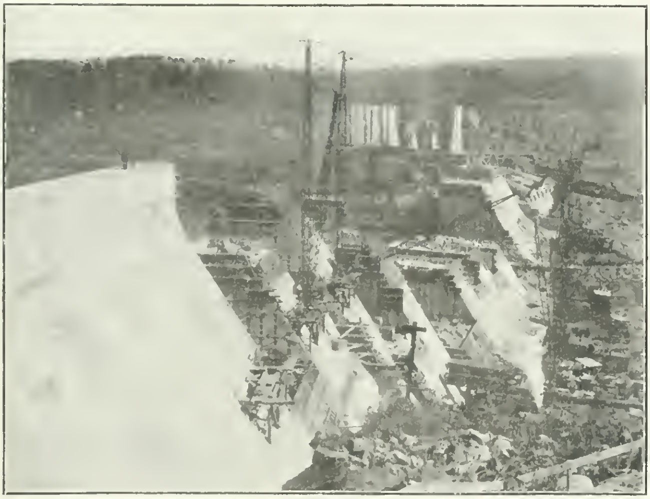


FIG. 1. THE YADKIN NARROWS DAM ABOUT NOV. 1, 1916

GENERAL PLANS OF PRESENT DEVELOPMENT

The plans of the French engineers (that is, of the Southern Aluminium Co.) because of the features of novelty—judged from American standards—excited unusual interest in engineering circles. The old French plan, briefly reviewed, consisted of throwing a curved non-overflow gravity-section concrete dam about 1,350 ft. long and 200 ft. high (maximum) across a deep rock gorge, the creation of a reservoir covering about 8 sq.mi. of territory and the construction of a power station on the west bank immediately below the dam, housing sixteen 5,200-kw. direct-current and two 1,200-kw. alternating-current units. The effective head was to be 175 ft.

In connection with this dam there was to be no side canal or bypass, as commonly provided in American practice. There was, instead, a short overfall section with 10 control gates above the crest, at the east end of the dam, disposed in a curve around a bowl excavated in the hillside and drained by two big wells, 60 ft. in diameter, connecting with two bypass tunnels which were also to be used during construction to divert the river from its original course.

The changes made by the Tallassee Power Co. principally concern the conversion of the dam into an overfall section clear across the river, the use of a spillway bypass channel instead of wells and tunnels, the building of a new power house, the use of vertical-shaft turbines, and the generation of alternating current instead of direct.

The Tallassee Power Co. in order best to utilize the concrete placed in the dam by the French company, without accepting all the features of the layout, retained the idea of a curved dam of gravity section—making the main dam of overfall section along the entire length, except for about 450 ft. of wing at the west end and 100 ft. at the east end, increasing the base width and the area of cross-section and modifying various other details. The cross-section of the dam as now being built is shown in Fig. 4. In connection with this it should be noted that the weight of the cyclopean concrete is unusually great—162.5 lb. per cu.ft. This is due to the high specific gravity of the porphyry aggregate.

A new power station was built across the river and designed to house four 27,000-hp. single-runner vertical-shaft Francis turbines driving alternating-current generators. These are the largest-capacity single-runner wheels yet built. Only three units are to be installed at the present. The penstocks are of steel plate and come down from an intake section at the east end of the dam proper. Inclined stop-log grooves are provided in front of the trash racks of the intake, and motor-operated hoist-lifted Stoney gates will be installed—to be controlled from the power station.

There are 22 Taintor gates, 25x10 ft., placed between piers along the crest of the main length of dam west of the intake. From the intake a spillway section, with a lower elevation of crest, curves sharply away to the southeast. This section is about 44 ft. long over all and carries 10 Stoney gates, each of 33 ft. clear width between piers. The combined discharge capacity of the Taintor and Stoney gates is computed to be 250,000 sec.-ft.—or 90,000 sec.-ft. greater than the biggest flood flow of the last century.

The more important features of the Taintor gates are shown in Fig. 5. It is especially interesting to note that these 22 crest gates are operated by a single movable hoist that travels along the overhead bridge. This is an economical departure from the usual expensive practice of individual hoists for each gate. Each gate carries

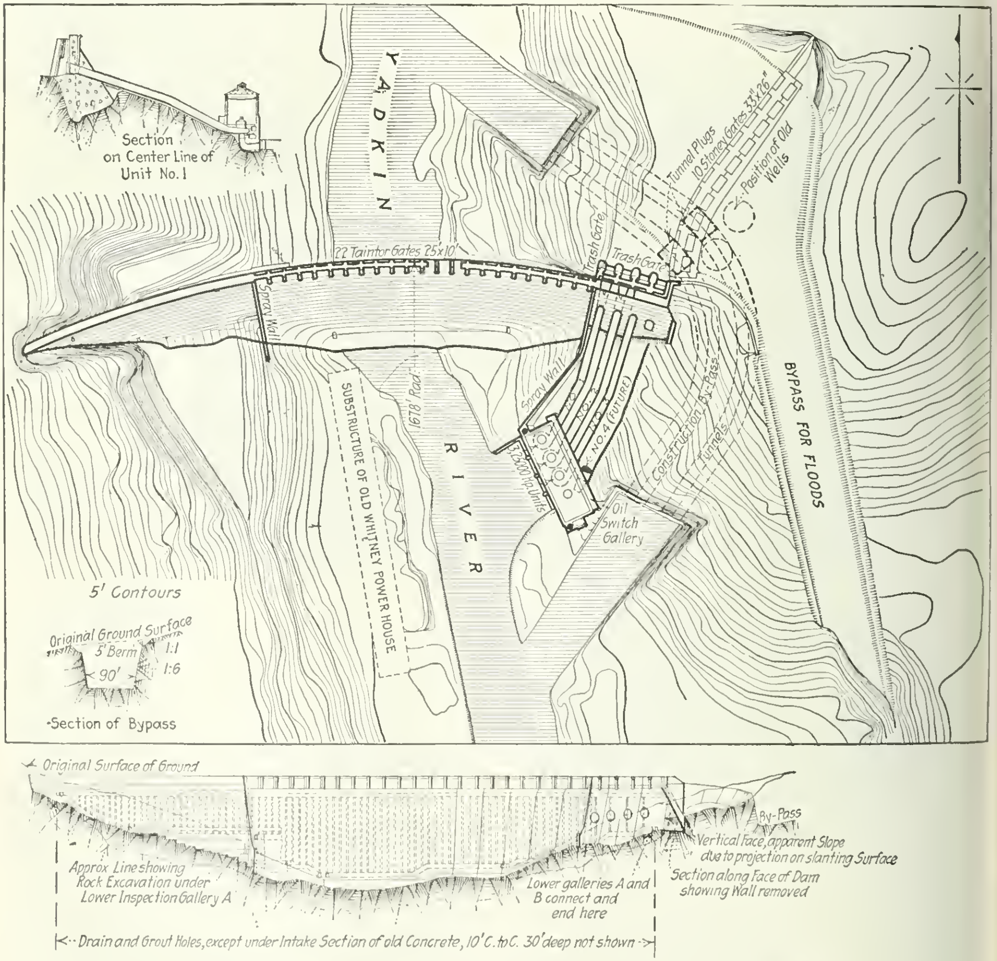

Section on Center Line of Unit No. I
YADKIN
RIVER
22 Taintor Gates 25x10'
Spray Wall
Trash Gate
Trash Gate
Tunnel Plugs
10 Stoney Gates 33'x26"
Position of Old Wells
SUBSTRUCTURE OF OLD WHITNEY POWER HOUSE
1678' Rad.
Spray Wall
NO. 2
NO. 3
NO. 4 (FUTURE)
3-27,000 Hp. Units
Construction By-Pass
Tunnels
Oil Switch Gallery
BYPASS FOR FLOODS
5' Contours
Original Ground Surface
5' Berm
1:1
1:6
90'
Section of Bypass
Original Surface of Ground
By-Pass
Vertical Face, apparent Slope due to projection on slanting Surface
Section along Face of Dam showing Wall removed
Approx Line showing Rock Excavation under Lower Inspection Gallery A
Lower galleries A and B connect and end here
Drain and Grout Holes, except under Intake Section of old Concrete, 10' C. to C. 30' deep not shown

FIG. 2. GENERAL LAYOUT OF YADKIN NARROWS DEVELOPMENT, TALLASSEE POWER CO.

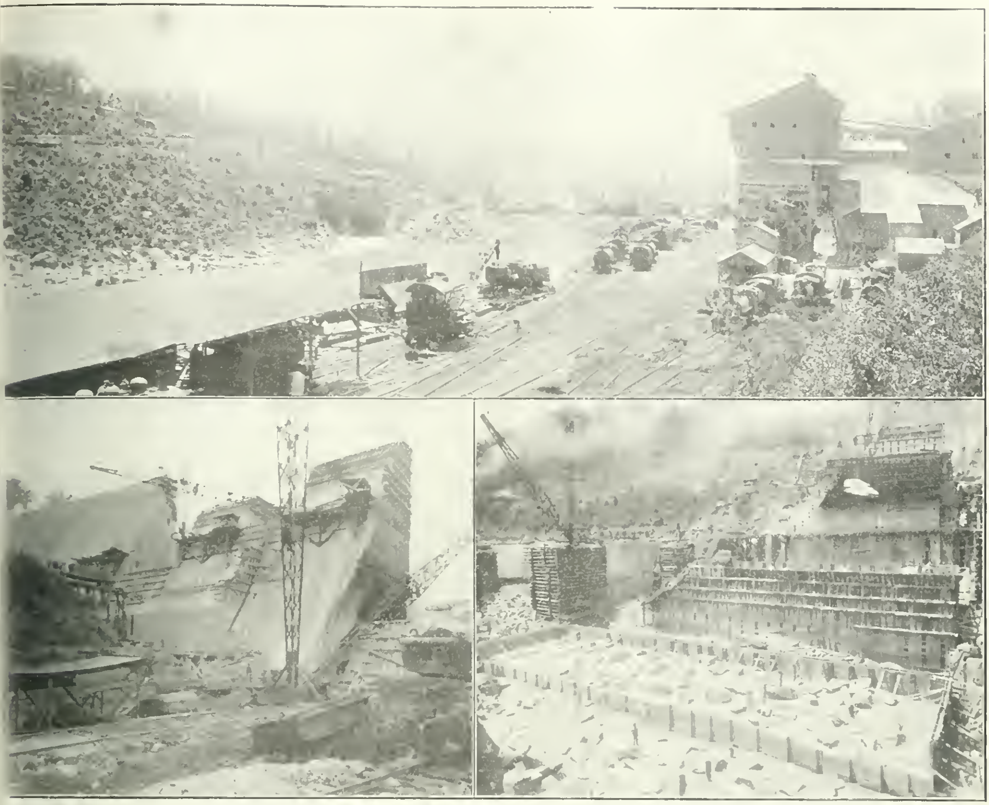


FIG. 3. VIEWS OF YADKIN NARROWS DAM AT VARIOUS STAGES OF WORK

Top—From upstream, showing conditions at about time Tallassee Power Co. took over the project. Lower Left—Showing spray wall at junction of overfall and high sections. Lower Right—Showing plums, drainage-tube forms, key joints, etc. Photographs by E. Jungerman, Columbus, Ga., photographer for the Hardaway Contracting Co.

vo hoist chains, which are picked up by the traveling oists for raising and lowering. The gate, when raised, held up by dogs on the chains and bridge engaging, that the hoist is freed for service. The bottom seal of e gate is a bolted-on plank with rubber-packing strip. he sides are sealed by a strip of rubber belting folded)° longitudinally.

The bypass Stoney gates are also shown in Fig. 5. The sign of gate and guides, it should be noted, was conolled by the dimensions of the concrete piers, which ere partly built before the Tallassee Power Co. took er the project. The gate slots were already molded in the d piers, and this limited the treatment of gate ends. hese Stoney gates are among the large ones in this untry—though hardly approaching the largest built—d well illustrate the best-recognized practice of the y. They are 35 ft. wide, 26 ft. high, are horizontally amed structures with built-up horizontal girders and e open at the back. The downstream flanges of the t horizontal girders are hung by channels from a top uss.

Each gate is lifted by a pair of permanently attached rews, the lower ends of which engage 3-in. pins in side ates at the upper gate corners. Each screw is lifted by non-rising nut rotated through worm gearing by a 25-hp. motor. The details of guides, rollers and seals for the Stoney gates are shown in Fig. 5.

To provide contraction joints and to facilitate construction the dam is built in vertical blocks of about 50-ft. width, measured on the upstream face. One block was carried up several lifts before the adjacent one was started. The horizontal joints (marking a day's work) were allowed to come at the convenience of the contractor, but never closer than 5 ft. The concrete was continuously poured during each day's work, except where the inspection galleries were inclined.

The vertical faces of the blocks of the dam are marked with key grooves 2½ ft. wide and 1 ft. apart, as shown in Fig. 4. These are painted with coal-tar paint (1 pt. of kerosene to 1 gal. of tar) applied hot. This is to prevent all bond of concrete to concrete; and while there is no appreciable thickness to the tar coating, it sufficiently serves as a contraction joint.

Although the upstream cutoff trench was carried to sound tight rock, a line of 30-ft. drill holes on 10-ft. centers was put down in the ledge under the heel of the dam. These holes will be grouted from the lower upstream inspection gallery. Eighteen-inch drain holes, on 10-ft. centers, were cored in the concrete to rock under the downstream gallery; from the bottom of these drain holes, 40-ft. holes were drilled into the ledge—and left open to serve as drains and thus prevent uplift due to water which may percolate past the line of grouted drill holes. Along the dam and 7 ft. below its crest runs an upper inspection gallery, connected to the lower upstream gallery by 18-in. drain holes, on 12½-ft. centers for the entire length of the dam. These holes were cored in the concrete, using collapsible steel forms. The drain-hole openings in the upper and lower galleries are covered by cast-iron gratings.

As the dam is curved (radius 1,678 ft.) and the piers supporting the gate-operating bridge are on radial lines, the piers were tapered so as to provide parallel walls for each gateway.

The spillway apron, formed by the downstream face of the main dam, is dished toward the downstream corners, so as to form a bucket that shall guide the overflowing water toward the river channel. The apron is separated by spray walls from the non-overflow section on the west end and from the penstocks and power house on the east end.

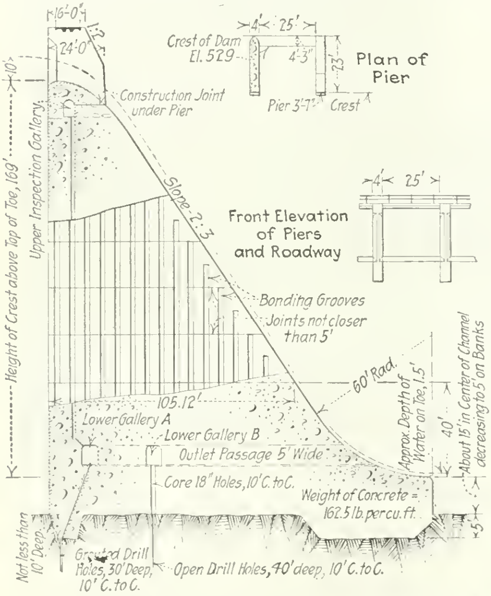

16'-0"
24'-0"
1:1.2
10'
Crest of Dam El. 529
4'
25'
4'-3"
23'
Plan of Pier
Pier 3'-7"
Crest
Construction Joint under Pier
Height of Crest above Top of Toe, 169'
Upper Inspection Gallery
Slope 2:3
4'
25'
Front Elevation of Piers and Roadway
Bonding Grooves
Joints not closer than 5'
60' Rad.
105.12'
Lower Gallery A
Lower Gallery B
Outlet Passage 5' Wide
Approx. Depth of Water on Toe, 1.5'
40'
About 15' in Center of Channel decreasing to 5' on Banks
Core 18" Holes, 10' C. to C.
Weight of Concrete = 162.5 lb. per cu. ft.
5'
Not less than 10' Deep
Grouted Drill Holes, 30' Deep, 10' C. to C.
Open Drill Holes, 40' deep, 10' C. to C.

FIG. 4. MAXIMUM SECTION, YADKIN NARROWS DAM

Unusual Features of Power Station

The power station, for many reasons, is one of the most interesting built in recent years. By generating at the transmission voltage (13,200) no station transformers are required, except for the building services. This greatly simplifies the switching layout, and the effect is increased by using outdoor type of main oil switches on a gallery outside the generating station. Fiber conduits carry the conductors from the generators to the oil-switch terminals.

The remarkably steady load to be furnished by the nearby aluminum works permits an efficient use of very large generating units—larger than is commonly desirable in general practice. Each turbine will develop 27,000 hp. at maximum efficiency and 31,000 hp. at full gate, so that in point of capacity these are the largest hydraulic turbines ever built. Each turbine drives an 18,000-kv.-a. 36-cycle 1,320-volt three-phase generator with its exciter on top. Aside from this they have points of interest in their mechanical design, notably the use of steel-plate scroll casing embedded in concrete and a scheme of dismantling the runner from below, as described more in detail in another article. The runner diameter is 108 in.; the speed, 154 r.p.m.; and the head, 165 to 180 ft. The casing inlet is 12 ft. in diameter, and a tapering thimble connects to the 15-ft. penstocks. The upper part of the draft tube is of cast iron and telescopes into the section below, which is molded in the concrete substructure. The draft tube is 11 ft. in diameter at the top, but immediately begins to flare; and it flattens as it makes the usual right-angle turn, the outlet being 32 ft. wide by 13 ft. 3 in. high.

Dismantling Turbine

One feature of particular interest is the method adopted for removing a turbine runner without disturbing its generator or dismantling much of the turbine itself. The upper section of the draft tube telescopes downward exposing the runner which can be lowered on a spider carried by a cable running up through the hollow turbine and generator shafts to the main station-crane hook. The runner, once clear of the shaft, is lowered upon a service car and shoved out through an adit between the draft-tube chamber and a longitudinal tunnel 11½ ft. wide and 8½ ft. high. Tracks in the latter allow the runner to be carried on a car to a hatch, up through which it is lifted by the main-station crane and carried to the railway connection in the south end of the building.

Above the runner-shifting tunnel is a second and smaller longitudinal tunnel (9 ft. wide and 10 ft. high) that serves two purposes. It gives access through a manhole to each turbine scroll case, and it also serves as the exhaust duct for the cooling air from the generators. Four 3x4-ft. passages come down from each generator into the tunnel. The tunnel terminates at each end in a vertical 11-ft. well whose top is outside the building. The generators are inclosed in air-tight sheet steel cases and act as their own fans, drawing cool air in from the generator room, which is replaced by air coming through the roof monitor, and forcing it through the tunnel and wells. The upstream air well can be protected from extreme high water by a timber and steel cover.

A control gallery, about 13x20 ft. in plan, projects out into the generator room from the east wall of the station. It is 10 ft. above the generator-room floor. From it, steps lead up to the switch-gallery door and down to the generator floor. A continuous steel platform runs from unit to unit at the control-gallery level and provides a walkway around each thrust bearing, so that attendants may pass from one machine to another without descending to the main floor. The generator-room floor will be of concrete, in 6-ft. squares with troweled joints.

The superstructure of the station is a steel frame with brick curtain walls rising 40 ft. above the substructure, which itself has foundation walls rising 18 ft. above the generator-room floor, to provide for flood conditions. The steelwork of this structure is material taken over from the original station superstructure, now dismantled. The columns have been reinforced with channels, etc. A pumphouse to supply the town and works with water, is located at

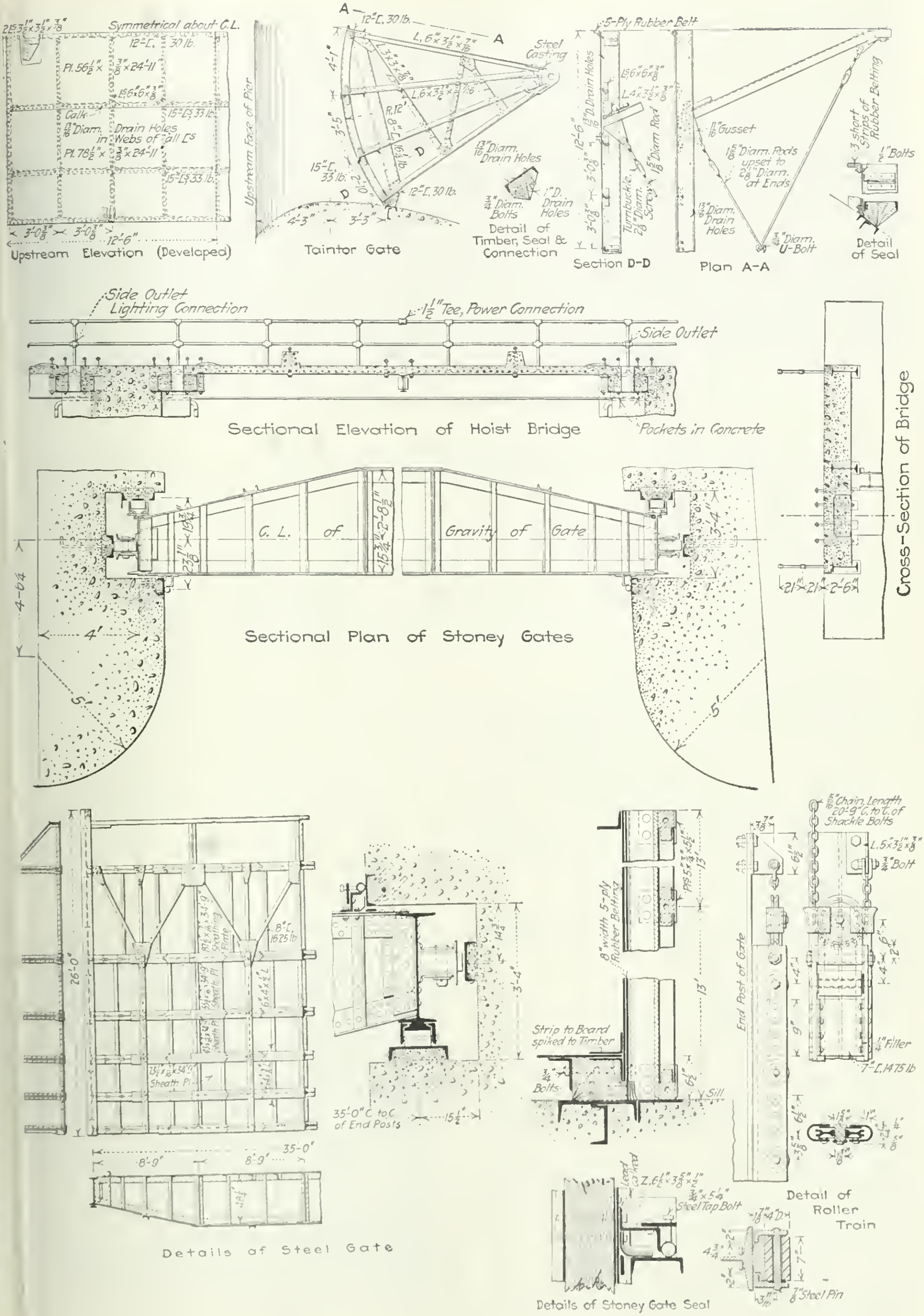


FIG. 5. DETAILS OF TAINTOR AND STONEY GATES, TALLASSEE POWER CO., YADKIN RIVER DEVELOPMENT

the south end of the building next to the air well. The power house is 213½ ft. long over all and 76 ft. wide. Under the railroad siding in the south end of the generator room are the lockers, shower, toilet and battery room.

The penstocks are 15 ft. in diameter and from 270 to 370 ft. long. They are made of steel plate, the thicknesses varying by 11 steps from ⅜ to ¾ in. They are anchored at the top in the dam and below this in the power-house substructure. In between they rest on steel saddles supported by concrete piers, and are free to slide as they expand or contract.

On the Contractor's End of the Yadkin Development

The most striking things about the Yadkin work, as a construction job, perhaps are the large number of unusually high, steel, guyed derricks used for handling material and the multiplication of railroad tracks to serve them. This arrangement affords not only great capacity, but almost complete flexibility also—blocking of one track or a delay or accident to one derrick reduces the capacity of the outfit only a little. This job illustrates the well-known practice of this contractor in the multiplication of derricks, which marks most of his work. There are in all 17 of these derricks—all built by the American Hoist and Derrick Co.—with 115-ft. steel masts and 100-ft. steel booms. One derrick has a lifting capacity of 50 tons; and the 46 others, 20 tons each. There is here used about 60 mi. of guy cable.

All the hoist-engine and swinging-gear units for thes derricks are alike—a somewhat special Lidgerwood outfit with 9x10-in. tandem engines, steel gears, extra-heavy swinging-gear drumshafts, and double brakes on both drums.

These engines have been adopted as standard by the contractor for his derrick work generally, as this simplifies maintenance, and has resulted in always having the enginemen familiar with every hoisting outfit on the job. The engines are run on compressed air supplied at 100 lb. gage. Each branch line to each engine from the distribution lines has a small iron coil inserted, and in this the enginemen keep a small wood fire on cold days and early mornings to prevent frost causing trouble in the engine exhaust.

There are two compressor plants on the work, housing electric-driven machines having a total capacity of 13,200 cu.ft. of free air. The main plant is located on the west bank, near the dam. A smaller plant is placed at one of the downstream quarries about a mile below the dam. Electric power for construction service is brought in by a transmission line tapping the system of the Southern Power Co.

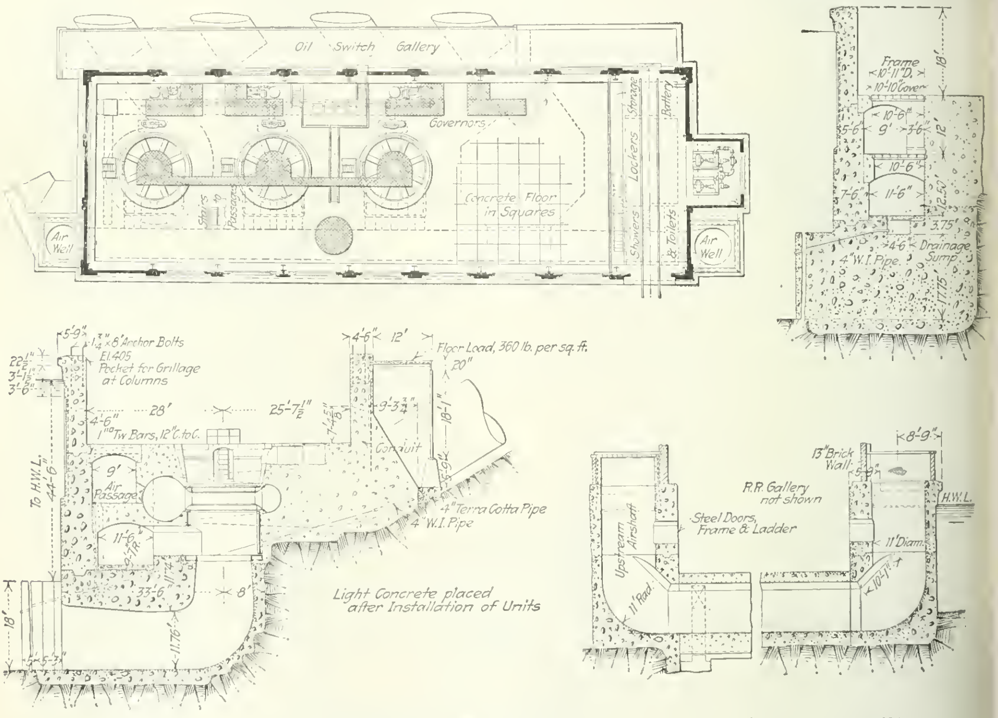


FIG. 6. PLAN OF YADKIN NARROWS POWER HOUSE, STANLEY COUNTY, NORTH CAROLINA

USE OF LARGEST MIXERS

This job is the one on which are used the largest concrete mixers yet built—two 4-yd. units built especially for this work by the T. L. Smith Co., as described in *Engineering News,* Apr. 6, 1916. Each drum is 9½ ft. in diameter and is supported on a structural-steel framing.

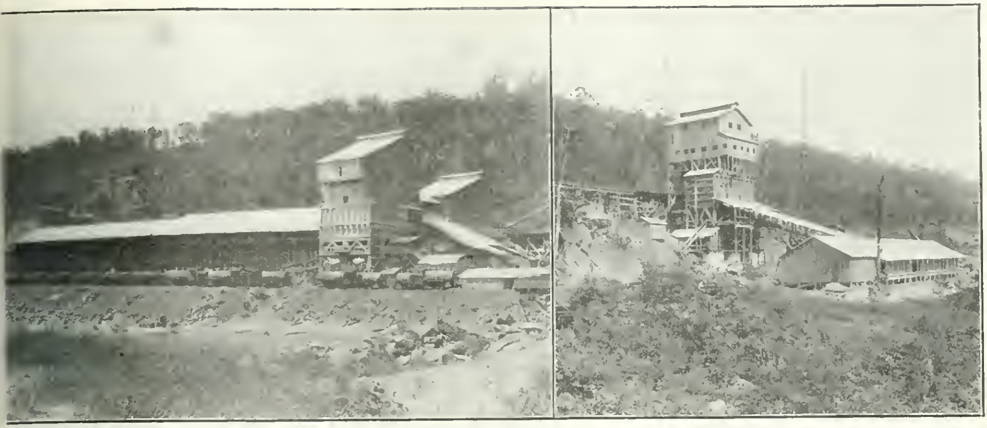


FIG. I. CRUSHING AND MIXING PLANTS OF THE HARDAWAY CONTRACTING CO. ON YADKIN RIVER WORK
Left—Upstream plant and cement storage. Right—Downstream plant

The great gain through the use of these mixers comes om the concentration of capacity in two working units stead of distributing it over four. The desire here was retain the simple plant with two mixers and one rail-ty track but turning out about 50% more concrete an the four-mixer two-track layout. The mixers are n on 3-yd. batches instead of being pushed to capacity. ere has been a gain by the concrete trains getting away icker, and the load being taken off quicker at the dam that the train can return sooner. The derricks also ve to make only two-thirds the number of movements place the concrete.

On this job there are two mixing plants, one upstream om the dam (four 2-yd. cube mixers, each pair dis-arging to separate tracks) and one downstream (with o 4-yd. mixers). The output of each has been about 80 cu.yd. on an ordinarily good day. The upstream ncreting plant has cement storage for 40,000 bbl. All nent is brought in sacks and chiefly from Southern lls. At the end of the cement shed is the crushing ant. Stone is brought in on tracks from upstream and sses in order through a 64x42-in. jaw crusher, a No. 10 ratory, four No. 6. gyratories, and then goes to a 2½-in. revolving screen. The rejections are returned to a pair of special No. 6's—fitted with No. 5 throws for finer crushing. A $\frac{5}{16}$-in. jacket on the screen takes out the sand, which goes with the material under $\frac{5}{16}$ in. from the first screens to the sand pile. Stone under 2½ in. is elevated to the mixing-plant bins. A No. 21 Gates gyratory is also installed for use in case the jaw or No. 10 is out of service because of repairs or otherwise.

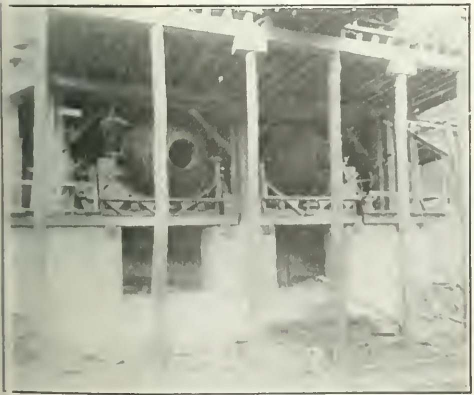


FIG. 2. THE TWO 4-YD. MIXERS INSTALLED ON YADKIN WORK

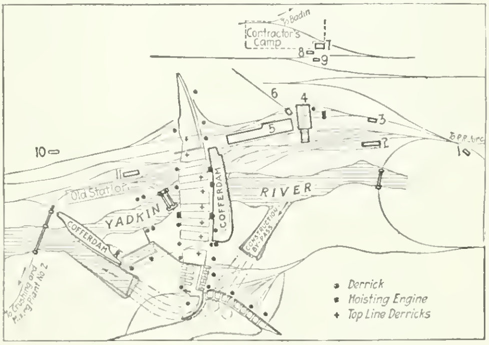


FIG. 3. LAYOUT OF HARDAWAY CONTRACTING PLANT BEFORE FLOODS

Not to scale. 1—Wood shop. 2 Machine shop. 3—Supply house. 4—Crushers and mixers. 5—Cement storage. 6 Sand conveyor. 7—Commissary. 8—Transformer house. 9—Compressor plant. 10—Tallassee Power Co., engineer's office. 11—Machine shop. Topline of derricks placed later.

The downstream mixing plant has but small cement storage, the shed serving more as a transfer depot between the car and mixer house, to which the cement is elevated on a belt conveyor. Stone is brought in from three downstream quarries and passes through an 84x60-in. jaw crusher, two No. 8's and then over 2½-in. screens. The stone between $\frac{5}{16}$ and 2½ in. going through is elevated to the bins, while the rejections go to two No. 6 gyratories and an elevator. A portion of the stone between $\frac{7}{16}$ and 1 in. goes to sand rolls and screens and finally to sand bins.

The sand used at both concrete mixing plants is washed Catawba River sand, mixed with 26 to 28% of crusher sand, the latter running from $\frac{5}{16}$-in. size to dust. This proportion is found to give the best grading of the sand for concrete work. The river sand is brought in on cars and dumped down the hillside to a belt elevator, 500 ft. long (descending and braked), which carries it farther down to the mixing plant. To avoid a higher trestle, the elevator belt is in two sections, the second ascending to the mixer house.

Daily tests of sand, cement and concrete are made in a well-equipped field laboratory. The cement tests, however, are few and only checks, as the cement is tested by an independent commercial-laboratory company before shipment.

At first a 1:3:5 mix was used; but as studies into sand, aggregates and concrete were continued, this was changed to 1:2½:5, which gives the best and strongest concrete. The concrete is unusually heavy, weighing 162½ lb. per cu.ft. This is due to the high specific gravity (2.92) of the local porphyry rock used as aggregate and crusher sand. About 25% of displacers are used in the concrete, these varying from 1 to 4 cu.yd. in size.

In excavating the porphyry, sharp shots of 60% nitroglycerin dynamite are used. The hardness of this rock causes heavy expense for maintenance of mixing machinery. Screens last only about two weeks; elevator-bucket bolt heads are cut off in about 10 days; mixer linings and sheet-steel plates last but little longer.

The contractor employs about 2,000 men, including 350 convicts, for whom the state is paid a specific sum per man (fixed by bidding) and provides quarters, meals, guards, etc. These convicts are engaged on quarrying, excavating and filling.

Three-room houses are provided for the married foremen, hoist enginemen and carpenters. Two-room houses are provided for the men who board at a mess hall run by the contractor for unmarried labor. Negro labor is taken care of in one-room houses. None of the men live in bunk houses. The contractor also maintains a large commissary store. The water for the camp is pumped from deep bored wells.

Floods Delay Work

The work of the contractor was interrupted in July, 1916, by the extreme high water in the Yadkin River prevailing at the time of the phenomenal rain in that region. The flow reached 160,000 sec.-ft. in round numbers, and the river rose above the tracks and coffer-dam. The end of the upstream coffer-dam was carried away by the flood, and its downstream side was damaged by the overflow. The downstream cover was very largely carried away, parts of the stone cribbing remaining, however. A portion of the outer wall of the old power-station substructure fell out, owing to the pressure of the wet fill inside. All the slabs, wells and tunnel on the dam were lost. Two derricks were carried away upstream at the face of the dam, and three downstream below the dam. Practically all the railway tracks for 300 ft. upstream of the dam and 600 ft. downstream were carried away.

In rebuilding the construction work, the coffer-dams were replaced upstream and downstream as before, and the upstream tracks were replaced in practically their original position.

Few of the downstream tracks were replaced, although without them only half the designed rate of progress in concreting could be secured. It would have taken so long to restore the lines that the concreting could be completed as quickly without them. The contractor therefore had to lose for about two months the extreme progress which he would have showed on the larger sections of the dam. This was perhaps the most serious effect of the flood.

Engineers and Contractors

The Tallassee Power Co., making this development, is a subsidiary of the Aluminum Co. of America. All the main works at Badin were designed under Edwin S. Fickes as Chief Engineer and G. F. Murphy as principal assistant. The complete plans for the electrical installation were elaborated by William Hoopes, Chief Electrical Engineer, and T. J. Bostwick, his principal assistant. The hydraulic development was designed by James W. Rickey, Chief Hydraulic Engineer, and C. B. Hawley, his principal assistant. J. E. S. Thorpe, as resident engineer for the power company, has charge of construction work at Badin. He is directly in charge of the work at the dam site. The work on the industrial plant and town of Badin is under the immediate supervision of R. R. Stevenson.

The Hardaway Contracting Co., of Columbus, Ga., is the contractor for all the work at the vicinity of the dam. The contract for the bypass excavation channel was sublet to Rinehart & Dennis, of Charlotteville, Va. The hydraulic turbines and related equipment were built by the Allis-Chalmers Manufacturing Co., of Milwaukee. The generators and exciters were from the General Electric Co., of Schenectady, N. Y.

Three 31,000-Hp. Turbines for Yadkin Plant

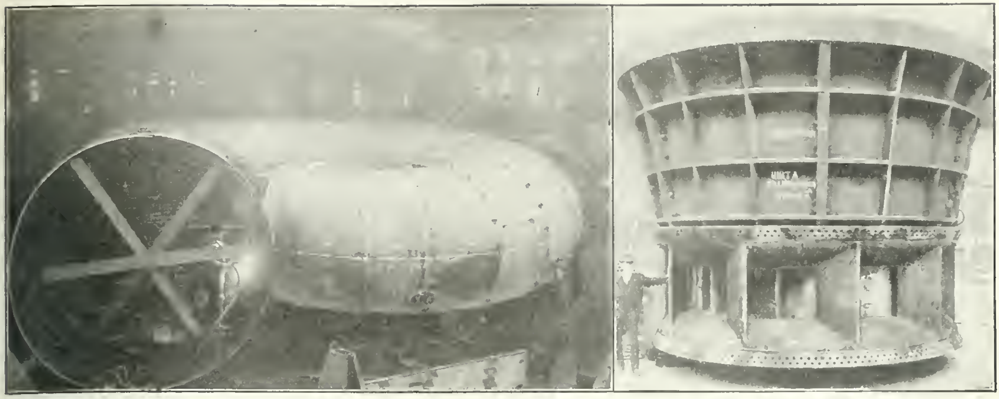
The three turbines built for the initial installation of the Tallassee Power Co. at its Yadkin River development in North Carolina (described in the preceding articles) are by far the largest single-runner Francis turbines yet built and show features of unusual interest and novelty, aside from size, particularly in the steel-plate spiral casing and the provision for dismantling the runner.

The spiral casing for each unit is of circular section and is made of shaped steel plates riveted together and to a cast-steel speed ring delivering the water to the guide vanes and runner.

Fig. 1 shows the casing practically assembled with the speed ring in the manufacturer's shop. The immensity of the casing can be realized from the size of the man inside the entrance. The casing is formed by about two dozen conical sections, each one matching into the other so as to form a continuous smooth passage. The thickness of the plate varies from $\frac{7}{8}$ in. at the large diameter to $\frac{7}{16}$ in. at the smallest diameter. This type of casing has been patented by the manufacturers; the design is simple and the cost very reasonable. With it a smooth interior is secured. The casing joints are beveled but the rivet heads are not countersunk—not being countersunk in the penstocks.

Shaft and Guide Bearings

The shaft of the turbine is 24 in. in diameter; that of the generator is about the same. The two shafts are joined by forged flanged couplings between the wheel-guide bearing and generator. The flanges are made of larger diameter than usual, and the bolts are much heav-



FIGS. 1 AND 2. STEEL-PLATE SPIRAL CASING, CAST-STEEL SPEED AND UPPER SUPPORTING RINGS OF 31,000-HP. TURBINES

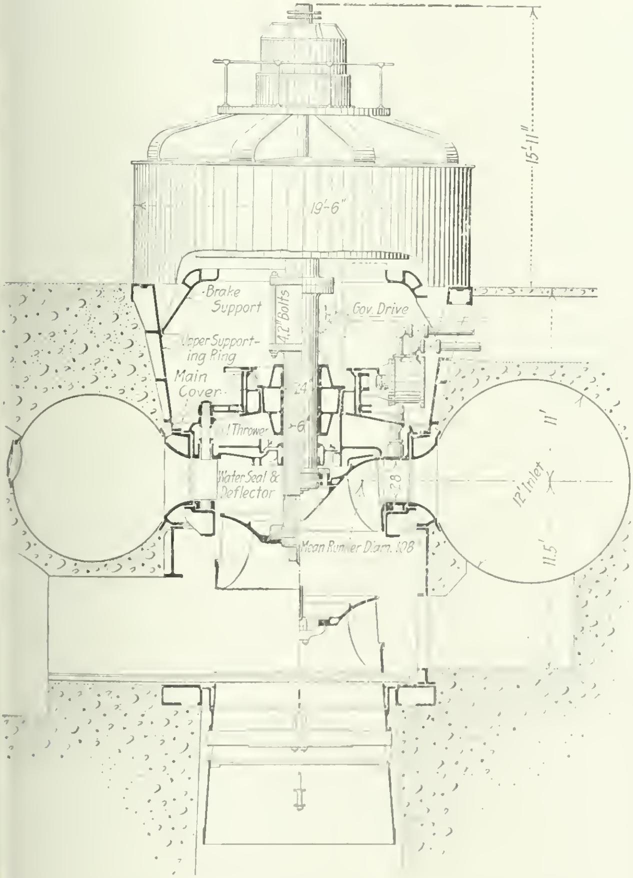


FIG. 3. SIMPLIFIED SECTION THROUGH TALLASSEE TURBINE UNIT, SHOWING SCHEME OF DISMANTLING RUNNER

ier than necessary to transmit the torque, the heavy bolting being necessary in order to make the shaft substantially as strong in bending at the flange as at other points. The shafts of both waterwheel and generator are hollow, to facilitate inspection of the forging and to permit handling the runner and upper section of the draft tube by means of a cable passing through the center of the shaft to the hook of the main station crane. The waterwheel and generator are designed as a mechanical unit, so that the lower guide bearing usually furnished with a generator is omitted; the machine, then, is what may be called a "two-guide-bearing unit." One guide is located above the rotor of the generator, immediately under the thrust bearing. The large guide bearing of the turbine serves as the lower guide bearing for the generator, as may be seen in Fig. 3. The guide bearing on the waterwheel is a babbitted casting with 18-in. shaft face, oil lubricated. It is supported in a conical seat of the main cover plate, which also carries the shifting ring and the guide-vane shafts. Oil is forced in through a pipe line and a flow meter is fed to the top of the guide bearing. The housing cover has an overflow pipe to the oil drain below the bearing. The oil is prevented from being drawn into the shaft tube by providing a large oil-throwing ring on the shaft between the lower end of the bearing and the oil drain. The elevation of the oil catcher from the turbine guide bearing is sufficiently high so that the oil drains horizontally over the top of the distributor plate and is led down through one of the vanes of the speed ring to a sump tank below the level of the spiral casing. A short pipe connection with union joints connects the oil passages in the main cover plate and the speed-ring casting, and between the speed ring and the sump. Below the oil thrower is a double water seal with air vent between, and grease-lubricated shaft rings.

The total weight of the revolving parts and the reaction thrust of the loaded runner are carried by a Kingsbury thrust bearing. The total weight of the various revolving parts is as follows:

Turbine shaft	18,000 lb
Runner	20,000 lb
Generator and exciter rotor	146,000 lb
Hydraulic thrust	60,000 lb.

The weights of the various stationary parts are as follows:

Stators and bridge	142,500 lb.
Upper supporting ring and brake ring	80,000 lb.
Spiral casing and cover plates	160,000 lb.
Lower supporting ring	40,000 lb.

The turbine runner, weighing 20,000 lb., is a single piece of solid bronze and is probably the largest casting of the kind ever made.

Each guide vane is supported upon an oil thrust bearing placed just underneath the guide-vane lever so as to maintain the guide vane in central position and avoid friction at each end of the vane. To keep the guide vane from bearing on the upper distributor ring, due to the water pressure in the casing, a collar is provided below the upper vane bearing. The connection between the guide-vane levers and the shifting ring is such that adjustment can be made on any vane that may have become distorted.

A brake support has been provided, consisting of a heavy cast cone fitted into the upper supporting ring between the waterwheel and the generator. This casting has openings permitting inspection of the windings on the rotor of the generator from the turbine pit. These openings, however, have sliding doors so that when they are closed the cone forms a partition between the generator and the wheel pit, preventing the hot air from the generator from being driven down into the turbine pit before it is led off to the exhaust tunnel in the station substructure.

The governor is essentially the standard design of the wheel manufacturer, in which fly-ball actuated valves control the admission and discharge of oil to two operating cylinders ("servomotors") that have piston rods running to the shifting ring.

Capacity and Efficiency

As the head available for the operation of these units will vary considerably, two guarantees of output at given heads were made. Each unit is designed to deliver to the generator shaft not less than 27,000 hp. when operating under an effective head of 165 ft. and running at a speed of 151 r.p.m. Under these conditions it is to develop an efficiency of not less than 90.5% (efficiency being defined as ratio of water horsepower delivered to the unit to mechanical horsepower output at the turbine shaft). Each unit also is guaranteed to deliver not less than 31,000 hp. operating under an effective head of 180 ft. and at 154 r.p.m. A 36-in. model runner was constructed and tested at Holyoke, having dimensions homologous to those of the large design. Extracts from the Holyoke tests are appended. An efficiency of practically 91% was shown, and it is expected that this will be exceeded in the large units by a wide margin.

HOLYOKE FLUME TESTS OF YADKIN TURBINES

(Extracts from report of tests of 36-in. R. H. Allis-Chalmers turbine wheel. Test 2446, made Mar. 18 and 20, 1916; swing gate, conical draft tube.)

Proportional Opening of Speed Gate, In.	Part Full Discharge	Head on Wheel, Ft.	Speed of Wheel, R.P.M	Relative Velocity Based on 36-In. Diameter	Water Discharged, Cu Ft. per Sec.	Power Developed, Hp.	Efficiency of Wheel, %
3 000	1 002	17 32	143 67	0 676	67 55	109 89	82 82
3 000	0 998	17 37	148 00	0 696	67 41	110 48	83 20
3 000	1 000	17 31	158 00	0 744	67 41	111 18	84 02
2 750	0 959	17 11	146 00	0 691	64 25	107 20	85 99
2 750	0 955	17 08	153 25	0 726	63 98	107 84	87 01
2 750	0 950	17 10	158 00	0 748	63 64	106 35	86 17
2 500	0 908	17 40	146 50	0 688	61 40	107 57	88 78
2 500	0 903	17 41	151 50	0 711	61 06	107 53	89 20
2 500	0 895	17 44	157 00	0 736	60 59	105 67	88 18
2 125	0 799	17 80	155 25	0 721	54 64	99 75	90 43
2 125	0 796	17 79	163 00	0 757	54 38	99 74	90 91
2 125	0 793	17 95	167 50	0 774	54 44	100 44	90 63
2 060	0 782	16 60	151 80	0 730	51 61	88 24	90 82
2 060	0 780	16 86	154 50	0 737	51 87	89 81	90 56
2 060	0 779	16 59	154 50	0 743	51 42	87 92	90 88
2 000	0 775	17 70	149 00	0 694	52 83	95 73	90 27
2 000	0 769	17 70	156 50	0 729	52 44	95 76	90 97
2 000	0 767	17 75	159 50	0 741	52 38	95 65	90 71
1 875	0 738	17 87	148 60	0 688	50 53	92 75	90 57
1 875	0 735	17 85	154 25	0 715	50 28	92 50	90 87
1 875	0 729	17 86	158 00	0 732	49 90	90 88	89 92
1 750	0 690	17 90	149 40	0 692	47 27	85.93	89 55
1.750	0 689	17 84	149 75	0 694	47 15	85 22	89 33
1.750	0 685	17 92	153 75	0 711	46 96	85 61	89 71
1.375	0 560	16 80	130 75	0 625	37 17	60 00	84 73
1.375	0 555	16 71	138 75	0 665	36 77	59 43	85 29
1 375	0 541	16 54	151 50	0 730	35 68	56 55	84 49
1 000	0 420	16 89	117 25	0 559	27 98	43 05	80 32
1 000	0 413	16 90	124 50	0 593	27 51	41 90	79 47
1 000	0 408	16 91	132 75	0 632	27 20	40 61	77 86

Turbine and dynamometer carried on ball bearings. Weight of dynamometer and that portion of shaft above lowest coupling, 2,600 lb. With flume empty a strain of 0.5 lb. applied at distance of 3.2 ft. from center of shaft sufficed to start wheel.

The generators for these units are 28-pole 13,200-volt machines rated at 18,000 kv.-a. They have, however, an overload guarantee of 22,500 kw. (at unity power factor). The efficiency at 18,000 kw. (unity power factor) is 96.9%. The stator is 19 ft. 6 in. in diameter, and the rotor 14 ft. 9 in. The rotor flywheel effect (WR^2) is approximately 4,000,000. The weight of the rotors given above includes that of the bridge between generator frame and exciter. The latter is a 72-kw. 250-volt machine.

These turbines were designed, built and installed by the Allis-Chalmers Manufacturing Co., of Milwaukee, under direction of W. M. White, Manager and Chief Engineer of the Hyrdaulic Department. The generators and exciters were furnished by the General Electric Co., of Schenectady, N. Y.

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A Water-Works Rate Decision holding that a dentist's revolving bowl is not a machine and that water supplied to it should be charged for under the domestic and not the industrial schedule has recently been handed down by the Westminster County Court, England. According to the London "Surveyor": "The plaintiffs were the Metropolitan Water Board, and they sought to recover £3, being the charge for six years at the rate of 10s. per annum, from a dentist for water used for alleged nondomestic purposes for a revolving bowl at the side of the patient's chair. Water was, of course, also used from this tap for washing out the mouth and the usual antiseptic purposes. The surgery formed part of the defendant's house, on which the ordinary domestic water rate was paid. The board claimed that this use of water was nondomestic under Sec. 25 of their Charges Act, 1907, on the ground that it was water used for working any machine or apparatus, and in addition or alternatively because it was water used for a trade, manufacture or business. The learned judge delivered a written judgment to the effect that, although the mechanical contrivance perhaps came within one of the dictionary meanings of machine, it was not, in his opinion, a machine within the meaning of the act, nor was the water used for the purpose of working it, the contrivance being used merely for sanitary reasons. On the second point he held that washing out the mouth was an ordinary domestic use of water, and that, although such use was ancillary to the defendant's business, which indeed could not be carried on without it, his honor found himself unable to distinguish the case from that very far-reaching decision of the House of Lords in the case of the Metropolitan Water Board vs. Avery, 1914, A.C., 118, and gave judgment for the defendant."

Change from Alum to Iron at Clarksburg Water Filters

By Perkins Boynton*

The substitution of sulphate of iron for aluminum sulphate at the filtration plant of the Clarksburg, W. Va., water-works has greatly reduced the war-time cost of coagulant and yielded some other noteworthy results.

The water-supply of Clarksburg is taken from the West Fork of the Monongahela River and is purified by coagulation and sedimentation, mechanical filtration, and sterilization by hypochlorite of lime. The plant was designed by George W. Fuller, of New York, and the filters were equipped by the New York Continental Jewell Filtration Co. The capacity of the filter plant is 3,000,000 gal. per day with four filters, a coagulating basin of 600,000 gal. and a clear-water well of 200,000 gal. The filter plant was put into operation in November, 1911 (the pumping station had been running since 1888), with sulphate of alumina as the coagulant and with the use of lime when necessary to increase the alkalinity of the river water. The river before reaching the water-works flows through a clayey, limestone region and is contaminated by mine wastes.

Last winter the greatly increased price of sulphate of alumina led the Water Works and Sewerage Board, under the advice of S. G. Highland, superintendent, and the writer to make a trial of sulphate of iron and lime to coagulate the water. The American Steel and Wire Co. through its Chicago office courteously supplied, free of charge, the sulphate of iron for the trial run and sent its representative, E. V. Wintzingerode, to assist the writer in the experimental work.

The original design of the filter plant does not include a mixing chamber, but provides that the chemicals be pumped into the low-lift line, carrying the water from the river to the coagulating basin, the lime entering the line about 50 ft. ahead of the alum. No trouble has ever been experienced in obtaining a good floc with alum. The same general plan, with the substitution of iron for the alum, also produces a good floc as soon as the water flows into the basin over the weir. A secondary treatment, with iron only, is possible just as the water enters the second half of the basin, so that any considerable amount of fine material passing through the first half of the basin is coagulated by this second dosage, sufficient lime being introduced into the water at the outset to allow for this.

During the two weeks of the trial run, there were several days of low turbidities (10 parts) and two periods of high turbidities, one including a turbidity of 1,500 parts. These covered all conditions, as far as turbidity was concerned, that had been met with heretofore. The smallest amount of iron used was 0.1 grain per gal. and the largest, 8.1 grains.

The conclusions drawn from the trial run were that a clear sparkling effluent can be obtained at all times, with original turbidities varying as stated, by the use of the same amount of iron as of alum. The results in the last six months have borne out this conclusion. The comparative costs of the two coagulants—iron, including the use of lime all the time, and alum, using lime when necessary—were \$5 and \$13 per million gallons.

Several interesting facts have been brought out since the use of iron and lime was begun. When the first water treated with iron and lime reached the filters, the loss-of-head gages began to show a decrease in the loss of head instead of an increase. The curve continued to drop for two or three hours and recorded a loss of head from 1 to 1½ ft. less than when the drop began, then began to rise normally again. This was explained as follows: The filters were saturated with free CO_2, although never having shown that they were "bound" by it; and this CO_2 was absorbed by the normal carbonates in the water, 10 to 20 parts of phenol alkalinity being carried by the water upon reaching the filters.

The fact that the filters were impregnated with CO_2 leads to the statement of another item of interest, indirectly the result of using iron and lime. At times the water in the river reaches the plant with a turbidity of 5 or less, an alkalinity approaching 0, sometimes with a slight acidity, a CO_2 as high as 30 parts and magnesium, 17 to 21 parts. At such times the lime added to produce normal carbonates in the water to prevent the solution of the iron throws out the magnesium in sufficient quantity to act as a coagulant for the low turbidity and permits the supply of iron being cut out entirely.

Since beginning the use of iron and lime the quantity of hypochlorite of lime required to kill B. coli in the filtered water has been increased from 5 to 6 lb. to 8 to 10 lb. per million gallons. This is in accord with the theory that a longer time is necessary for a given quantity of hypo to act in a water free from CO_2 than in one with CO_2 present. In order to obtain negative results in testing for B. coli in the water leaving the plant, more hypo is required to complete the germicidal action with a water freed of CO_2 than formerly with CO_2 present, using alum.

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*Chemist-in-Charge, Clarksburg Water-Works, Clarksburg, W. Va.

Concrete Barges Stand Test

Two concrete barges or pontoons in service at Balboa on the Panama Canal recently passed through a successful service test, according to the *Panama Canal Record*. They were rectangular pontoons, 120 ft. long by 28 ft. wide by 8 ft. deep, with bottom, sides and deck of reinforced concrete. They were built to be used as landing stages for boats up to 65 ft. in length. The concrete in each is about 186 cu.yd. Buffer timbers were affixed at the ends and sides by means of anchor bolts.

At the time of the blowing up of the coffer-dam behind which the pontoons were built the surface of the water in the entrance basin was about 15 ft. below the mean tide level. The gap made by the explosion did not allow the water to pour in from the sea until the tide rose. The stream which broke over the dam at high tide cut an increasing channel in the earth, resulting in a strong inrushing current sufficient to make the barges part their moorings and circle about the basin. In so doing one of them struck a fender pile and broke it at a point about 20 ft. below the butt, where its diameter was about 12 in. The barge groaned under the impact, and one of the end timbers was sheared off, dragging its anchor bolts through the concrete and causing it to crack. This damage was above the water line. In other respects the pontoon was uninjured. The two pontoons collided once in their course around the basin, but this did no damage to either.

Both pontoons have been in regular use since that time as landings, and are standing the service well.

A 30-Mile Railway Tunnel Under the Cascade Mountains

By H. M. Chittenden*

SYNOPSIS—The longest railway tunnel ever projected is that proposed by the author of this article to carry railway traffic under the high mountain wall of the Cascades, which divides eastern and western Washington. The engineering problem as to whether such a tunnel would be a paying enterprise or not requires for its solution data on the cost of tunneling and shaft sinking and on the cost of railway-train movement on mountain lines and in tunnels. These data are given in the paper. General Chittenden was, when on the active line, one of the best-known officers of the Corps of Engineers. Through his service as Chairman of the Seattle Port Commission since his retirement from active service in the army, he has been brought in contact with traffic conditions in the Northwest. His project for the tunnel will receive the careful attention of the profession, not only because of its magnitude, but because at various other points in the United States, projects for long tunnels to carry railways under high mountain ranges are under consideration.

Puget Sound is one of the best terminals for ocean traffic in the world. On the Pacific Coast of the United States, where safe harbors are so few, Puget Sound is an asset of enormous value to the country's trade. But on its eastward side the Sound is hemmed in by the high mountain wall of the Cascades. The lowest passes across this great barrier are more than 3,000 ft. high, and in the more severe storms of the winter they become practically impassable.

In the past ten years there have been three winters in which rail traffic across the Cascade Mountains in Washington has been completely stopped for periods of from one to three weeks. There have been several other winters in which the interruptions, though less complete, have been serious. There have been only two or three winters in which approximately normal traffic conditions have been maintained throughout. During the past decade there have been some grave accidents with heavy loss of life, and there has been a prodigious financial loss to the railroads and the community. Last winter some of the worst storms on record visited the State of Washington, and the accidents, loss and inconvenience have again forced upon public attention the serious meaning of the Cascades problem. What this Cascades barrier means to the future development of Puget Sound and its usefulness as a seaport for the rest of the country may be estimated by imagining what such a barrier would have meant to the Port of New York, if Nature had planted a high mountain range entirely around that port from New Haven to Philadelphia.

Railroad enterprise has indeed done much toward overcoming this great handicap. Equal terminal rates place Puget Sound, in a certain sense, on a par with its great commercial rival, Portland, at the mouth of the Columbia, from which a water-grade route extends up the valley of the Columbia to the interior; but so long as the present high crossings are maintained, it will never be possible to eliminate the waste of energy involved in the half-mile vertical lift over the range; nor the delays, dangers and enormous maintenance cost due to heavy gradients, excessive curvature and to winter conditions.

A Tunnel Project

The problem as it presented itself to the writer ten years ago was: Can a route be found on which a tunnel may be built under the Cascades, at an elevation low enough to eliminate the worst grades and practically all the winter difficulties of the present crossings?

The destructive floods of November, 1906, first drew the writer's attention definitely to this subject, and in the course of the next two years he gave it a great deal of study. The Cascade Range had been thoroughly explored throughout its length, and the best passes had already been occupied. With the limited traffic of a new country, the railroads in their pioneer work could not afford long tunnels. The three so far built are, in the chronological order of construction: The Stampede tunnel (Northern Pacific), length 9,834 ft., elevation above sea level, 2,83 ft.; the Cascade tunnel (Great Northern), length 13,500 ft., elevation 3,375 ft.; and the Snoqualmie Pass tunnel

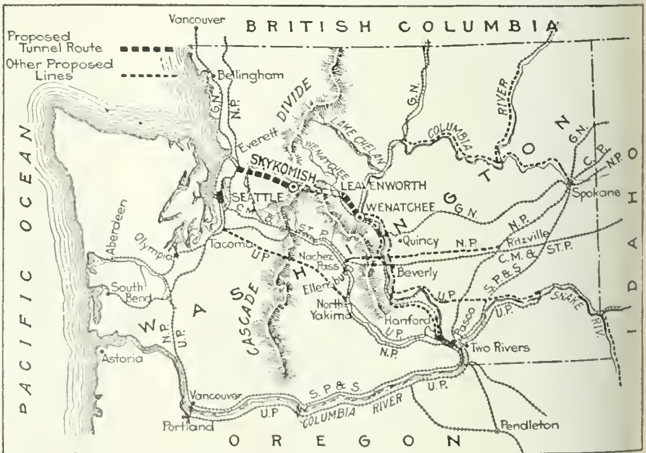

FIG. 1. SKETCH MAP, SHOWING THE RELATION OF PROJECTED TUNNEL ROUTE TO EXISTING RAILWAY LINES IN WASHINGTON

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*Brigadier-General, U. S. A. (retired), 2010 Broadway, N., Seattle, Wash.

(Chicago. Milwaukee & St. Paul), length 11,890 ft., elevation, 2,560 ft. The gradients on the approaches to these tunnels range from 1% to 2.2% over distances varying from 10 to 30 mi.

As will be seen from these figures, the tunnels simply pierce the thin comb of the ridge, leaving the approaches or long distances supported upon precipitous mountain slopes with excessive gradients and subject to the dangers nseparable from such situations. It was manifest that no substantial relief from existing conditions was possible except by building much longer tunnels—three or four imes as long at the very least; and it was equally maniest that the railways individually could not go to this xpense unless driven to it by dire necessity.

This consideration suggested a combination by which he roads might jointly build a low-grade route between he Columbia River and the Sound. If such a route could be located where it would be conveniently available to the everal lines, a large expense might be incurred without nduly burdening any single company.

The Most Feasible Route

Starting on this theory of a Puget Sound terminal ailway, the writer carefully studied existing data for a ossible location. It was a simple matter to demonstrate hat there was but one such, but it was an unexpected atisfaction to find that this one would serve the through raffic of all the roads as well as, and some far better han, the present lines. This location is at the point where he Columbia River, in its great southern swing through he State of Washington on the eastern side of the Cascades, comes nearest Puget Sound—namely, at the mouth f the Wenatchee River. The distance between tidewater t Everett or Seattle and the Columbia at Wenatchee elevation about 600 ft.) is barely 90 mi. The valleys of he Wenatchee (east side) and Skykomish (west side) re almost in direct line with each other and lead by posble gradients not exceeding 0.6% to points separated by distance of only about 30 mi.

At no other point in the entire range could so favorable situation be found that would be available to all the oads. The trend of the Columbia Valley from the Snake River to Wenatchee is westward and would lead the Northern Pacific and the Union Pacific to Puget Sound by as short or shorter routes than by their present lines. This may at first thought seem doubtful, but the map shows it to be true. It is interesting to notice how little this route from the mouth of the Snake to Everett on Puget Sound varies from a straight line. Table 1 and the accompanying profiles exhibit the distance and gradient relations of the proposed and existing routes.

First Presentation of the Project

Having demonstrated the very advantageous distance and grade relations of the new route and its availability for every Eastern line that now reaches Puget Sound or ever will, the writer proceeded to consider what to do with the 30-mi. obstacle which stood in the way of so desirable a consummation. It was at this point that he placed his professional reputation in jeopardy by suggesting that the whole distance be covered by a tunnel. The radical thoroughness of this solution of the problem, made possible by topographical conditions unparalleled in any other situation within the writer's knowledge, appealed to him very strongly. The project, once carried out, would be in every respect as advantageous as if the Columbia River itself had pierced the range at this point. Far to the south its course to the sea is through a defile nearly 200 mi. long. Here the short distance of 80 to 90 mi. would accomplish an even greater transition, for it would connect the interior with maritime facilities of the finest inland roadstead in the world.

The scheme was set forth by the writer in 1909 in a pamphlet, which considered the subject in all its phases. Its reception showed how local prejudice may prevent honest consideration of even the most important enterprises.

The Portland newspapers gave an elaborate review of the pamphlet, because it showed how dire were the straits in which Seattle admitted herself to be and from which she could never expect relief because, of course, the tunnel scheme was utterly visionary! The Seattle papers gave the project short shrift, dismissing it contemptuously and in hot anger that one of her citizens should *admit* that Puget Sound was laboring under any handicap com-

TABLE 1. TRAFFIC RELATIONS OF PROPOSED CASCADES TUNNEL ROUTE

Name of Railroad	Differences in Distance by Present and Proposed Routes Between Columbia River and Four Principal Ports on Puget Sound, Mi.*				Saving in Vertical Lift, Ft.	Location of Columbia Crossing
	Tacoma	Seattle	Everett	Bellingham		
orthern Pacific (present route)..	—45	—14	+39	+39	1,693	Pasco, just above Snake River
orthern Pacific†	+45	+76	+129	+129	1,693	Eight miles above Beverly
nion Pacific (via Portland)‡.....	+69	+136	+188	+188	No material difference	Two Rivers, just below Snake River
icago, Milwaukee & St. Paul§...	—46	—28	+26	+26	2,255	Beverly
eat Northern‖	+48	+37	+23	+23	2,166	Wenatchee

* + indicates saving by new route; — indicates loss. †Should the tunnel project ever become a reality, the Northern acific would extend its proposed Ellensburg cutoff (already begun) to the Columbia only and build thence to the new ute at Wenatchee. The second group of distance relations in the table is figured on this assumption, and the initial point taken at Ritzville, where the line leaves the present line of the Northern Pacific. Possibly a better route would be across e plain of the well-known Quincy Valley in a northwest direction, reaching the Columbia at about the same point that e Great Northern does, thus still further shortening the distance to Puget Sound. If that remarkable region—the uincy Valley—is ever brought under irrigation, its enormous resources will produce a traffic that will be sought by all the ilroads. ‡The distance relations of the Union Pacific have been figured from the mouth of Snake River, as the most ntral point of the activities of that system in the region round about. For traffic going southeast over the Blue ountains, Pendleton would be the point to estimate from and the figures in the table should be reduced about 40 mi. The nion Pacific has also considered extending its Yakima Valley branch across Nachez Pass to Puget Sound. In that case the stance and gradient relations would be comparable to the first group in the table for the Northern Pacific, but even ore favorable to the proposed tunnel route. §The Milwaukee crosses the Columbia about halfway between Pasco (where e Northern Pacific crosses) and Wenatchee, and the Northern Pacific, as already stated, has begun a parallel line a little orth of the Milwaukee in order to shorten by something like 80 mi. its present roundabout route between Spokane and attle. Both these routes, immediately after crossing the Columbia, encounter natural obstacles second in magnitude ly to those in the Cascades. The Saddle Mountain ridge lies between the Columbia and Ellensburg, involving very avy work, gradients of 2% and a long tunnel. The Wenatchee line would save all this as well as the high Cascade crossings. e "North Bank" route from Pasco to Puget Sound via Vancouver, Wash., is closely comparable with the Union Pacific, far as the data in the table are concerned. The Canadian Pacific has long sought an entrance into Seattle. It now erates into that city over the Northern Pacific from Sumas. It also operates into Spokane from Dunmore Junction. If it ere to extend its Spokane connection to Wenatchee and utilize the tunnel route, it would save fully 125 mi. of distance and 700 ft. of vertical lift. This would be a great saving in freight, a matter of no little importance in connection with e grain export trade and shipments eastward of timber and fish products. Passenger traffic would make only a limited use the line, because that is controlled largely by the scenic attractions of the Canadian Pacific west of Dunmore. ‖The stance figures for the Great Northern are based upon the assumption that a crosscut to Seattle will be built instead going around by Everett, as at present, and that the Tacoma connection will be via the east shore of Lake ashington instead of through Seattle.

mercially as compared with Portland! In engineering and railroad circles the scheme was looked at askance, though there were many who referred to it as only a little in advance of its time and certain of ultimate realization.

The idea quickly dropped out of sight until the winter of 1910, when a disastrous tie-up occurred on all the lines and with it the appalling accident at Wellington on the Great Northern Ry. in which a passenger train was swept down the mountain side by an avalanche and most of the passengers killed. This brought the tunnel scheme into great prominence and general favor, and it was seriously proposed to take the matter to the state legislature. Upon the advice of the writer this was not done, as he considered such action at the time premature.

As always happens after great disasters, public interest in remedial measures waned rapidly with the lapse of time. The Great Northern, however, was faced with a situation that it had to meet at once, and this it proceeded to do by the erection of the most elaborate system of concrete snowsheds ever constructed. The cost has been very heavy.[1] No serious conditions arose thereafter until the past winter, when former experiences were gone through with, including even the avalanching of a passenger train on the Great Northern with serious loss of life, and a narrow escape from a similar accident on the Northern Pacific. It was reported in the press that the State Railway Commission had threatened to take a hand and compel the Great Northern Ry. to lower its tunnel.[2] The whole subject is thus revived again and every such revival serves to accentuate the necessity of definite action for the radical improvement of existing conditions.

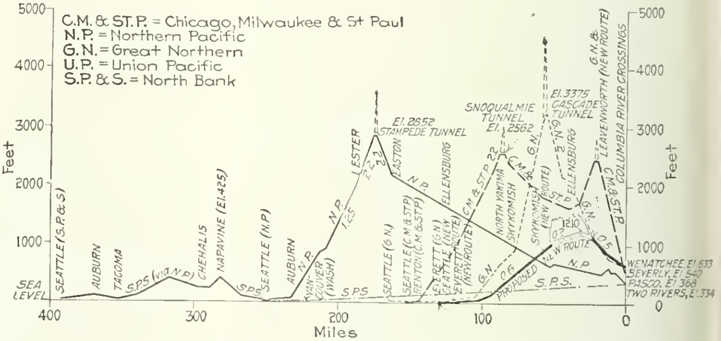

FIG. 2. PROFILES OF EXISTING RAILROAD LINES CROSSING THE CASCADE MOUNTAINS, AND OF PROPOSED 30-MI. TUNNEL LINE UNDER THE RANGE

With the foregoing general statement of the problem, let us examine in detail its technical and economic features. It may be stated at once that the technical problem presents nothing which should seriously challenge the resources of the engineering profession. The only feature that would establish a precedent would be the length, which would be nearly three times as great as that of any railway tunnel yet built.

The nearest approach is in the Alps, where there are five tunnels—Mont Cenis, 8 mi.; Saint Gothard, 9.3 mi.; Arlberg, 6.5 mi.; Simplon, 12.3 mi.; and Loetschberg, 9 mi.—the aggregate length of the three longer being just the same as that of the proposed Cascades tunnel. There are many railway tunnels in various parts of the world ranging from 2 to 7 mi. in length. The Catskill Aqueduct for the New York water-supply is 120 mi. in length, of which 49 mi. was driven in tunnel.

Some of the Alpine tunnels developed obstacles much more serious than any which it is believed will be encountered here. The Cascades rock is mainly granite, with some schist at the western end and possibly a short stretch of sandstone about midway. (The geology along most of the line has not been developed, and these conclusions are based upon the geology along the Great Northern.) It is not likely that serious difficulty will be encountered from excessive heat, the sole surface indication being a warm spring on the Great Northern, 3 mi. north of the line and at elevation 2,200, with a temperature of 130° F. No trouble from this cause was experienced in any of the three tunnels already built through the Cascades. The Cascade granites carry more or less water, but not in troublesome quantities, judging from experience on the Great Northern tunnel.

If the tunnel were to be excavated only from the ends, a summit level about midway would facilitate drainage during construction. If shafts were to be used, this would not make much difference, unless one of the shafts were utilized to develop the water power of Icicle Creek. In that case the outflow would have to be to the east, because the irrigation districts of the east slope would not permit any of their water resources to be diverted to the west side, and the slope from the power shaft eastward would have to be sufficient to carry off the water. On the accompanying profile (Fig. 3) a summit is shown about 3 mi. west of the lower Icicle Creek shaft, with an elevation of 1,210 ft.

Rate of Progress and Cost

The cost of the work as affected by interest charges during construction is so dependent upon the rate of progress that both matters will be considered together in this division of the subject.

In the matter of progress in tunnel building there has been continuous improvement since the first long Alpine tunnel was built. This is well shown in the following table:

ALPINE TUNNELS

Name of Tunnel	Date	Length, Mi.	Rate of Progress, Ft. per Day
Mont Cenis	1857-71	7.5	7.75
St. Gothard	1872-81	9.5	18.00
Arlberg	1880-84	6.5	27.25
Simplon	1893-99	12.25	36.00
Loetschberg	1906-11	9.00	36.00

The Rogers Pass tunnel, now nearing completion, is a double-track tunnel nearly 5 mi. long through the Selkirk Range on the Canadian Pacific Ry. Progress has been made at a rate of 3.6 mi. per year, or about 52 ft. per day. As an example of rapid work on a small tunnel (about 12 ft. wide and 13.5 ft. high), we may cite the Pirahy tunnel in Brazil, in which 27,657 ft. length was driven in 489 days, or 56 ft. per day. This work was done under great pressure for time and with the inducement of a liberal bonus. Several shafts were sunk to facilitate progress.[3]

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[1] The outlay by the Great Northern since 1910, including work now ordered, amounts to about $6,000,000 expended in snowsheds, tunnels and realignment. What the cost of accidents has been the writer does not know, but it must have been heavy.

[2] The chairman of the Public Service Commission has since informed the writer that the commission has compromised with the company on concrete snowsheds, their location and sufficiency to be approved by the commission's engineer.

Upon the whole, the Rogers Pass experience seems most applicable to our present estimates. The extraordinary record made was due to a favorable rock and to the use of the comparatively new method of driving a small auxiliary tunnel in advance of and at one side of the main bore, from which cross-galleries were run and additional headings opened up. Undoubtedly the same expedient would be applied to the much larger work here considered.

In the estimates for the Cascades tunnel the following dimensions for the cross-section of the tunnel have been assumed: Width, 30 ft.; height at center, 25.5 ft.; height over outer rail, 22.5 ft.; net cross-sectional area (after lining), about 650 sq.ft.; gross area in excavation, about 850 sq.ft.

SINKING INTERMEDIATE SHAFTS

The great length of the tunnel naturally suggests resort to intermediate shafts in order to facilitate progress. The question of their use turns mainly upon their effect in shortening time of completion and thereby saving interest and hastening the period when the work may become revenue producing. These shafts would be expensive, about $100 per foot depth for a deep shaft of, say, four compartments (about 250 sq.ft. cross-section) and would take considerable time to construct, 100 ft. per month being standard experience.[4] Four possible locations are indicated on the profile (Fig. 3). In analyzing their probable value in expediting the work and reducing interest charges a somewhat higher rate of cost than previously indicated has been assumed—namely, for the lower Icicle Creek shaft (1,100 ft. deep), $150,000; for the Middle Icicle and Deception Creek shafts (1,700 and 1,860 ft. respectively), $250,000; and the upper Icicle shaft (2,320 ft.), $350,000. The estimated effect of these shafts in reducing time and cost is shown in Table 2.

VENTILATION AND WATER-POWER DEVELOPMENT

The pioneer tunnel and the several shafts would be of great value in the subsequent operation of the tunnel. While ventilation with electric-train operation is not a difficult problem, still it would be materially simplified by the auxiliary tunnel and the shafts. High-speed operation of trains would be essential, and the air pressures would be lessened by frequent connections with the side tunnel, while the shafts would have a similar effect and would promote frequent complete changes of air.

Two of the construction shafts could be cheaply utilized for the development of power. Icicle Creek has a dependable low-water flow at the site of the lower shaft of over 50 sec.-ft. The head at the shaft exceeds 1,000 ft. Corresponding data for Deception Creek are 20 and 1,850. In addition to these shafts, designed primarily for construction purposes, a small one for power only could be let down from the Wenatchee River. The head would be a little over 200 ft., and the dependable low-water flow in excess of 500 sec.-ft. These figures indicate a possible aggregate development of 21,300 hp. theoretical. The water would be disposed of through the auxiliary tunnel and would require but a small percentage of its space, except from the Wenatchee shaft outward, where it would require practically all. With any reasonable assumption as to volume of traffic, this power ought to operate the entire line from Wenatchee to near Monroe, with sufficient surplus to ventilate and light the tunnel. That is to say, the tunnel itself, by the mere fact of its construction, would create power not otherwise available sufficient to operate the entire terminal system here considered.

COMPUTING RATE OF PROGRESS

At Rogers Pass, as already stated, a rate of progress of 3.6 mi. a year was attained, or a mean of 1.8 mi. from each end. In the estimates from which Table 2 is made up, it is assumed that 1.6 mi. per year could be maintained from each portal and 1.4 mi. each way from each shaft. It is assumed that the widening for necessary sidetracks would be equivalent to 1.2 mi. of full tunnel section, thus making an equivalent total length of 32 mi. If shafts were used, the time would be controlled by the longest subdivision and by the rates of progress at its two ends. Thus, with no shaft, the length would be 32 mi. and the annual rate 3.2 mi.; with one shaft, the controlling section would be 17.4 mi. and the rate 3 mi.; with two shafts, these figures would be 11.4 and 3 respectively; with three shafts, 11.2 and 2.8; and with four shafts, 7.5 and 3. It is assumed that two full years would be consumed in installation of plant, including shafts, and in getting well started; 12 months in getting the tunnel into operation after the main bore is holed through. The times of completion under these assumptions are shown in Table 2.

In arriving at an estimate of cost the writer has relied largely on the Rogers Pass experience, but has consulted other work and authorities as well. He believes that the following unit prices are conservative, if the tunnel is driven from the ends only:

	Per Lin.Ft
Plant (except shafts)	$5
Excavation of bore	120
Lining tunnel	75
Tracks and equipment	5
Surveys and miscellaneous	5
Total	$210

It is assumed that the item for excavation from the shaft headings will be $5 greater than given in the preceding tabulation, this increase to cover the extra cost of removing muck and water through the shafts.

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[3] "Engineering News," May 18, 1916, p. 921.

[4] The Woodbury shaft now being sunk in the Lake Superior ining region has already reached a depth practically the ame as that of the deepest shaft here proposed. The rock is uartzite and granite. There is but little water. The net mensions in cross-section are 13 ft. 1 in. by 21 ft. 1 in. The ross dimensions in excavation are about 15x23 ft. The shaft as sunk 2,180 ft. in the period from Mar. 1, 1915, to Mar. 1, 16, or at an average monthly rate of 182 ft. The average st, including everything complete, has been $102.30 per lin.ft. he shafts herein proposed would not be quite so large as the oodbury shaft and would probably cost no more per unit of pth. Our estimate, both as to time and cost, would there- re seem to have a margin of safety of 50%. The cost of aft operation in the Lake Superior region is about 8c. per n of material hoisted. Assuming a figure of 10c. in the case re considered, headings of 850 sq.ft. and a weight of rock 170 lb. per cu.ft., the cost of the hoisting would be about .20 per lin.ft. of tunnel. Offsetting this by the cost of moval of the material by way of the portals, if the tunnel ere excavated without shafts, the additional cost by the use shafts, assumed in this article as $5 per lin.ft., would em to be about right.

With the foregoing assumptions, with an interest rate of 6% and an interest period equal to half the period of construction, the details as to costs and times are shown in Table 2. The second column includes the increased plant cost of shaft installation as already given and the extra cost of $5 per ft. for removing muck and water by the shafts.

TABLE 2. TIME REQUIRED FOR COMPLETION AND COST OF CASCADES TUNNEL

Scheme	Cost	Time, Yr.	Interest	Total
No shafts	$35,481,000	13.0	$13,837,000	$49,318,000
One shaft	36,127,000	9.0	9,754,000	45,881,000
Two shafts	36,429,000	8.0	8,743,000	45,172,000
Three shafts	36,659,000	7.0	7,698,000	44,357,000
Four shafts	37,114,000	5.5	6,123,000	43,237,000

A. C. Dennis, Superintendent for the contractors on the Rogers Pass tunnel, to whom the writer referred these estimates, expresses some doubt as to the practicability of securing this efficiency from the shafts. He is inclined to favor doing the whole work from the portals only, or at least using only the one shaft nearest midway of the tunnel. In this connection he made the following observation in a letter to the writer:

> Under normal rock and water conditions this tunnel can be finished ready for operation, working from the portals only, in nine years. With a bonus, or forfeit claim based on nine years' time limit, I am satisfied that this work can be let for $33,000,000, to cover every expense in connection with the work until ready for operation and with an additional reduction of $70 per ft. for any unconcreted section.

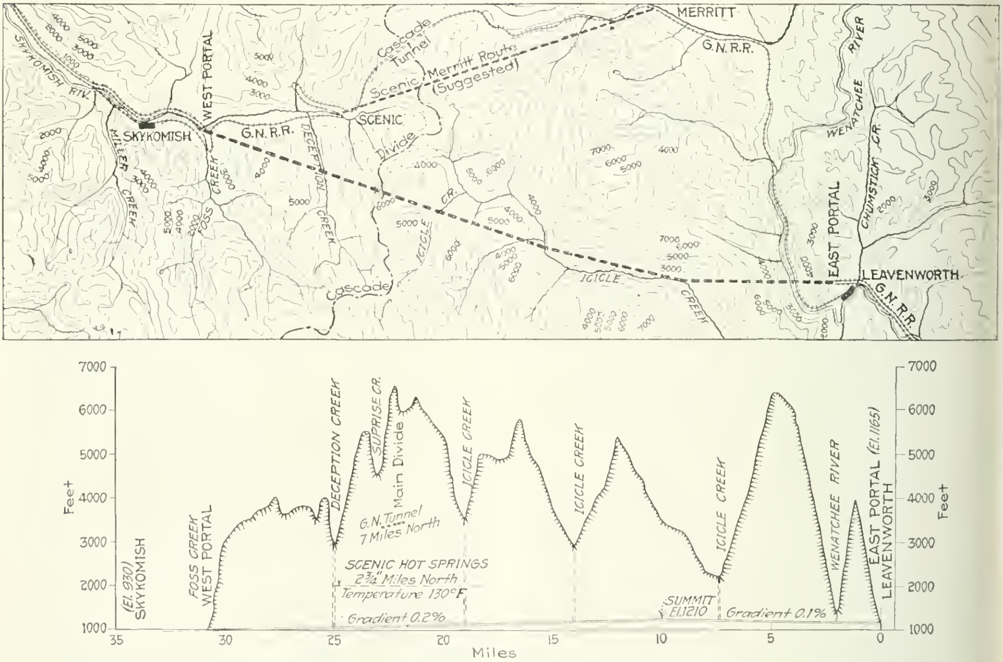

FIG. 3. MAP AND PROFILE OF PROPOSED 30-MI. RAILWAY TUNNEL AND APPROACHES UNDER THE CASCADE MOUNTAINS

The costs as given in Table 2 pertain to the tunnel only. To make this work properly available by giving unrestricted access to all railway lines, the system should be extended on both sides to the natural points of divergence, say to Wenatchee on the east side and to some point near Monroe on the west. This would add probably 50 mi. of open-country double track, which we will estimate at $4,000,000. A more complete system would result if it were extended into Everett, Seattle and along the east shore of Lake Washington to Renton, from which point all lines are available to Tacoma. Doubtless this would be the ultimate outcome.

It may be objected that this route would be practically available to only one of the railroads entering the Puget Sound country—namely, the Great Northern, which lies directly on the route of the tunnel. The answer is that, long before such a work could be carried to completion, the development of the Columbia Valley will have brought the other lines as far north as Wenatchee for local traffic only.

The Economic Problem

We come finally to the crucial test that any project of this character must pass before it can commend itself to the favorable judgment of practical men. As an economic proposition, will it pay? To answer this question as we should like to answer it would require definite data concerning the traffic movements across the Cascade Range and the saving on that portion which could advantageously use the new route; the saving in future maintenance and construction cost to the several lines affected; the saving to the railways by avoidance of delays, interruption of traffic and losses from accident; and finally the advantage to the public in different ways.

It is manifest that a complete analysis of the problem on this comprehensive basis is a practical impossibility. The records of the railroads are not kept in form to furnish the precise information necessary. The cost of freight movement is so intimately dependent upon its volume that conclusions based upon a particular example might be quite inapplicable to any other. Then, the effect upon the public interest is never made a matter of record—in fact, could not be—and therefore the public advantage of the new route, though certainly very great, cannot be computed in definite terms.

The best we can do as to the several railroads is to show for each the difference of conditions between present service and that by the proposed route, and then make the best assumptions we can as to the saving due to this difference. It is manifest that the advantage to some would be greater than to others, even for the same volume of traffic, and that mere tonnage figures would not be a sufficient guide. With frank acknowledgment of the unavoidable uncertainties, both as to the data and assumptions involved, we will state the conclusions reached.

Great Northern—The other railways would still maintain their present lines for local traffic and possibly to some extent for through traffic, but the Great Northern would probably abandon most of its present line between Skykomish and Leavenworth, these points being at the foot of the mountain grades on the two sides and the locations of the portals of the proposed tunnel. This would mean abandoning 57 mi. of railway, all of which requires pusher service and has gradients as high as 2.2%, curvature amounting to 6,855°, an average vertical lift of 2,335 ft., mountain grades costly to maintain and dangerous to operate, enormous winter difficulties, 3 hr. passenger time and 10 hr. freight time. In its place the company would have a nearly straight and level line, free of all the difficulties just enumerated, with a passenger time of 40 min. and a freight time of 1.5 hr.

The writer has obtained four separate and independent estimates of the probable annual saving by the proposed route on the basis of four passenger trains and six freight trains each way daily. One of these estimates is based upon Wellington's treatise, another upon an analysis of the Rogers Pass tunnel problem, a third is by a prominent railway engineer, and the fourth is independently worked out by the writer. These estimates range from about $900,000 to $1,500,000 on the basis of present service. Capitalized at 7%,[5] this would indicate a justifiable expenditure of from $13,000,000 to $20,000,000 to produce the proposed change.[6]

The higher figure may be reached in a different way. The late Alexander Stuart, the Great Northern's engineer on this coast for many years, strongly urged the building of a new tunnel between Scenic and Merritt (see Fig. 3), a distance of about 13 mi., reducing the vertical lift about 1,200 ft. and the distance about 11 mi. The project, indeed, was about halfway in magnitude between the present Great Northern tunnel and that proposed by the writer. The cost would probably have been about $15,000,000. There is little doubt that the Great Northern might better have followed this advice than the course it has pursued, which has already cost a sum fully half as great as that of the Scenic-Merritt route without any of its advantages. But the point here emphasized is that, if this tunnel would have been a justifiable project at the cost stated, the larger tunnel would certainly justify an outlay of $20,000,000.

Northern Pacific—The advantage of the proposed route to the Northern Pacific must be estimated from the second group of traffic relations given in Table 1, based on the construction of a line west from Ritzville to the Columbia River. The cost of the proposed line from the Columbia to Ellensburg (the Ellensburg cutoff, which would become unnecessary if the tunnel project were adopted) would easily build the line up the Columbia to Wenatchee.

The average distance by the existing line between Ritzville and Puget Sound points (324 mi.) would be reduced about 90 mi. and the vertical lift about 1,850 ft. Assuming that the train-mile cost over the mountains, with extensive pusher service, will average $2.25, and by the proposed route $2, and that the through traffic which would take advantage of this route would amount to eight trains a day each way, we should have an indicated annual saving in train service of $1,242,840, which would justify an outlay of $16,000,000. The time is rapidly approaching, moreover, when the Northern Pacific will have to double-track its line across the Cascades, and it may very likely be necessary to lower its present tunnel. Such a course would involve a cost of probably $10,000,000, which might far better be applied to the more thorough project here proposed.

Union Pacific—Second only in its advantages to the Great Northern, and possibly even exceeding them, would be those of the proposed tunnel route to the Union Pacific.

The project which the Union Pacific at one time had in mind of building down the Snake River from Huntington, thus flanking the Blue Mountain Range, was found not to be worth while, so far as its present line down the Columbia is concerned, because the increased distance and curvature more than offset the climb over the mountains. But such a project would fit in perfectly with the proposed tunnel route and would give a low-grade line from Puget Sound all the way to the Wyoming plateau and the mountains of Colorado.

The average saving of distance between Puget Sound and Inland Empire points by the proposed route as compared with the detour via Portland would be at least

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[5] Rates of 6% for corporate funds and 5% for funds guaranteed by the public (state, counties or cities) are generally held to be amply sufficient. This would increase the capitalization figures here given by 14 to 20%.

[6] Since the above estimates were prepared, the writer has obtained the train-mile costs on two widely dissimilar divisions of the Great Northern Ry. One of these is the Cascade division, extending from Leavenworth to Seattle, and includes the mountain section between Leavenworth and Skykomish. The other is a prairie division in North Dakota, on which both gradients and curvature are very light, being comparable in these respects to the proposed tunnel section here considered. The train-mile costs are averages for the entire division in each case and include all expenses of operation, etc. They apparently do not include the item of snowshed construction. The average totals on the two divisions are per train-mile: For freight service, $5.40 on the mountain division and $1.90 on the prairie division; for passenger service, $1.72 on the mountain division and $1.05 on the prairie division. Applying these figures as they stand to the Skykomish-Leavenworth section, with the same assumptions as before as to the volume of traffic, we have an indicated annual saving of $1,447,250, virtually the same as the largest of our previous estimates. But this, manifestly, does not tell the whole story. The train-mile cost on the Skykomish-Leavenworth section may be assumed conservatively as 50% greater than upon the Cascade division as a whole. On the other hand, the train-mile cost on the tunnel section, if the tunnel is built with the thoroughness that it naturally would be, would probably be less than that on the prairie division above given. Be this as it may, the cost itself would be divided among the coöperating roads, which amounts to saying that it would be distributed over a traffic three or four times as great as that on the main line of the Great Northern. This would reduce the train-mile cost by one-third at the very least. Revising our estimate on the basis of 50% increase of cost over the figures for the mountain division and one-third decrease from the figures for the prairie division, we have an indicated annual saving of over $2,100,000. These figures show that the Great Northern can pretty nearly afford to build the tunnel single-handed, if funds can be raised at 6%, if snowshed cost be taken into consideration and if reasonable allowance be made for increase of traffic by the time the tunnel is completed.

180 mi., while that via Pendleton to southern Idaho, Utah and the southeast would be about 140 mi. Assume an average of 160 mi., a traffic of eight trains daily each way, a train-mile cost of $2 by either route, and we have an indicated annual saving of about $1,870,000. Deducting a reasonable sum for building connections on the two sides and for a proper share in the maintenance of the new route, we shall still be justified in claiming a net saving of $1,400,000, which should justify an outlay for construction of $20,000,000.

Considering now the proposed Nachez Pass extension, the average distance to Puget Sound points from, say, the mouth of Snake River may be taken as the same as that by the Northern Pacific from Pasco—about 250 mi.—which is approximately the same as by the proposed tunnel route. The construction of this extension, with an adequate tunnel at the summit, would cost probably $15,000,000, and the route would then be subject to all the drawbacks of these high crossings. Assuming an operative cost over the range 25c. greater per train-mile than by the low tunnel route and a traffic of eight trains daily each way, we have an indicated annual saving of $365,000, which would justify a capital expenditure of $5,200,000. Adding this to the construction cost of the Nachez Pass route, we have practically the same result already arrived at.

FIG. 4. A TYPICAL VIEW IN THE CASCADE MOUNTAINS

Chicago, Milwaukee & St. Paul — The Milwaukee system would profit least of any by the proposed route, as compared with its present line, because the distance from the Columbia to Puget Sound points would be lengthened about 25 mi. Assuming the present average distance to be 170 mi. and, owing to the two summits, the heavy gradients and excessive curvature, the train-mile cost to be $2.50 as compared with $2 by the tunnel route, we have for an eight-train daily service each way an indicated annual saving of $205,000, which would justify an outlay of about $3,000,000. The time will come, it must be assumed, when increase of business will make it necessary to double-track its present line between the Columbia and the Sound. The cost of such an enlargement, with its two mountain crossings and two long tunnels, might far better be expended in aid of the proposed low-grade route.

From the foregoing analysis it is apparent that, unless we are utterly astray in our assumptions, the four transcontinental lines having access to Puget Sound could well afford, as an economic proposition, to build this low-grade route between the Sound and the Columbia River. The tonnage between Puget Sound and points east of the Cascades, including the small percentage that moves by the Canadian Pacific, the Union Pacific and the "North Bank" (Spokane, Portland & Seattle Ry.), is over 60,000 tons daily. This is train tonnage and includes passenger as well as freight traffic and also locomotives. It represents the average total load daily hauled in and out of the Puget Sound country, fully 90% of which could advantageously use the proposed route, if developed on the lines herein suggested. If we assume, as was done in the preliminary studies of the Rogers Pass project, a doubling of traffic by the time the work is completed, the justification of the expenditure would be overwhelming.

Difficulties in the Way

What, then, are the chief obstacles in the way of so important a consummation? We have shown that they are neither technical nor economic. Carried out as proposed, the project would be practicable from an engineering point of view and feasible from an economic point of view. The real obstacles are of a character far less definite, but also far more troublesome to deal with.

There is, first, the heavy investment in existing lines. The most striking example is that of the "North Bank" line (a Great Northern-Northern Pacific property) between Spokane and Portland along the Columbia River. It is one of the best-built railways in existence and is said to have cost upward of $40,000,000. It is idle now to argue that this immense sum, or a part of it, might better have been spent in securing an equally good route through the Cascades to Puget Sound. The "North Bank" is a fact, and it must get a great deal of business in order to pay its fixed charges and running expenses, to say nothing of paying dividends. Anything that might cut into this business as the proposed tunnel route would certainly do, would naturally be looked upon with disfavor from this particular direction.

Another intangible obstacle in the way of this comprehensive course lies in the independent action of the several roads. Each will continue to improve its present lines by building snowsheds, making minor changes of alignment, etc.; and the more each expends, the less will it be inclined to aid in the greater work.

Then there is the perfectly natural opposition to pernitting the invasion by one railroad of territory hereofore exclusively tributary to another. It is too much o expect of railroad human nature that the Great Northrn, for example, would welcome with open arms any ther line within its exclusive bailiwick of the Wenatchee nd Upper Columbia Valleys.

Finally, there is the "get-together" difficulty—the roverbial reluctance to direct coöperation on an exensive scale among independent and competing lines. ortunately, the State of Washington furnishes a comlete answer to this objection in several of the most nlightening examples of coöperation to be found anyhere. The Great Northern and Northern Pacific jointly uilt the "North Bank" road. The Union Pacific, nstead of building a separate line from Portland to eattle, secured traffic privileges over the Northern acific from Portland to Tacoma and over the Milwaukee om Tacoma to Seattle; later, the Great Northern ecured similar privileges over the Northern Pacific, overing the whole distance. As a part of this agreeent the Northern Pacific has double-tracked its entire ne from Portland to Seattle. All these examples show at coöperation among railroads, even where there is rong competition, is no new thing in this section of e country.

It is apparent from the foregoing that the real ostacles in the way of this project are of that indefinite d intangible character that only mature study and conderation can overcome. They are based upon prejudices ther than upon facts. The purpose that the writer has iefly in view in this presentation of the subject is to rn public thought in this direction and dissuade the ilways from continuing the policy of radical improveent of their present lines in the Cascades until they have oroughly investigated the advantages that would result om building this 30-mi. tunnel.

PUBLIC AID

A work of this magnitude, fraught with so many public nefits, is entitled to public aid. Commerce, both intrad interstate, is frequently brought to a standstill unr present conditions, mails are interrupted, vexatious lays are experienced, and business is temporarily deoralized. These are evils of a public character which stify public action for their removal. It is idle, hower, to expect any aid from the Federal Government. lthough the project would accomplish more for the nefit of interstate commerce than the improvement of e Columbia River,[7] for example, and although it would cilitate traffic where the interests of the Government e particularly heavy, still it would be practically imssible to induce Congress to grant any assistance. The ecedent would be too far-reaching.

But with the State of Washington the project would a measure of internal development of the first imrtance. On one side of the great mountain wall that retches from north to south across the state is a great d richly favored maritime section, abounding in the est harbors in the world. On the other side is a h agricultural domain, which has come to be called, not inappropriately, the Inland Empire. The wall that separates these two sections compels trains to climb half a mile into the air to get over it and entirely stops all highway communication for six months in the year. The state can well afford to make a considerable investment in order to bring these two sections into closer relations with each other.

All that New York Harbor has meant to the State of New York, Puget Sound should mean to the State of Washington; and all that the Erie Canal meant to the states bordering on the Great Lakes, this low-grade route should mean to the Northwest. When New York had a population of about a million, it assumed the burden of building the Erie Canal and paid for it $7,600,000. If the State of Washington were to make the same per capita contribution to this work, based on its probable population when it is done, it would amount to more than $10,000,000.

It would be easy to demonstrate, if space permitted, that this tunnel could be utilized, in addition to its ordinary rail service, to maintain highway traffic between the sections for the year round. Such traffic is now wholly non-existent for seven months of the year, and of little practical value the rest of the time. This is one specific example of justification of public aid which certainly does not fall within the constitutional provisions which exist in the State of Washington against lending the credit of the state to private individuals, companies or corporations.

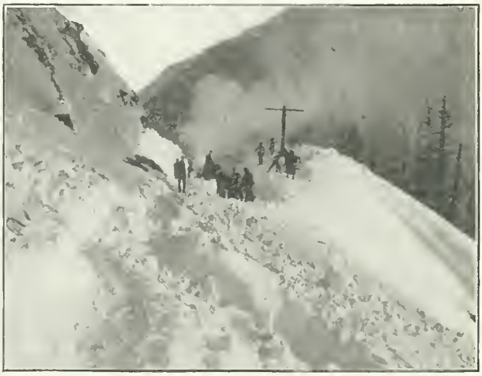

FIG. 5. A SNOW BLOCKADE IN THE CASCADES

None of this public aid should be given outright, but it should be made available, say, when the main tunnel is first opened, with a definite time limit fixed within which the work must be done. This would obviate risk of failure and avoid interest charges until the work is ready for use. If such a sum could be guaranteed, subject to these conditions, it might prove of great assistance in encouraging an early undertaking of the work.

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A Landslide on the Great Northern Ry. in the Cascade Mountains occurred on Sept. 13, after the preceding article was written. It is remarkable because of its occurrence at the driest season of the year. The Seattle "Post-Intelligencer" of Sept. 14 said:

Passenger trains of the Great Northern Railway Co. were routed over the Northern Pacific lines last night following a big slide of earth, trees and débris at Windy Point. The slide covered the entire track for 400 ft. and is about the same point where a fatal slide occurred last year.

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[7] The Government outlay on the improvement of the Colum- River above Portland aggregates $11,000,000, or nearly -third the cost of the proposed tunnel. Yet it is doubtful the river will ever carry 10% of the traffic that would pass rough the tunnel.

Pneumatic Mixer Lines Railway Tunnel Under Traffic

SYNOPSIS—Sandy Ridge tunnel on Carolina, Clinchfield & Ohio Ry. is being lined under traffic with concrete mixed and delivered from gasoline-driven car equipped with pneumatic mixer. Steel forms in 30-ft. sections are moved from place to place in tunnel. Records of progress.

The Sandy Ridge tunnel on the Elkhorn extension of the Carolina, Clinchfield & Ohio Ry., which was opened for traffic in 1915, is being lined with concrete, the pneumatic process of concreting being used, with the novel addition of a portable mixing and placing plant. The system comprises the following elements: A self-propelled mixer car, a loading and storage trestle, a compressed-air plant outside the tunnel, an air pipe line through the tunnel, and forms that can be easily erected, moved and taken down. The tunnel is 7,804 ft. long by 19 ft. wide.

The central element of the method is the concreting car, shown in Figs. 1 and 2. This is a steel frame, gasoline motor-driven car, carrying a pneumatic concrete mixer and space for aggregate, cement and water. It is run into the tunnel on the regular railway tracks and mixes and delivers the concrete through the medium of air compressed outside the tunnel and delivered through a pipe line with regularly spaced taps, to which the mixer on the car is attached.

The dimensions of the car are 40 ft. long over end sills, 10 ft. 4½ in. wide over braces, and 17 ft. 9 in. from top of rail to top of car. A central chamber, open on the sides, 8½ ft. long, 9 ft. 8 in. wide, and 10 ft. 3 in. high, contains on one side the pneumatic concrete mixer and on the other side the charging skip. Over this chamber is a water tank of 1,850 gal. capacity. This furnishes water for the concrete and is also connected with the cooling system for the gasoline engine. Facing the central chamber is the stone bin (30 cu.yd. capacity) on one end and the sand bin (12 cu.yd. capacity) on the other. Each bin has a chute 20 in. wide leading to the charging skip, and each chute is controlled by an undercut gate. Under the stone bin is space occupied by a 96-cu.ft. air receiver standing vertically and also space for storage of bags of cement, which is protected from water by the bin overhead.

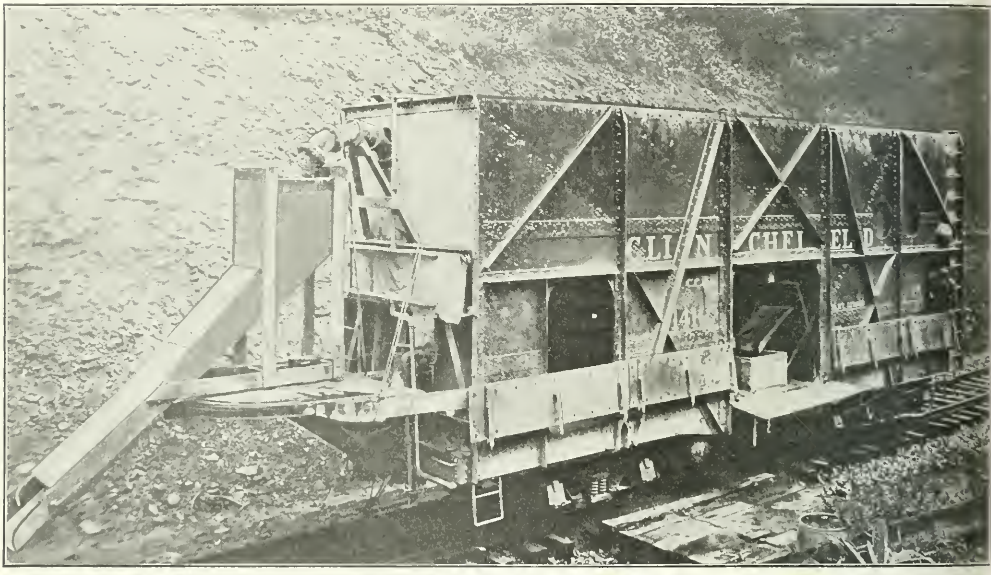

FIG. 1. CONCRETING CAR FOR CAROLINA, CLINCHFIELD & OHIO RY. TUNNEL
Delivery pipe arranged for sidewall concreting

LINEAL FEET OF CONCRETE PLACED AND HOURS OF LABOR IN LINING SANDY RIDGE TUNNEL

	Lineal Feet of Concrete Placed						Number of Hours Spent on Each Operation								
1916 Month	Form 1	Form 2	Form 3	Form 4	Form 5	Total Lin Ft.	Building Masonry	Moving and Setting Forms	Trimming Sidewalls and Roof	Unloading Material	Night Watchman	Repairs to Plant	Miscellaneous Work	Total Hours Worked	Remarks
February..	112	112	112	112	140	588	4,606	1,110	1,769	818	372	137	273	9,085	
March.....	83	112	112	112	84	503	3,644	2,410	1,279	980	348	384	384	9,393	
April....	140	112	112	112	140	616	4,280	2,779	1,447	860	372	295		10,013	
May	112	140	140	140	140	672	4,169	2,587	1,324	905	372	93	448	9,898	
June.	140	112	112	112	140	616	3,455	1,366	1,312	797	372	90	590	7,982	
July	28	28	56	56	28	196	1,370	1,018	802	560	372	132	140	4,456	15 days repairing flood damage
August	28				28	56	646	440	160	210	366	100	484	2,400	24 days repairing flood damage
Sept 1 to 20	28	28	28	56		140	1,465	910	200	280	240	50	2,252	5,397	Delayed 69 hr , no cement

Under the sand bin is the gasoline engine and its auxiliary equipment, completely housed from water and dust. In its lower position the charging skip stands with its top rim about 1 ft. 3 in. above the floor, and it travels on inclined guide-rails (40-lb. T-rails) to its upper position over the mixer, being hoisted by a compressed-air cylinder 9¼ in. diameter. The gate of the skip works automatically by means of a guide-rail. The mixer is for a two-bag batch ($\frac{4}{10}$ cu.yd.) and has its 8-in. outlet pipe at the bottom running horizontally and curving to the outside of the rear truck and thence vertically to near the top of the car, where it branches by neans of a Y into two lines—one a 180° bend to the rear for "shooting" in foundation and sidewall, and he other going to the roof for "shooting" into the arch.

The entire arrangement is made compact with a view o saving manual labor. One man controls the hoisting of skip, injection of water and mixing and discharge of he batch. One man is placed at each chute, and two nen carry, open and empty the cement bags. The car and gasoline engine were built by the McKeen Motor Car o., of Omaha, Neb. The car was sent knocked down nd was erected in the railway shops at Erwin, Tenn., nd moved to the work (105 mi.) under its own power, raveling at speeds of as high as 25 mi. per hr. The nixer was installed and the piping done on the car by the 'neumatic Placing Co., of 2 Rector St., New York City.

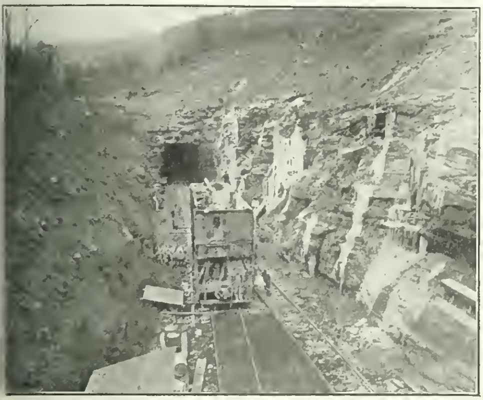

FIG. 2. CAR AT ENTRANCE TO SANDY RIDGE TUNNEL
Delivery pipe arranged for arch concreting

Loading and Storage Trestle

The service trestle is of special design and is so arranged that the concreting car goes under it and receives tone (crusher run), sand, cement (in bags) and water, ll by gravity and frequently all at the same time. The and and stone are drawn from overhead bins by means f undercut gates. Cement is conveyed into the car by chute. The trestle (Fig. 3), has over its deck a track pon which stone and sand in hopper cars are stored or nloaded into the bins below. There is a continuous ow of 27 bins with an aggregate capacity of 321 cu.yd. nd a total length of 162 ft., and five loaded cars can e stored over these bins, giving an additional storage f 200 cu.yd. The trestle is built of timber and has a mewhat unusual arrangement of posts and bracing.

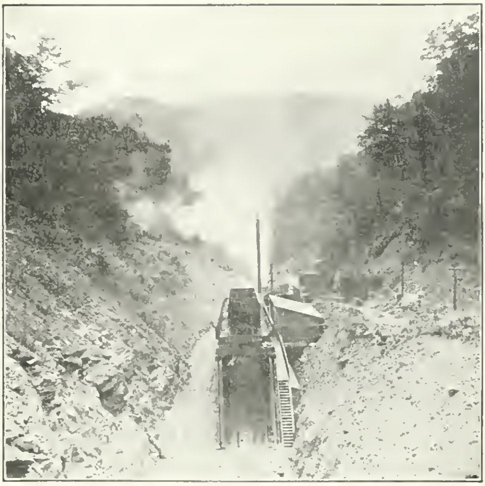

FIG. 3. LOADING TRESTLE FROM SOUTH PORTAL OF SANDY RIDGE TUNNEL

The forms are of steel, except the arch ring, which is of 3-in. hard pine on steel ribs. They are of the Blaw collapsible type and are held to the rock wall by anchor bolts, as shown in the sketch (Fig. 5). First, a hole is drilled in the rock, and a rod 18 to 20 in. long, split at one end and threaded at the other, is inserted, with the point of a wedge just entering the split. The rod is driven against the end of the hole, causing the wedge to spread the split end. A square cast coupling or nut is screwed on the tapped end of the rod, and a second rod is screwed into the outer end of the coupling. A similar coupling is placed on the free end of this second rod, and the last section of the hanger is screwed into this coupling.

The most important feature of the hanger is the square couplings, whose shape prevents their turning in the con-

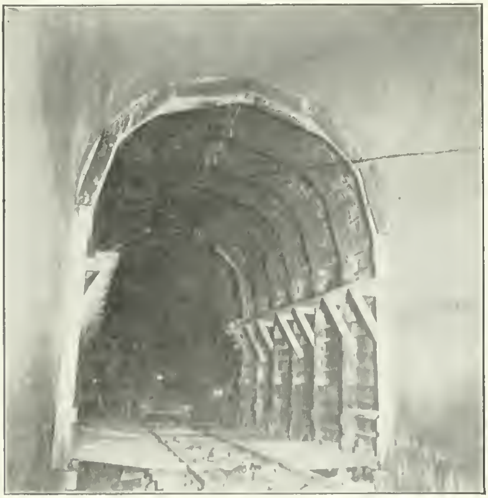

FIG. 4. A 30-FT. SECTION OF STEEL FORMS

crete when the outer rod is unscrewed. Pipe couplings were tried at first, but being round, they turned with the rod and gave much trouble. Standard bolt thread is used as being more satisfactory than standard pipe thread.

Five 30-ft. sections of forms are provided, and these are distributed through the tunnel as seems best. On account of the pressure of the wet concrete an entire section is not concreted in one operation. After concreting the walls up to spring-line the car moves to another section.

Had it been possible to place concrete at full capacity, the five sections would probably have proved inadequate to keep the car busy. Difficulty in obtaining sufficient cement—due to some local conditions—has kept the rate of progress notably low.

Sand-Bag Bulkhead Retains Concrete

When a section is moved to a new position, one end is caused to overlap the concrete last placed. At the other end of the form a bulkhead of sand bags is constructed. Burlap bags are preferable, but cement bags also can be used. These are half filled with sand and are stacked a foot thick all around the opening, the bulkhead rising with the concreting.

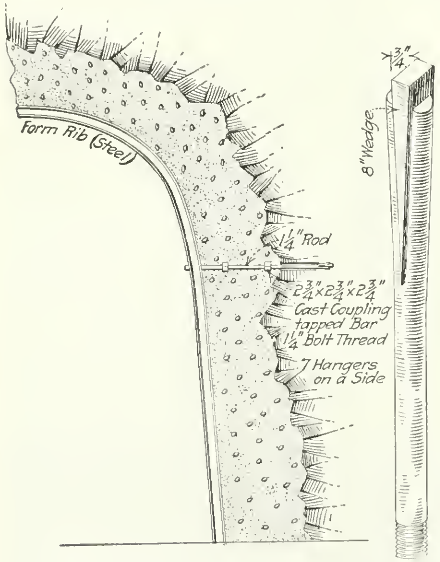

FIG. 5. HOW THE STEEL FORMS ARE HELD IN PLACE

The progress in lining, from February to September inclusive, is given in the table on p. 936. The sharp drop in "concrete placed" in July, August and September is attributable to lack of cement.

The concreting car was put in service on July 9, 1915. The high record for concrete placed in one day was 230 cu.yd., on May 12, 1916. The daily records and monthly totals for the summer months just past were respectively as follows: June, 214 yd., total of 4,098; July, 191, total of 1,570; August, 154, total of 508; to Sept. 20, 181, total of 1,317.

The maximum advance was made in May, 1916, the weekly totals being as follows: First week, 590 cu.yd.; second, 1,020 cu.yd.; third, 1,098 cu.yd.; fourth, 990 cu.yd.; fifth, 564 cu.yd. The total concrete placed from July 1, 1915, to Oct. 31, 1915, was 10,438 cu.yd., while from the latter date to Apr. 30, 1916, the weekly totals averaged more than 600 cu.yd. It is expected that the tunnel lining will be finished next summer.

The work is being done by the company forces under the general direction of O. K. Morgan, Engineer in Charge of the railway, who also designed the car.

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The Motor-Truck Menace to Street Pavements

A paper by Eugene W. Stern, chief engineer of the Bureau of Highways, Borough of Manhattan, New York City, on the "Necessity for Limiting the Loads, Speed and Size of Vehicles," read before the American Society of Municipal Improvements at Newark, N. J., Oct. 12, gives in greater detail than the article in *Engineering News* of the same date, the damage done New York City pavements by the 18- or 19-ton motor trucks used to haul material from the subway excavations. The pavements ruined include not only the granite-block pavement on West 42d St., but the sheet-asphalt pavements on this and West 50th St.

All this damage, Mr. Stern said, has been done in a very short time (about nine months) and has amounted to 5,400 sq.yd. of repairs on granite blocks (equal to 32% of the total area), costing $6,000, and 1,900 sq.yd. of repairs on sheet asphalt (equal to 30% of the total area), costing $1,900, whereas prior to this time the average cost per year of maintenance on these granite-block pavements was $150 and on the sheet asphalt $70.

In common with others who have studied the problem Mr. Stern comes to the conclusion that little damage is to be anticipated from vehicles with rubber tires, because as he said, "The manufacturers of motor vehicles have found by experience that about 750 lb. per in. width of tire is about all the load rubber tires will stand, and this load, together with the resiliency of the rubber and the adequate springs that good construction demands, seem to be the saving features in protecting the pavements against undue wear, even under heavy loads."

Mr. Stern contended that immediate action must be taken to protect not only the pavements of the cities and the municipalities immediately surrounding the cities, but also the country highways that are liable to be exposed to such kinds of traffic, as the taxpayers will be called upon to make very heavy payments to maintain their streets and highways, although these have been constructed in thoroughly first-class manner and in accordance with the latest practice.

An investigation was made of the laws and ordinances governing the weights and loads of vehicles, which covered those in effect in eight states and 49 cities in this country and Europe. Among the most uptodate of these ordinances Mr. Stern listed the following:

CHICAGO, ILL.:

Maximum weight of vehicle	15 tons
Maximum load on any one axle	12 tons
Maximum load on the wheel	6 tons
Maximum load per inch width of tire	1,000 lb
Maximum length	40 ft
Maximum width	8 ft. 6 in

Speed: Compatible with safety, but not to exceed 9 mi. per hr. Not to exceed 4 mi. per hr. when truck has defective tire that would cause injury to pavement.

Motor trucks must have rubber tires.

Trailers must have steel tires.

NEW YORK STATE:

Maximum weight of vehicle	14 tons
Maximum load on any one axle	9 tons
Maximum load per inch width	800 lb.
Maximum width (except traction engines, which may have a width of 9 ft. 2 in.)	8 ft. 4 in.
Speed: Over 4 tons, 15 mi. per hr.; over 6 tons, 6 mi. per hr. with steel tires, 12 mi. per hr. with rubber tires.	

STATE OF NEW JERSEY:

Maximum weight of vehicle	12½ tons
Maximum load per inch width of tire	800 lb.
Speed: 4 tons, 12 mi. per hr. with iron tires; 6 tons, 8 mi. per hr. with iron tires, 10 mi. per hr. with rubber tires.	

STATE OF PENNSYLVANIA:

Maximum weight of vehicle	12 tons
Maximum load on any one axle	9 tons
Maximum load per inch width of tire	750 lb.
Maximum width, 7 ft. 6 in.; for busses in large cities, 8 ft. 4 in.	

STATE OF MASSACHUSETTS:

Maximum weight of vehicle	14 tons
Maximum load per inch width of tire (except for hard pavements)	800 lb.
Speed: 4 tons, 15 mi. per hr.; 6 tons, 6 mi. per hr. with iron or steel tires, 12 mi. per hr. with rubber or similar tires.	

OAKLAND, CALIF.:

Maximum weight of vehicle	14 tons
Maximum load per inch width of tire (except for hard pavements)	800 lb.
Speed: 4 tons, 6 mi. per hr. with iron or steel tires; 12 mi. per hr. with rubber tires.	

ENGLAND:

The English have much the most complete and scientific ordinances of any of those examined.

Maximum weight of vehicle	12 tons
Maximum load on any one axle (for trailers, 4 tons)	8 tons
Maximum weight of vehicle without load	5 tons
Combined weight of motor car and trailer	6½ tons
Weight of axle to be proportioned to diameter of wheel.	
The load per inch width of tire (steel) shall be 840 lb. for wheels 3 ft. in diameter; and an additional allowance of 9⅓ lb. for every additional increase in diameter beyond 3 ft.; and for wheels less than 3 ft. in diameter, a deduction of 18⅔ lb. per inch width of tire for every inch less in diameter than 3 ft.	
Vehicles for military service limited as follows:	
Weight of car unladen	6 tons
Weight of car with trailer	8 tons
Unit of registered axle weight with tires shod with crossbars	560 lb
Maximum width, 90 in. for 3 tons; 90 in. for trailer.	
Speed: Dependent on axle weight for iron-tired vehicles; 6 tons, 12 mi. per hr. for rubber tires; over 6 tons, 8 mi. per hr. for rubber tires; should car unladen weigh more than 3 tons, speed is limited to 8 mi. per hr.; if motor draws trailer, maximum speed is 5 mi. per hr.	

The points that Mr. Stern considered should be covered y such a law are: (1) The load; the diameter of the heel; the width of tire; whether or not the tire is of a esilient material such as rubber, or of steel; the kind of prings. (2) Speed.

⁂

The Human Factor in Industry*

By F. H. Newell†

The engineer, if true to his name, is the man of inenuity. He has made the strength of one man equal to hat of a hundred of his forefathers. His machines perorm the intricate tasks that a generation ago required the kill of a score of workers. He has rendered it possible or millions to live and to find work in the narrow connes of a city, by providing the machinery to bring them ood and other necessities of daily life.

The human units, under this development of mechanal efficiency, have attained a wonderful efficiency in prouction of more things at cheaper prices. But success in his direction has been accompanied by serious defects f which the engineer is rapidly becoming aware. The ruit in hand has crumbled to ashes. What profits it if he world of *things* is gained to the loss by the many of heir higher life?

The present unrest among the industrial workers is evident. Many fail to recognize, however, that this is the necessary outgrowth of the work of the engineer concentrated on narrow lines.

In many industries the investment in machinery and equipment represents roughly 50% of the outlay; the amount expended for labor is approximately equal. The engineer has been educated to think almost exclusively in terms of machinery and equipment. Absorbed in these details he has apparently overlooked the obvious fact that there is a limit to the effective working of this machinery, and that limit is set not by the inventor, but by the man who must operate it. The relative efficiency on the part of the improved machines may be 80 or 90% of perfection, while that from the human side may be as low as 20%.

Here, then, is a lack of proper balance. It is of no avail to secure 1% or 2% increase by throwing out the old and procuring better machines, if there is a persistent loss ten times as great on the labor side. It is becoming evident that, if the engineer is to continue to add to the health, comfort and prosperity of mankind through more inventions, it will be by a larger recognition of the fact that these inventions must aid the men who use them to progress upward rather than downward.

The application of economic laws to human welfare in industry is far more complicated and subject to more exceptions than the application of physical laws to engineering, yet these laws are as ascertainable as those which govern the action and reaction of the so-called forces of nature.

Engineers are awakening to the fact that they have a duty as well as an opportunity, and they are getting down to specific details. The progress is illustrated by the work done by the United States Reclamation Service. Beginning with the necessity of providing medical and surgical aid to its laborers in remote construction camps, it has taken up not merely the proper feeding, but also the housing of its men and their families—in some cases providing schoolrooms and lending a hand in social activities that tend to keep the men not only on the job, but also at their best.

These and similar lines of work were not dreamed of at the time the Reclamation Act was passed. They were regarded as wholly outside the domain of engineering. Today the responsible man in immediate charge of construction regards it as an essential part of his work, as well as a privilege. He can show, in his final statement of cost compared to output, economy in the expenditure of time and money in ways that a generation ago would have been regarded as purely altruistic and inconsequential. We are no longer compelled to defend this new emphasis on the human factor, but on the contrary we may properly apologize for doing too little rather than too much. We now know that the efficiency and economy of the final results depend not alone on properly cared for machinery, but on the welfare of the men and women who use it.

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State Highway Maintenance Cannot be Forced according to county court decision in Pennsylvania in a case where the county commissioners sought a mandamus on the State Highway Department to compel the state to construct and maintain a road between Nazareth and Bethlehem. The judge held the state highway act of 1911-'13 requires the repair and maintenance of highways incorporated in the state system "only in cases where the state formally takes over this duty and assumes responsibility."

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*Extract from an address before the Congress of Human ngineering, Columbus, Ohio, Oct. 26, 1916.

†Professor of Civil Engineering, University of Illinois, hampaign, Ill.

Engineering Literature

Engineers as Readers and Writers of Fiction

By R. Fleming*

In reading fiction an engineer's professional experience enables him to appreciate some passages that a reader without technical training would pass unnoticed.

In Kipling's story, "The Ship That Found Herself," the Scotch captain who is showing the owner's daughter around the new and untried vessel says:

> But it's this way wi' ships, Miss Frazier. She's all here, but the parts of her have not learned to work together yet. They've had no chance. . . . Every part of her, ye'll understand, has to be livened up and made to work wi' its neighbor—sweetenin' her, we call it technically. . . . For a ship, ye'll obsairve, Miss Frazier, is in no sense a reegid body closed at both ends. She's a highly complex structure o' various an' conflictin' strains, wi' tissues that must give an' tak' accordin' to her personal modulus of elasteecity.

Here may be the answer to the question, Why do some structures stand? The principles of mechanics are ignored, indeterminate stresses and redundant members abound, and yet the structure does not fail. The members of the structure adjust themselves to work together, each to its "personal modulus of elasteecity."

There is a passage in "Pickwick Papers":

> That's the wery prudentist resolution as you could come to, sir, replied Mr. Weller. You rayther want somebody to look arter you, sir, wen your judgment goes out a wisitin'.

Mr. Pickwick had found himself in a most embarrassing situation because his judgment had gone visiting. How many mistakes of engineers, good and reliable men, are explained by the simple statement that their judgment went visiting. One engineer estimated the "typical floor" as a single floor; another used a table of areas instead of a table of weights; another scaled drawings with a wrong scale—all three allowed their judgment to go visiting.

In "The Turnstile," a recent novel by A. E. W. Mason, a member of the English Parliament is thus addressed:

> You must all know that a man who is any use at all does change his opinions as his experience widens. Surely that's true. What's the use of thought at all if it leaves you precisely where you were? . . . And why, when he has risen, doesn't he say: "Of course I have changed my views. I am a better man than I was two years ago."

Of course! This may explain why the answer to a problem in a textbook on reinforced concrete is given differently in two editions, or why tension in the anchor bolts of a steel stack is treated in three ways in as many editions of a standard book on steel structures. These writers became wiser men in the two years or so between the different editions.

An eminent professor writing of beam flexure followed the accepted theory that the neutral axis of a section (symmetrical or unsymmetrical) passes through the center of gravity of the section. In the second edition of his book he located the neutral axis so as to make the moments of the horizontal forces on the two sides equal. In later editions he came back to the accepted theory as given in the first edition. Was there a growth or a retardation in the professor when he wrote the second edition? Or did his judgment go visiting?

It is seldom that marked mathematical ability and unusual imaginative powers are found in the same writer. Yet Rev. C. L. Dodgson and Lewis Carroll are the same person. It seems hardly credible that he wrote both "An Elementary Treatise on Determinants" and "Alice in Wonderland." But note how the mathematician betrays himself in that delightful children's classic, "Alice in Wonderland." At the tea party Alice is asked to take some more tea:

> "I've had nothing yet," Alice replied in an offended tone, "so I can't take more."
>
> "You mean you can't take less," said the Hatter; "it's very easy to take more than nothing."

It may not be generally known that Rankine wrote a volume of "Songs and Fables."[1] There is a fine blending of mechanics and humor in the introductory poem, "The Mathematician in Love." "The Three-Foot Rule" is a skit against the adoption of the metric system. The "Fables" are short and amusing. The "Goat and Compasses" is one:

> A pair of compasses, belonging to a geographer, was lying on a table, when a goat, happening to pass by, addressed to it the following taunt: "Your limbs serve but to straddle across a piece of paper, mine, to bound over the mountains."
>
> "Your limbs," replied the instrument, "enable one wretched animal to seek its food; mine assist a sage to map the world."
>
> Moral—Science, though despised by the ignorant, is better than bodily strength.

The engineer will have his horizon broadened, his youth renewed and his life prolonged by frequent incursions into the realm of the best fiction. It may not help him to make a better living in the way that phrase is usually interpreted, but it will help him to new sources of pleasure in his life.

REVIEWS AND NOTES

Centrifugal Pump Practice

Reviewed by H. E. Longwell*

CENTRIFUGAL PUMPS AND SUCTION DREDGERS—By E. W. Sargeant. Philadelphia: J. B. Lippincott Co. Cloth, 6x9 in.; pp. viii + 188; 160 illustrations, including 14 folding plates. $3.25.

A little book so modest and unpretentious as to disarm hostile criticism. The reader will easily recognize the author as belonging to the older school of engineers, who followed their respective specialties from the drafting board, through the pattern shop, foundry and machine shop into actual service.

The work is in no sense profound. On the contrary it is essentially a simple and readable description of methods and constructions that have worked out satisfactorily in widely diversified centrifugal pump practice.

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*American Bridge Co., 30 Church St., New York City.

[1] It is to be regretted that this little book is not more accessible. The writer knows of but one copy in the United States—that owned by the Boston Public Library.

*General Manager, The Westinghouse Air Spring Co., New Haven, Conn.

The principles of design laid down by the author are strictly empirical. being based on formulas deduced from tests of a number of pumps of known dimensions. This of course presupposes that the pumps tested represent the utmost possibilities in point of efficiency—an assumption that is perhaps hardly justifiable. However, the method has the advantage of being conservative and safe, even though so easy as not to be particularly stimulating.

A somewhat unusual feature in books of this character is Chapter VII, which touches on patterns for casings and runners and methods of molding them in sand and loam. These suggestions are not at all out of place, as centrifugal pump castings—especially in the larger sizes—have bothered a good many fairly well-experienced foundrymen. There are also in this chapter a few directions as to convenient methods of machining these castings.

The book deals briefly with the more modern developments of series pumps for unusually high heads, and parallel pumps for large capacities at high speeds. Various forms of charging or priming apparatus are described, and concise directions are given for carrying out tests. Considerable attention is given also to the important subject of the arrangement of piping and valves.

A fairly comprehensive treatment is given of the application of centrifugal pumping machinery to sundry specific purposes, such as drainage, irrigation, handling sewage, pumping out docks, salvaging wrecked vessels, fire service and dredging and conveying solids. There is a brief chapter on rotary air pumps, but the treatment of the subject is quite superficial and no attempt is made to go into the details of design.

American readers must bear in mind that in the numerous formulas and tables capacities are given in Imperial gallons, which are 20% larger than the measure which is standard in this country.

The book is copiously illustrated. Many of the illustrations are dimensioned and appear to be reproductions of scale drawings of actual machines.

On the whole the work is scarcely one that would be classed as a textbook. Its contents savor more of the general counsel of an engineer of broad practical experience. It would do excellent service as a corrective with which to temper the ultra-theoretical treatment that is often encountered in textbooks dealing with this subject.

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Dissertations on Ozone

OZONE: Its Manufacture, Properties and Uses—By A. Vosmaer, Ph.D., M. Am. Inst. E. E. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xii + 197; 67 illustrations. $2.50 net.

Ten years ago the subject of ozone was a much more live matter for engineering study in this country than it is today. It has apparently taken a back seat as a universal sterilizer, in America at least, through the greater commercial development of such disinfecting processes as those employing chlorine gas, and ultra-violet light. Therefore Mr. Vosmaer's book at this moment is probably more of academic interest than practical service. Perhaps that condition explains some of the more outstanding peculiarities of the volume.

There is much within the covers of the book that is worthy of permanent record, but the author's statements of scientific fact and engineering development seem rather too meager in technical detail and limiting circumstance to be successfully applied by other workers in this field. Fact is curiously interwoven with mere opinion; and there is an obtrusive display of irrelevant discourse on the author's experimentation. The English in spots hides the thought. There is a multitude of three-page chapters. All of which points to the need of stricter editing of the text.

The author starts by discussing the history and nature of the gas, its occurrence, properties and identification. A second part deals with matters of manufacture. Ozone production as a side effect of chemical reactions and thermal processes is reviewed preliminary to taking up the use of electrical discharges. Spark, arc, and brush discharge are compared at length—always of course from the standpoint of ozone production, though it may seem to some that the digressions are rather far pursued. Then the effects of placing solid dielectrics between the discharge electrodes are described, with emphasis on the comparative uselessness of the older open-electrode systems.

A considerable part of the text is taken up by the notes on utilization of ozone in the purification of drinking water, air and industrial materials. The author laments the lack of American initiative that prevents wide utilization of ozone over here, but he fails to account for the large expenditures in generating the gas that have been indicated as necessary, the inherent difficulties of applying it, and the lack of any American demand (such as has been reported in Europe where ozone has been commercially employed) for sterilization as compared with reasonably complete disinfection of water, air, or industrial products.

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Municipal Functions

PRINCIPLES AND METHODS OF MUNICIPAL ADMINISTRATION—By William Bennett Munro, Professor of Municipal Government in Harvard University. New York: The Macmillan Co. Cloth; 6x9 in.; pp. xi + 491. $2.25 net.

In this volume on the organization, work and method of the principal departments of American cities, Professor Munro has provided a valuable supplement to his excellent earlier books on "The Government of European Cities" and "The Government of American Cities." The present volume deals with the leading functions of municipalities as did the two other ones with their framework. For the general student who wishes to go farther afield, Professor Munro has already provided a useful "Bibliography of Municipal Government." (For reviews of the three earlier volumes just named see *Engineering News*, May 13, 1909, Apr. 17, 1913, and Dec. 16, 1915.)

The subject matter of the volume now before us is introduced by a chapter on the current demand for municipal efficiency. A second chapter which in a measure may be considered as introductory also reviews briefly the history, principles and practice of city planning. The author then takes up in order streets, water-supply, garbage disposal and related subjects, sewerage and sewage treatment, public lighting, the police, fire prevention and protection, and the administration of schools. The final chapter is devoted to financial questions.

Each of the main functions or departments indicated is presented from the viewpoint of the work to be done, the organization for such work, and the various methods of accomplishing the results to be obtained. Obviously, the treatment must be sketchy in a volume dealing with so many subjects and written presumably for students of municipal government in and out of college rather than for men or women who expect to follow any one of these subjects professionally.

Notwithstanding the limitations just stated, the author has succeeded admirably in presenting a general view of each of the municipal functions indicated. Here and there statements appear that to one versed in the technicalities of the subjects treated seem unhappily expressed and in a few cases actually misleading. For instance, we are told on page 107 that asphalt differs from certain other pavements previously described "in that it is not laid unit by unit, but in the sheet." Close by language is used that would lead any uninformed person (and presumably the book is for the uninformed) to think that asphalt pavements are laid on a foundation of broken stone. The paragraphs on bitulithic and on macadam are also likely to give wrong impressions to the uninitiated. In dealing with water waste the author makes the curious suggestion that it would be cheaper to buy fertilizer than to use so much water on lawns. Elsewhere reference is made to figures which the author says "prove very clearly that under a metered system much less water is used in the homes of the poor than in those of the well to do," overlooking the fact that meters or no meters the "poor" use less water than the "well to do."

All these are of course relatively minor blemishes that probably will do little harm among the class of readers for which the book was designed.

Industrial Electricity

HANDBOOK OF MACHINE-SHOP ELECTRICITY—By C. E. Clewell, Assistant Professor of Electrical Engineering, University of Pennsylvania. Leather; 4x7 in.; pp. xi + 461; 61 illustrations. $3.

This compact and concise encyclopedia of machine-shop electricity really can serve the engineering profession as a dictionary of industrial electricity. It obviously was carefully planned, and it is clearly written. The illustrations are all well chosen, and for the most part are particularly attractive. The few of inferior execution set off the others and disclose the advance of recent years in technique of publishing such books. The ground covered by the text includes industrial-machine nomenclature, circuits, fundamental laws, communication systems, power and lighting supply, measuring instruments and miscellaneous appliances.

Geodetic Survey Centennial

CENTENNIAL CELEBRATION OF THE UNITED STATES COAST AND GOEDETIC SURVEY, April 5 and 6, 1916. Washington, D. C.: The Survey. Leather; 7x10 in.; pp. 196; illustrated.

The very interesting papers and historical documents connected with the celebration of the 100th anniversary of the United States Coast and Geodetic Survey last April are brought together in permanent form in this volume. Regret is often expressed that so little attention is paid to the history of engineering achievements. It is a matter for congratulation, therefore, that some of the interesting history of the work of the Government's earliest scientific bureau is here made available to the profession.

Physics Uniquely Treated

CONCISE TECHNICAL PHYSICS—By J. Loring Arnold, Ph. D., Professor Electrical Engineering at New York University. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. v + 275; 294 illustrations. $2 net.

The chief claim of this new physics text is that it is short. Various novelties of treatment have been adopted to secure the desired brevity. They make the book attractive for either classroom or home use.

Standard Duties and Salaries for New York City Employees

STANDARD SPECIFICATIONS FOR PERSONAL SERVICE—Prepared by the Bureau of Standards for the Board of Estimate and Apportionment of the City of New York, Municipal Building, New York City. Paper; 7x10 in.; pp. 931.

This bulky volume represents what has thus far been accomplished in a herculean task; to wit, the classification of all the many thousand officers and employees of New York City, from the Mayor down to the common laborer. This work has been done by the Bureau of Standards, of which George L. Tirrell is Director, for the Board of Estimate and Apportionment. A statement concerning this task of standardizing duties and salaries was published in *Engineering News* of Jan. 14, 1915. The system has been in practical operation now for some 18 months and is comparatively simple. All the officers and employees of the city are first grouped in divisions called "services." There are sixteen of these services. Examples are: Executive, Professional, Investigational, Inspectional, Police, Fire, Skilled Trades. Each service is divided into subdivisions termed "groups." Under the professional service, for example, there are the Accountant group, Architect group, Bacteriologist group, Engineer group, Pathologist group, Physician group, etc. Each group may be divided into grades according to its relative importance and the number of employees it contains. There are six grades, for instance, in the Engineer group. Under each grade are stated the titles of the different positions, and the duties, qualifications and compensation, with any special regulations governing compensation. A grade itself may be divided according to the class of work performed in it; for example, under Grade 3 of the Engineer group some of the positions classified are (1) Assistant Engineer, (2) Assistant Engineer, Civil, (3) Assistant Engineer, Mechanical, (4) Electrical, (5) Sanitary, (6) Power-plant Supervision. The rates of salary for this group vary from $2,280 per annum to $3,180 per annum.

Here, as practically everywhere else in the classified service, the idea is that persons entering the service in a certain grade will do so at the lowest salary rate and will be promoted to receive larger salaries year by year as they gain in experience, even though they remain in the same grade. It is the expectation, apparently, that the best men in each grade will so demonstrate their ability as to justify their promotion to the next higher grade.

Everyone has heard the chronic kicker declaring that the money which a city raises in taxes is spent in paying extravagant wages and salaries to a lot of idle fellows who hold their places by political pull and who would not be tolerated for a day if employed by a private business firm. Those who make such criticisms as a rule have no conception of the other side of the picture—the amount of faithful, hard work, year in and year out, given by men in the municipal service who work often for lower wages, less appreciation, and smaller prospect of bettering their condition than the average employee in a commercial concern.

Criticisms and kicks at the waste and inefficiency of city service have been in circulation time out of mind in cities without number; but the New York City government is the first, so far as we are aware, to undertake a broad constructive plan to better the conditions of city employment by placing it on a systematic basis.

The aim is of course to create a business-like organization in which the pay and promotion of every man will be proportioned to the work which he performs; needless positions will be eliminated; and every competent employee will be encouraged to render better service by placing his pay and promotion on a definite basis.

The size of the volume attests the magnitude of the task. The payroll of New York City is far larger than that of any other city in the world.

Before the Bureau of Standards undertook this work, the city's payroll had been increasing steadily at the rate of $2,000,000 to $2,500.000 a year. In 1915, as a result of the work of standardization, checking salary increases, etc., the city's payroll was reduced more than $300,000. In preparing the budget for 1916, when a more sweeping application of the standard system was made, many salaries lower than the standard rates were raised, and many positions found to be unnecessary were abolished. The saving made was over $600,000.

It is of course too much to expect that any system of his sort can of itself produce efficiency and industry, or can prevent money from being wasted in payment for unnecessary service or service slovenly performed. It is apparent, however, that without some systematic grading of employees such as has been here undertaken, those at he head of a city's government are practically helpless o produce the good results in the way of a businesslike administration, which is always promised in the election campaign but seldom performed.

In the introduction to the volume the basis on which alary rates are fixed is explained. A large amount of data was obtained as to the salaries and wages paid by prominent business corporations, also compensation paid by the Federal Government and by other large cities, espeially where some sort of scientific method had been used n fixing the salary rate. Director Tirrell then reviews he conditions of employment in Government service, aderse and favorable. It is of interest to quote his statement that, "excepting a relatively small number of positions, the city service is not at the present time atractive to the best talent. Advancement and promotion re slow, and it is generally believed that they are not based solely upon merit. . . . Many branches of private business offer far greater opportunities for conpicuous material success than Government employment. . . . It is necessary for the city to pay higher ates than those paid in the most progressive private employments, if it is hoped to attract and retain equally ompetent men."

* * *

A valuable aid to the water-works engineer is the new index of the "Transactions" (1883-1885) and the Journal" (1882-1915) of the New England Water-Works Association. This is a 123-page booklet containing subject and author references to a veritable mine of data on water-works practice. While the early volumes of the "Journal" are rare, it would seem that most of the engineering libraries are supplied with files of the issues ince 1890, so that the greater part of the references could be accessible to engineers in the larger cities. The ndex has been prepared for the Executive Committee by Richard K. Hale, editor of the "Journal." Copies may be obtained by nonmembers of the association for $1, by addressing the headquarters, 715 Tremont Temple, Boston, Mass.

Electrical Design for Students

PRINCIPLES OF ELECTRICAL DESIGN: D. C. and A. C. Generators—By Alfred Still, Fel. Am. Inst. E. E., Professor of Electrical Design, Purdue University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiv + 365; 146 illustrations. $3 net.

The practical designer of electrical equipment will not need this book, and his needs have been purposely neglected to emphasize fundamental ideas. The text obviously is not a compendium for the student either, but rather a convenient guide to be supplemented by lectures, further book study, and home work with design problems. The author's method seems to be so far as possible to proceed logically from fundamental principles, neglecting the practical short cuts which experience generally places in the practiced designer's hand, but employing empirical data and statements where advisable.

A unique feature of the book is the first or introductory chapter which gives some sound advice on qualifications to be cultivated by the student who aspires to be a good designer—on acquiring sound knowledge of engineering principles, respect for ability to draw and write, development of self-confidence, self-reliance and personality.

The course starts off with the magnetic circuit and electromagnets, then goes into direct-current dynamo-electric machinery and finally ends with alternators.

* * *

Rochester Government

GOVERNMENT OF THE CITY OF ROCHESTER, N. Y.—General Survey, Critical Appraisal and Constructive Suggestions. Prepared for the Rochester Bureau of Municipal Research by the New York Bureau of Municipal Research, May-July, 1915. Paper; 6x9 in.; pp. 546; illustrated.

So complete an analysis as this of the operation of the municipal government of a typical American city is sure to prove most instructive and valuable to all who are interested in promoting efficiency in public affairs. The study is the more interesting because Rochester has, like many other Eastern cities, an old-style charter which provides for a single executive and a large council. The investigators have come to the conclusion that this form of charter is not essentially bad, and that a great many improvements in the line of efficiency could be made without changing the charter.

Notwithstanding criticisms which point to many defects in the organization and administration of the city government, the statement is made that the New York Bureau of Municipal Research, after an administrative study of some fifty different municipal governments and a comprehensive study of twenty-five, has decided that in Rochester the results and conditions are superior to those which have been found in any other city investigated. Where other old-type single executive, council-managed governments have broken down, this particular one has held together and done its work well.

The report is made up in exactly the reverse order in which most such documents are written. For the conclusion of the report, in the form of suggestions which can be made effective with and without charter change, form the first two chapters. The tenor of the whole criticism seems to be lack of coördination and lack of definite and single-headed responsibility. Work and responsibility which should be centralized is now divided among several bureaus more or less independent.

An entire reorganization of the Department of Public Works is recommended under a commissioner, with the city engineer made chief engineer of the Department. The Department would then be subdivided into bureaus, whose heads would be appointed by and be responsible to the commissioner, instead of being independent and responsible only to the mayor and council as at present.

Most of the suggestions are sufficiently general in character to apply to almost any other city-engineering organization, and if generally accepted would undoubtedly promote centralization and efficiency in any organization. One recommendation, however, regarding record maps and plans might well meet with some opposition from engineering departments. This is the recommendation that all record plans now kept by the engineering department should be divided up and filed with the different bureaus, as water-works, sewerage, etc.

The wisdom of this recommendation is well open to question, for there is no valid reason why there should not be a concentration of engineering records and data as well as of work and authority. The original plans—tracings—should certainly be kept with the bureau where they originated, and where they are most likely to be wanted for reference and correction. If it is necessary for the different bureaus to have copies for their records, this could easily be arranged, but it would seem far better to centralize the responsibility for keeping the city engineering records in available shape, and much more consistent with the general tenor of the recommendations.

Steinmetz Continues Revision

THEORY AND CALCULATION OF ALTERNATING-CURRENT PHENOMENA—By Charles Proteus Steinmetz, A. M., Ph. D. Fifth edition, thoroughly revised and entirely reset. New York: McGraw-Hill Book Co. Cloth; 6x10 in.; pp. 480; illustrated. $4 net.

The joint revision of Steinmetz's well-known "Elements of Electrical Engineering" and "Alternating Current Phenomena" was mentioned in these columns (May 18, 1916), on the appearance of the new edition of the first named work. It was then noted how the great expansion of electrical science and art had necessitated recasting the two books on new lines and putting some of the new material that had been made available into another, a third, number of the series.

The volume now at hand retains the old title "Theory and Calculation of Alternating-Current Phenomena," but the text shows limitation to discussions only of the more common and general phenomena and equipment—instantaneous values, vector representation, symbolic method, polar diagrams, properties of circuits, eddy currents, dielectric losses, transformers, induction motors and generators, reactions in synchronous machines, general waves, and polyphase power systems.

Estimate and Payroll Tables

STANDARD IMPROVED RATE TABLES—For Manufacturers, Engineers, Bankers, Brokers, Contractors and Shippers—Calculated by John W. Marshall. The Most Rapid Tables in the World for Finding Wage Earnings by Any Unit or Fraction Thereof, and for Any Length of Time. New York: Boorum & Pease Co. Cloth; 7x9 in.; pp. 80. $4.

Rate tables are useful in computing earthwork and concrete, and in preparing monthly estimates, as well as in making up the payroll.

Each leaf of "Standard" rate tables contains two tables; on the front side total amounts are given at a full cent rate, while on the reverse side the amounts are given for a half-cent rate. The total amounts are given from one-quarter unit to 200 units.

Iron and Steel Mysteries

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL—By C. A. Edwards, D.Sc., Professor of Metallurgy, Manchester University. Cloth; 6x9 in.; pp. x + 229; 181 illustrations. $3.50 net.

To the engineer ambitious to know more of the mysteries of iron and steel, a stimulative introduction into the subject of chemistry and structure is offered by the new work of C. A. Edwards. It appears mainly a fairly full discussion of the iron-carbon alloys, and in this part particularly is valuable for its wealth of references. Alloy steels do not seem to be as comprehensively treated. In this field and in the mill and shop field the book gives much less than the worker in the respective fields will look for. A large number of photomicrographs illustrates the structure of carbon steel.

New Art of Power-Belt Design

POWER TRANSMISSION BY LEATHER BELTING—By Robert Thurston Kent, Jun. Am. Soc. M. E., Consulting Engineer. New York: John Wiley & Sons. [Wiley Engineering Series.] Cloth; 5x8 in.; pp. vi + 114; 31 illustrations. $1.25 net.

The scientific refinement of machine-shop practice, wrought by the late F. W. Taylor and his associates, among its other effects has completely revised the old art of designing power-transmission belts. But so scattered in engineering journals and society publications has been the literature of this particular development that the average engineer has been ignorant of the change. This little book should alter that situation, and make the new knowledge accessible to all. The new schemes of design are highly logical, though of course employing empirical factors, compared with the crude rules of thumb which have heretofore prevailed. The new schemes usually call for heavier belts and lower tensions than the old formulas, but they result in a minimum annual cost—considering expense of repairs and maintenance and loss through breakages—as well as first cost.

Applied Electricity

APPLIED ELECTRICITY FOR PRACTICAL MEN—By Arthur J. Rowland, Professor of Electrical Engineering at Drexel Institute. New York: McGraw-Hill Book Co. Cloth; 5x8 in.; pp. xiv + 375; 323 illustrations. $2.

The better class of electrical texts for practical men are of great interest and importance to a wide variety of highly educated specialists—including of course the mechanical or civil engineer who comes in contact with electrical equipment at every turn though he never designs any of it. So it is that this book, though it is primarily intended for electrical workers, has a place in an engineer's library. One of its prominent features is the large use of numerical-computation problems to illustrate the action of apparatus.

The book starts off with "fundamental principles" and magnetic phenomena. Thus the road is paved for direct-current generators, heating and power service, distribution lines, and direct-current motors. Up to the close of this half of the work, nothing has been presented about alternating currents. For this field the author first goes back to elementary discussions of rudimentary matters like inductance, capacity, reactance, voltage and current waves, etc., preparing to carry the reader into such subjects as transformers, polyphase distribution, a.c. generators and motors. The end of the book covers storage batteries, electric lamps and house wiring.

The book is very readable and the discussions are helped by a moderate use of well selected illustrations.

Two new standard specifications for brick pavements iave been issued by the National Paving Brick Manufacturers' Association under date of Sept. 1. They cover he two new approved methods of brick-pavement construction—brick laid on the green concrete foundation (monolithic construction) and the use of a dry sand-ement mixture in place of sand as a bedding or so-called ushion course. The specifications for laying brick on he green concrete foundation state that after the foundation has been laid and shaped in the usual way it 'shall be brought to the required smoothness and condition for laying the brick thereon by adding thereto a hin coating of sand and cement." The following paragraph provides for the dry mixing of one part cement o three parts sand, and it is presumed that this mixture s applied dry to the foundation concrete, although the pecifications do not definitely say so. The brick are aid, rolled and grouted as in ordinary practice.

The specifications for the "sand-cement superfoundation type" vary from the standard sand-cushion type hiefly in the "superfoundation," which is a dry mixture f 1:4 cement and sand, stone screenings or granulated lag. This bedding course is not over 1 in. in depth. t is struck off to a smooth surface and rolled with hand ollers before laying the brick. Copies of these specifications may be obtained by applying to Will P. Blair, Secretary, National Paving Brick Manufacturers' Association, Engineers' Building, Cleveland, Ohio.

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So much interest has been manifested in the paper ntitled "The Typhoid Toll," presented by George A. 'ohnson, Consulting Engineer, New York City, before he recent convention of the American Water-Works Association, that the association has decided to reprint t in the hope and expectancy that it will be bought and istributed in large numbers by water-works men and thers interested in putting down typhoid fever. The rice per copy up to 99 copies will be 20c. without, or 5c. with, the discussion; for 100 copies the prices will e $15 and $18.75; 100 to 500, $14 and $17.50 per 00; over 500, $12.50 and $15.75. Orders should be ddressed to John M. Diven, Secretary, American Water-Works Association, 47 State St., Troy, N. Y. The paper eviews the causes and means of prevention of typhoid ever, with special relation to public water-supplies. It lls 77 pages, and is followed by an equal number of pages f oral and written discussions by many engineers and anitarians.

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Any one desiring information on autogenous welding f steel pipe by the oxyacetylene process should secure he new edition of Bulletin 26 of the National Tube Co., Pittsburgh, Penn. This bulletin gives the history and echnology of such work by an extensive reprinting of oteworthy papers. Use of welded gas mains and piping n general is treated. Efficiency, cost and strength of welded joints are discussed.

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The sections on cement, lime, sand and gravel and on sphalt, etc., have been reprinted separately from "Mineral Resources of the United States, 1915," published by he United States Geological Survey, Washington, D. C.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

THE ANALYSIS OF COPPER AND ITS ORES AND ALLOYS—By George L. Heath, M. Am. Inst. M. E., Chief Chemist, Calumet & Hecla Smelting Works. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. vii + 292; 20 illustrations. $3 net.

ANNUAL REPORT OF THE QUEBEC STREAMS COMMISSION, 1915—Quebec, Canada: the Commission. Paper; 7x10 in.; pp. 109; illustrated.

AUSTRALIAN COMMONWEALTH DEMOGRAPHY, 1915 and Previous Years—Melbourne, Australia: Commonwealth Bureau of Census and Statistics. Population and Vital Statistics Bulletin No. 33. Paper; 8x13 in.; pp. 272. 5s.

AUTOMOBILE WELDING WITH THE OXYACETYLENE FLAME: A Practical Treatise Covering the Repairing of Automobiles by Welding, with a Nontechnical Explanation of the Principles To Be Guided by in the Successful Welding of the Various Metals—By M. Keith Dunham. New York: Norman W. Henley Publishing Co. Leather; 4x6 in.; pp. 167; 65 illustrations. $1.

CHEMICAL STUDY OF ILLINOIS COALS—By S. W. Parr. Bulletin 3, Illinois Coal Mining Investigations, conducted jointly by United States Bureau of Mines, State Geological Survey and Engineering Experiment Station, University of Illinois. Urbana, Ill.: State Geological Survey. Paper; 6x9 in.; pp. 86; illustrated.

GAS, OIL AND PETROL ENGINES, Including Gas-Producing Plant and Humphrey Explosion Pumps—By A. Garrard. New York: Whittaker & Co. Cloth; 5x8 in.; pp. viii + 221; 112 illustrations. $2.

GEOGRAPHIC TABLES AND FORMULAS—Compiled by Samuel S. Gannett. Fourth edition. Washington, D. C.: United States Geological Survey. Bulletin 650. Paper; 6x9 in.; pp. 388; illustrated. 25c. per copy from Superintendent of Documents.

THE MEASUREMENT OF SILT-LADEN STREAMS—By Raymond C. Pierce. Washington, D. C.: United States Geological Survey. Water-Supply Paper 400-C. Paper; 6x9 in.; pp. 39x51; illustrated.

MECHANICAL EQUIPMENT OF BUILDINGS: A Reference Book for Engineers and Architects—By Louis Allen Harding, B. S., M. E., M. Am. Soc. M. E.; and Arthur Cutts Willard, S. B., formerly Assistant Professor of Mechanical Engineering, George Washington University, and Sanitary and Heating Engineer, United States War Department. New York: John Wiley & Sons. Leather; 7x9 in.; pp. 615; illustrated. $4 net.

MELTING ALUMINUM CHIPS—By H. W. Gillett and G. M. James. Washington, D. C.: United States Bureau of Mines. Bulletin 108, Mineral Technology 14. Paper; 6x9 in.; pp. 88. 10c. a copy from the Superintendent of Documents.

THE MODEL T FORD CAR: Its Construction, Operation and Repair—By Victor W. Page, Member of the Society of Automobile Engineers; author of "The Modern Gasoline Automobile." New York: Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 228; 94 illustrations. $1.

MORTALITY STATISTICS, 1914—Washington, D. C.: Bureau of the Census. Cloth; 9x12 in.; pp. 714.

NEW YORK STATE DEPARTMENT OF HEALTH: Report for the Year Ended Dec. 31, 1914. Albany, New York. Cloth; 6x9 in. Vol. I, General Information. Pp. 876; illustrated. Vol. II, Report of the Sanitary Engineering Division. Pp. 502.

PARKS: Their Design, Equipment and Use—By George Burnap, B. S., M. A., Landscape Architect of Public Buildings and Grounds, Washington, D. C., Lecturer in Landscape Design, University of Pennsylvania, Special Lecturer, University of Illinois; with an Introduction by Richard B. Watrous, Secretary American Civic Association. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 7x10 in.; pp. 310; 163 halftones and 4 diagrams. $6 net.

PASSENGER TERMINALS AND TRAINS—By John A. Droege, General Superintendent, New York, New Haven & Hartford R.R. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. v + 410; 220 illustrations. $5.

PROBLEMS IN PHYSICS FOR TECHNICAL SCHOOLS, COLLEGES AND UNIVERSITIES—By William D. Henderson, Ph. D., Associate Professor of Physics, University of Michigan. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 205; 167 illustrations. $1.50 net.

THE PURPOSES OF THE INDEBTEDNESS OF AMERICAN CITIES, 1880-1912—New York (261 Broadway): Bureau of Municipal Research and Training School for Public Service. No. 75, July, 1916. Paper; 6x9 in.; pp. 72. $1.

SEVENTH ANNUAL REPORT OF THE BOARD OF SUPERVISING ENGINEERS, CHICAGO TRACTION, Covering the Fiscal Year Ended Jan. 31, 1914—Cloth; 6x9 in.; iv + 277; illustrated.

A STUDY OF THE BEHAVIOR OF RAPID SAND FILTERS SUBJECTED TO THE HIGH-VELOCITY METHOD OF WASHING—By Joseph W. Ellms, M. Am. Soc. C. E., and John S. Gettrust. With Discussion. Reprinted from "Trans." Am. Soc. C. E. Vol. LXXX, p. 1342 (1916). New York. Paper; 6x9 in.; pp. 1342-1428; illustrated.

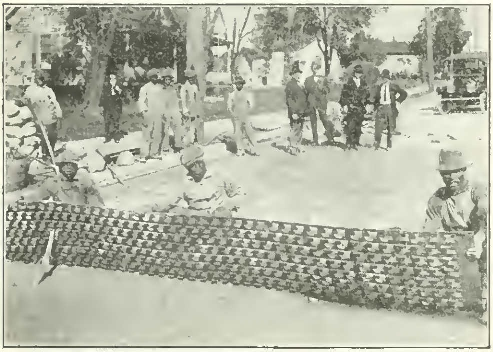
Notes from Field and Office

Charlotte tries sheet-steel paving—New York Central's experience with an electric tie tamper—Types of dumping trestle on 50-mile Southern relocation—Part sand plays in concrete failure—How one big New York contractor timbers and excavates the new subways—Pile jetting practice on several railways

Sheet Steel for Paving

A steel-plate pavement is the latest innovation of the seekers after the "universal" and "perfect" pavement. It harks back to the early sixties, when cast-iron blocks were thought to solve the same problem, and were actually tried out on Cortlandt St., New York City.

The city to be famed for trying out steel-plate pavement is Charlotte, N. C. The pavement has been laid on West Ave., where a macadam roadway 7 in. thick is under construction; the gradient at this point is 4%. The following method was employed: The macadam was built up to within 3 in. of net grade, forming a base 4 in. thick, upon which was deposited concrete proportioned 1 : 2 : 4, which the largest aggregate not over 3/4 in. in size. The surface was leveled with a strikeboard.



STEEL PLATES LAID IN CONCRETE AS AN EXPERIMENTAL PAVEMENT IN CHARLOTTE, N. C.

The wearing surface consists of steel plates 18 ft. long, 30 in. wide, and of No. 11 gage 1/8 in. thick, with trapezoidal-shaped perforations 2x1½x1¼ in. in size, spaced from 1 to 1½ in. apart. The shorter parallel side of each perforation is uncut, and the metal is bent down at right angles to form a projecting dovetail on the under side of the sheet. Along one side of each sheet, tongues or lugs 1 in. square are left at intervals of 6 in.; on the other side slots are spaced to correspond, forming a connection for adjacent sheets.

The steel sheets were placed in position and tamped to a solid bearing, with the tops flush with net grade. Each steel sheet was joined to the one already placed by raising the outer edge and slipping the tongues of the new sheet into corresponding slots of the other plate. The new sheet was then lowered, and at the same time pushed close to the other sheet. A space of about 1/8 in. was left between adjacent sheets. The accompanying view shows a sheet being lowered to place, also the finished pavement in the background.

The following items show the extent and actual cost of the work:

Area 18x80.34 ft., 160 68 sq.yd.	
Macadam base 4 in. thick	$48 00
Concrete materials	61 90
Steel surfacing	180 77
Labor, including supervision	40 00
Total cost	$330.67
Unit cost, $2.06 per sq.yd.	

The steel cost $50 per ton; cement $2.60 per bbl.; crushed stone $1.50 per cu.yd.; sand $1 per cu.yd.

The inventor and patentee of the pavement is J. F. Wixom, "a retired farmer," of Hammondsport, N. Y., who is quoted as stating that for an 18-ft. country road (for which the pavement is designed) the approximate cost of the steel plates would be around $10,000 or $12,000 per mile, and the estimated cost of getting the material on the ground and of the actual laying of the road is $5,000, which will total approximately $15,000 or $17,000 per mile. The city engineer of Charlotte, who has given the pavement a trial, is S. H. Lea.

*

Electric Track Tampers on the New York Central

By G. W. Vaughan*

An electric track tamper used in Germany was described in *Engineering News*, Mar. 16, page 515. On the same page is a column article dealing with electric, pneumatic and hand tamping of track ballast. Since seeing those articles it has been in my mind to comment briefly upon the German machine, and furnish further information on the Vaughan electric tamper. The accompanying views show the tamper in operation on the New York Central R.R.

Referring to the electric machine used in Germany, and which has been patented in the United States, I note from the photograph that the tamper evidently could not be used unless the ties were spaced farther apart than is the general American practice, and that in operating the machine the men have to bend over practically as much as if they were using a tamping pick.

The rate of progress of a gang of six men operating four of these machines on the Hamburg-Berlin line is given as 500 ft. per day, the cost per foot of track being 2.2 cents. The view in the Mar. 16 article, however, indicates that only one side of the tie was tamped, as is done when picks are used. Therefore, if these machines tamped both sides of the ties the cost would be double.

On account of the straight tamping bar and the position of the machine, it would seem that it would be impossible to use it to tamp switch ties or around switches and frogs or slip switches, where the ties are very close together. If I am right in this, the application of the machine would be limited to tracks where the ties are quite wide apart. There is no question that the machine will tamp ties providing the tamping bar is placed lower than the bottom of the tie, so as to drive the ballast under the tie.

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*Engineer of Maintenance-of-Way, New York Central Railroad Co., Grand Central Terminal, New York City.

In the Vaughan electric tamper, the motor of the machine, contained in a box on the side, drives the crank in the back of the casing. The crank moves a reciprocating cylinder within which is a free piston driven back and forth by the air compression in the cylinder and by a solenoid at the lower end of the tamper, the reciprocating cylinder shifting the magnetic field produced by the solenoid. The electric tamper weighs 86 lb. and the tamping bar 4 lb., making a total weight of 90 lb., and requiring two men to operate.

Fig. 1 shows a foreman and five men using these tampers on general section work. This foreman claims he would rather have this outfit in his gang than six addiional men. I think, however, that this statement can be aken with a grain of salt, as I believe that if the machine is equal to four additional men on a section, that is all that could reasonably be expected of it. Fig. 2 shows the tamper in operation in the third-rail territory of the Electric Division, taking current from the third rail hrough resistance boxes shown at the right of the track. Fig. 3 shows the tamper in operation in connection with generating set mounted on a handcar, which is equipped o that electric lights may be used when working in unnels. Fig. 4 shows the electric generator.

At the present time there are a number of these tampers working on the Electric Division, taking power from the third rail, and on the Exterior Zone taking power rom a generator car. The tampers are usually operted in sets of three, so that in case of accident there is spare tamper with which to continue the work.

In tamping tracks two of these machines are operted simultaneously from opposite sides of the tie which means thorough tamping of the ties. This necessitates twice as much work as required by hand tamping, as in the latter case only one side of the tie is tamped. If both sides were tamped by hand, the second tamping would loosen up the ballast previously tamped. Where the machine tampers are used on opposite sides of the tie, the track will stay up longer and better than by any method of hand tamping. On the New York Central there is track that was tamped by machine in 1914 and has not been tamped since that time.

The cost of operating the Vaughan tamper, first by using a portable gasoline-engine-driven generator and second by taking current from the third rail through parallel resistances is as follows:

Cost of generator	$600.00
Cost of two tampers	400 00
Cost of two resistances, including contact boards, cables, etc	100 00

Depreciation and interest per day is figured on the assumption that the machines were used 180 working days per year.

TAMPERS OPERATED FROM GENERATOR

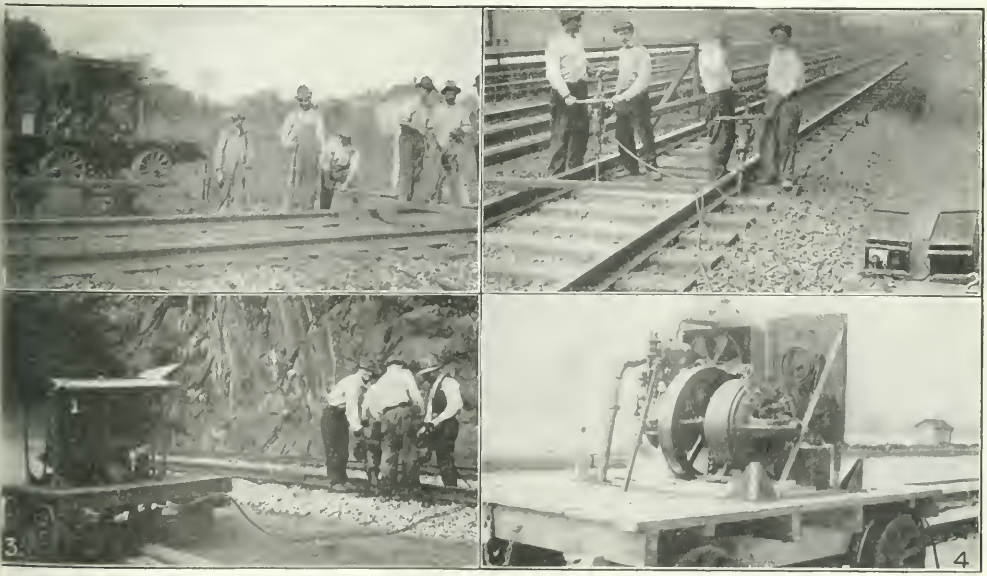
Operation		
Foreman, 10 hr	$0 27	$2 70
5 men, 50 hr	.19	9 50
Gasoline, 4 gal	20	80
Engine oil, ⅝ pint	.05	.03
Fixed Charges		
Depreciation (generator)	7½%	.25
Depreciation (two tampers)	10%	22
Interest and maintenance (generator)	10%	.33
Interest and maintenance (two tampers)	15%	.33
Total cost per day		$14 16

Tamped on average 356 ft. per day.
Total cost per foot, $0.04

TAMPERS OPERATED FROM THIRD RAIL

Operation		
Foreman, 10 hr	$0.27	$2.70
6 men, 60 hr	.19	11.40
Power, 96 kw.-hr	.01	.96
Fixed Charges		
Depreciation (2 tampers)	10%	.22
Depreciation (2 resistances)	7½%	04
Interest and maintenance (2 tampers)	15%	33
Interest and maintenance (2 resistances)	10%	.06
Total per day		$15 71

Tamped on average 356 ft. per day.
Total cost per foot, $0.044.



FIGS. 1 TO 4. VIEWS OF VAUGHAN ELECTRIC TAMPER AND POWER SUPPLY

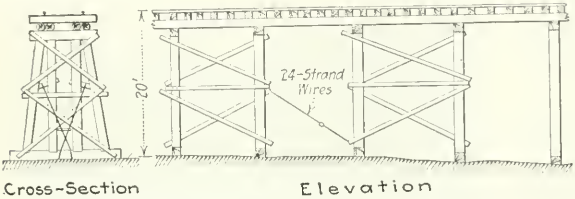
Dumping Trestles Seen on the Southern Ry.

Railway fills are made chiefly by dumping from one or more lifts of trestle or by building one trestle and then jacking the track to grade. As is the case on most large grading jobs where several contractors are doing the work, both these methods are in use in grading the 50-mi. second-track Southern Ry. relocation between Central, S. C., and Cornelia, Ga. Some of the typical dumping trestles are shown herewith.

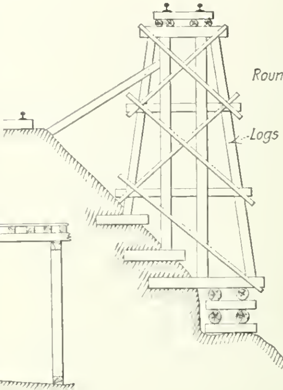
Half a mile south of Ayersville, Ga., the trestle for a fill on the new line is built on the side of the old 70-ft. fill. This trestle was not anchored very securely, as Figs. 2 and 5 indicate. In dumping, the 12-yd. cars were backed out on the trestle very carefully and just far enough to dump clear.

The timbers, which are obtained near the right-of-way, are hauled to place and hoisted by hand, by ox team or by mules. Fig. 1 shows the design of a trestle at Seneca, S. C., in which some of the bents were wired together. Some single-story bents that reach 70 ft. in height are shown in Fig. 4.

Two especially good examples of the trestle method and the jacking method are found on this work. The heaviest fill is 150 ft. high, and it has been carried up more than 60 ft., to date, by jacking the tracks from the first 18-ft. trestle lift. This work is near Toccoa, on the Lane section. Near Deercourt, Ga., a 105-ft. fill is being made from three parallel trestles of increasing height. This is on the Rinehart & Dennis section. This fill must be carried across a 30-ft. arch culvert at Walton's Creek. The 150-ft. fill is pierced by a 5-ft. arch culvert 533 ft. long, described in *Engineering News*, Nov. 2, p. 850. Both these large fills are almost entirely borrow.



Cross-Section
Elevation



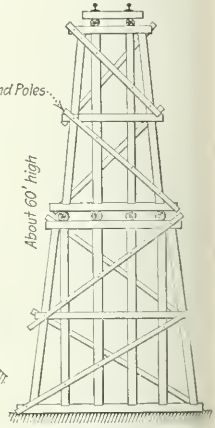
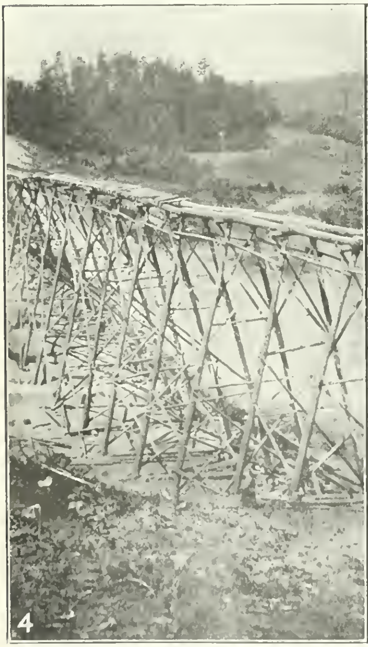
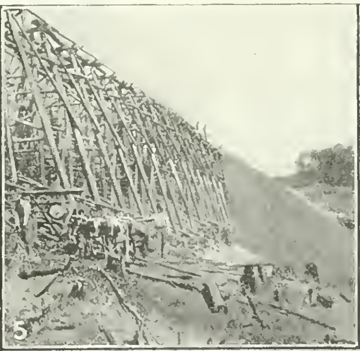
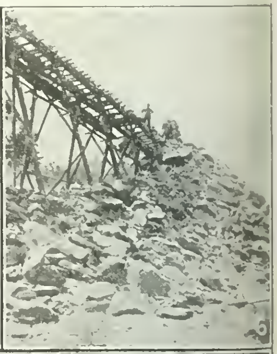


FIG. 1. TRESTLE AT SENECA, S. C., IN HEAVIEST FILL ON NORTHERN SECTION. FIG. 2. TRESTLE BUILT ON SLOPE OF OLD 70-FT. FILL. FIG. 3. TWO-STORY TRESTLE-BENT THREE MILES SOUTH OF TOCCOA, GA.







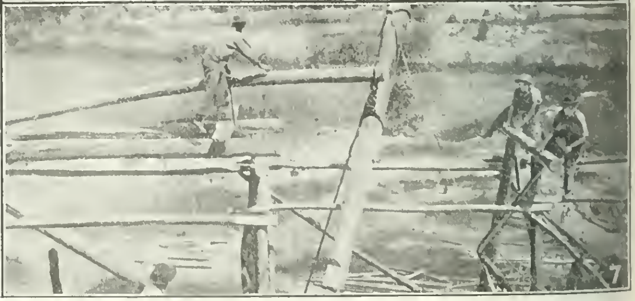


FIG. 4. HIGH TRESTLE WITH SINGLE-STORY BENTS. FIG. 5. BUILDING TRESTLE ON SIDE OF OLD FILL (SEE FIG. 2). FIG. 6. FILLING WITH ROCK. FIG. 7. ERECTING STRINGERS, USING MULE HOIST

Albany Engineers Discuss Sand

The increasing attention given to the quality of sand used in concrete was emphasized by D. A. Watt, Assistant Engineer, United States Engineer Department, Albany, at the "concrete meeting" held by the Albany Society of Civil Engineers on Oct. 24.

In all concrete failures that have come under Mr. Watt's observation it has been shown that bank sand was used. River sand seems to make a better concrete. It has been demonstrated that 5% silt increases the strength of concrete and that even 10% is not deleterious, but that beyond 10% the concrete becomes poorer.

Mr. Martin called attention to the fact that the presence of oxide of iron in sand retarded or actually prevented setting of concrete, depending upon the amount of the oxide present. It occurs as a hard reddish coating on the grains. This condition is found in Adirondack sand.

Quite a controversy arose on the subject of laitance and how far this feature of concrete work was due to the sand. I. S. Mattimore said that the State Highway Commission specifies coarse sand and that with this quality of sand and a drier mix than is common practice no trouble has been experienced with laitance.

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Subway Steelwork Kept 20 Ft. Behind Heading

By George D. Fried[*]

On Section 4 (Routes 4 and 38) of the Seventh Ave. subway between 12th and 13th St., New York City, progress in excavating was very much hampered after reaching groundwater—at 27 ft. below the street surface and about 9 ft. above subgrade of the subway. About 2 ft. below groundwater a mixture of very wet clay and fine sand was encountered having a bearing of approximately 4 tons per sq.ft. The subgrade of the trench was about 36 ft. below the street surface, and 90.5 ft. wide, where the completed subway has a four-track express station 500 ft. long. The distance between theoretical building lines is 100 ft., allowing only 4.75 ft. between neat lines of subway and building.

Excavating proceeded in four lifts, the first being from 10 to 15 ft. deep. This depth is practically the same as that of ordinary cellars and basements, the walls of which formed the sides of the excavation, thus affording easy access to the buildings for underpinning operations and eliminating also the necessity for sheetpiling. The second, third and fourth lifts were 24, 30 and 36 ft. respectively below the street surface.

Excavating was done with pitchforks and shovels. The muck was conveyed to the nearest shaft in 0.8-yd. buckets running on tracks on the finished floor.

Starting at the third lift, at points where the subway steel would not interfere, the street loading was transferred to four 30-in. 180-lb. 42-ft. longitudinal needle beams, as illustrated in Fig. 1. These I-beams were on 20-ft. centers, and from them were suspended 12x12 braces, as shown.

The needle beams, with 20 ft. of their forward ends resting on the third lift of the excavation and their rear ends supported on the finished floor of the subway, are the key to the timbering method, by which the finished structure was kept 20 ft. behind the heading face of the lowest lift. At the face 2-in. t. and g. sheeting was driven 3 ft. below subgrade and braced.

The posts adjacent to the heading—centered on the line of the temporary posts and having concrete footings extending 1 ft. 2 in. below subgrade to take the street load—were set before excavating the fourth lift. As soon

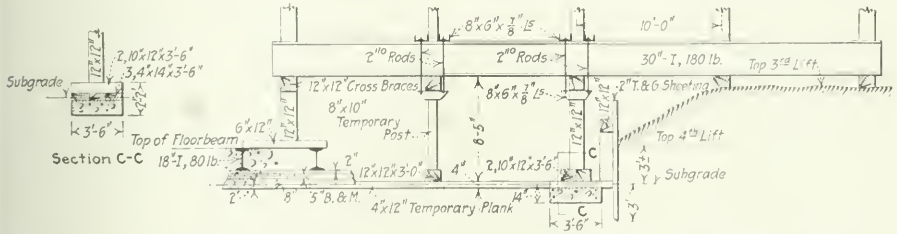

Fig. 1 Longitudinal Section

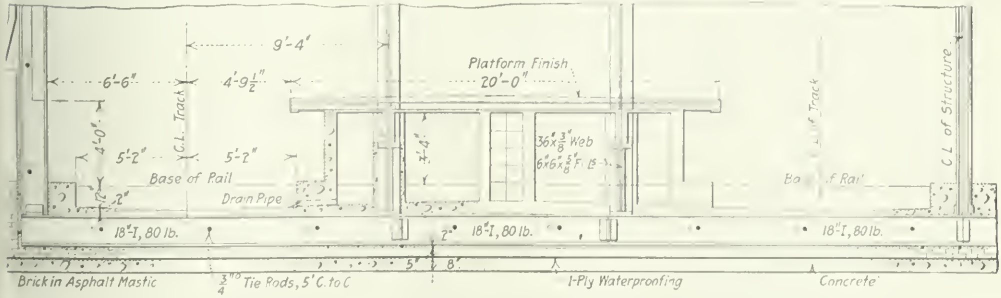

Fig. 2 Section of Completed Structure

NEEDLE-BEAM SYSTEM AND WORKING SPACE, AND CROSS-SECTION OF COMPLETED SUBWAY as the excavation of the fourth lift reached the final subgrade, 4x12-in. plain rough planks were placed on the bottom in order to keep the water down as much as possible. This plank bottom was held in place by means of intermediate temporary wood posts on spread footings placed on 10-ft. centers transversely.

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[*] 182 St. Nicholas Ave., New York City.

Just before placing the 8-in. concrete floor the planks and posts were removed. The waterproofing—one-ply fabric and 5 in. of brick in asphalt mastic—was placed on the floor concrete, and upon this was set the grillage consisting of transverse 18-in. 80-lb. I-beams, 5 ft. c. to c. longitudinally. These beams were concreted, and to them was transferred the load carried by the needle beams. The latter were then moved ahead 20 ft., to make ready for the next section.

At the inside column lines of the completed subway (Fig. 2), the 18-in. floor-beams carry 36-in. longitudinal girders 10 ft. long and 10 ft. 11 in. c. to c. transversely, weighing about one ton. These floor beams were not riveted until the bottom of the next 20-ft. section had been concreted, allowing the steel, which was set 1 in. high, to settle to grade. In only a few places was there any settlement below grade due to the vertical load forcing out the wet clay and fine sand on the bottom. This proved the effectiveness of the method safely to confine the running water and soil. Where the steel settled below grade, shim plates varying from 1¼ to ⅛ in. thick were placed on top of the 18-in. floor-beams, to insure the roof of the completed subway being set to the proper base-of-rail clearance.

The buildings were maintained against settlement or tranverse movements by driving 40-lb. arch-web steel sheetpiling 14 ft. below subgrade at subway neat lines, instead of the usual 4-in. t. and g. timber sheeting.

FINE AGGREGATE

Pile-Jetting Practice—In a recent investigation by the American Railway Bridge and Building Association on the subject of driving piles in railway construction it was found that the water jet is in successful use under proper conditions on about 50% of the 56 railways from which data were obtained. Some use it only with concrete piles, others for foundation piles or only with a marine piledriver. Only one failure is reported, and it is ascribed to the small size of the pump. Favorable conditions for jetting are sandy soil or gravel and deep penetration. The practice is fairly uniform, and that of the New York Central (Lines West) is typical. It is as follows:

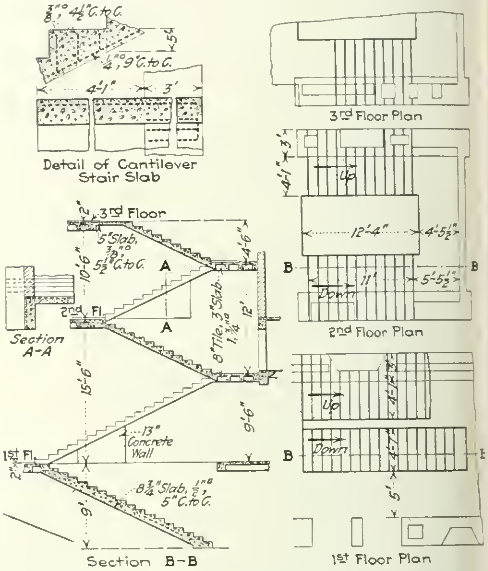
> The water jet is sometimes used to put down piles in sand, where the track can be adequately safeguarded and where there is plenty of water and provision for the waste water to run away. For jetting, a pump of sufficient capacity is placed near a stream or other body of water, when at hand, or else on the piledriver tank. A 2½-in. hose is used with a 2-in. iron-pipe jet 30 to 40 ft. long, with the lower end drawn down to a diameter of about 1¼ in. to serve as a nozzle. For a 30-ft. pile the jet is so manipulated that the pile will go down about 25 ft. under the weight of the hammer, then driven the remaining 5 ft. to place.

The committee report states that the jet pipes of the different railways vary from 2½ to 1¼ in. The Chicago & Northwestern Ry. uses the following jet pipe:

> A 2-in. pipe drawn out to a 1-in. nozzle, and somewhat longer than the depth to be penetrated, is used. The upper end is fitted with an elbow, a nipple and a loose connection to a duplex pump of sufficient capacity to maintain a pressure of 100 lb. per sq.in. in the pipe with an unobstructed flow through the nozzle. A separate line tied to the top of the pipe passes over a block to the top of the leads and down to the winchhead, furnishing means for readily raising and lowering the pipe.

On the Southern Pacific, difficult ground is penetrated using a pipe drawn out to a rectangular shape about 1¼ in. by 2 or 2½ in. Two jet pipes occasionally are used. The water pressure varies from 100 to 225 lb. per sq.in., and pumps with 3- or 4-in. discharge pipes are generally used. A large volume of water at moderate pressure gives the best results.

A Reinforced-Concrete Stairway cantilevering out from side walls was recently built for the residence of George Howe at Chestnut Hill, Philadelphia, by the Humphrey Construction Co. The owner of the house, an architect, had plans drawn in which stairs extended on opposite sides of a hall, leaving an open well down the middle. He particularly desired not to have columns on the outside edges of the stairs, so that it was necessary to tie them back by cantilevering to the brick walls. These brick walls were made 3 ft. thick and extended clear from basement to roof, and the stair was designed as shown in the accompanying cut. In this design each riser and tread i figured as a separate cantilever beam 12 in. wide and 5 in deep. Two openings in the brick wall precluded the prope bearing of the concrete on the brick, one because of a close and the other for a fireplace. In these two cases the rein forced-concrete stair was turned at right angles and continue vertically down as a 13-in. concrete wall to the nearest floor which was also of concrete joist construction; and the rein forcement from the stair was turned and tied down as a hoo around the steel of the floor joist. The work was designe under the direction of Louis Muhlhausen, 1029 Brown St Philadelphia, Penn., who was at that time engineer for th contracting company.



CONCRETE CANTILEVER STAIRWAY IN RESIDENCE

Repairing Narrow-Gage Steel Crossties—Steel crossties fo mine use are expensive, and it has been found justifiable t spend considerable time and money in repairing old broke ones, according to C. W. Stafford, of Stone, Ky., in "Coal Age. He says the tie in most extensive use and the one that ge out of commission easiest has lugs punched from the bod of the tie to form the rail fastenings. When a car is wreck and dragged along the track, the flange of the wheel mashe these lugs flat. When the trackman attempts to straighte them, they usually break off, rendering an otherwise goo tie useless. These broken ties are taken to the blacksmit shop, where they are repaired by one of two methods. By th first, a piece of ¼-in. iron is riveted on the end of the tie to take the place of the lugs. Two holes are punched in th end of the tie, outside of the old lug holes. A piece of iron i cut about 3x3x¼ in. and bent so that it will admit the ra when in place. Two holes are then punched in this piec to correspond to the holes in the tie, and the piece is rivete on. An improvement over the method just mentioned is t take a piece of iron about ¼x¼x6 in., neck it slightly, stic the head of this piece up through the old lug hole in th tie, turn it flat so that the head cannot slip out, and bend th end around and over the end of the tie. Using this metho instead of the other saves about one-third the amount o metal required and saves also in time.

Editorials

Why Not a Better Joint for Water Mains?

Do water-works engineers ever stop to consider that he present type of bell-and-spigot water-main joint has ndergone practically no change in a hundred years? Do hey ever question whether the method of making a joint an be improved? If not, why not?

The committee of the New England Water-Works Assoiation on leakage from pipe joints has clearly demontrated that there is an enormous economic loss resulting rom leaky water mains. This is an era of conservation, nd the cause and prevention of this loss should be looked nto.

The cause may be slippage of meters. If it is, there hould be more accurate meters. But some part of the 0% unaccounted for water in city systems, and probably large part, comes from leaky joints. Let waterorks men turn to and give this matter a little study.

So far the committee has not been able to draw any onclusions as to whether it is economically possible to educe the 20 to 30% water loss by a better type of joint, etter workmanship, testing at pressures above normal, or n some other way. The information most needed to reach onclusions is that giving the results of leakage surveys, actual tests made after the pipe has been in service ome years, of experimental work showing the relation beveen pressure on the joints and leakage, and particurly data from those water departments where accurate ests have shown leakage in mains to exist. F. A. Barour, Consulting Engineer, 1120 Tremont Building, Boson, Mass., is chairman of the committee.

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Patenting the Unpatentable

Another blow to patenting the unpatentable has been ruck. This time patent claims on mechanical water lters have received the sort of death blow that has been livered of late in a number of reinforced-concrete patit suits.

The case just decided involved the use of central opering control of valves, and also the use of screens beveen the sand and gravel, in the mechanical watertration plant of the City of Minneapolis, as stated n one of the last pages of this issue.

Two years ago a lower court threw out the same pattee's claims to control the combination of a filter bed ove and a clear-water chamber below with means of rcing water up from the chamber through the bed, and nied some other claims as well; but although expressing oubts as to the validity of the central-control and the reen claims, the court lacked conviction or courage to eclare them invalid also. By the recent reversal of the ecision of the lower court, three filter patents, either holly or in their leading claims, go by the board.

The marvel is not that these patent claims were declared valid but that they were ever allowed. The same is true of some of the patents on reinforced concrete held invalid during the last year or so.

In effect, the courts have decided in what is now a respectable number of cases that the Patent Office has been putting its great seal on solemn declarations that John Smith, Richard Roe and James Doe have made new and useful inventions when all these gentlemen really did was to search current engineering design for some detail or combination that would give them a basis for patent and royalty claims. This is not invention. It may yield royalties. It is sure to cause litigation. Happily the many recent adverse court decisions will tend to discourage inventors, and perhaps the Patent Office, from attempting to patent the unpatentable.

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Record Dam and Turbines in Yadkin River Plant

An overfall dam 169 ft. high from top of toe to crest, and turbines of 31,000-hp. maximum capacity are outstanding features of the Yadkin River development, described elsewhere in this issue, that command immediate attention. But beyond these, this whole development is of unique interest, historically and in its details of design and construction.

Probably no important plant in the country has passed through more surprising vicissitudes and has had more radical revisions of its engineering plans than has this one, now safely approaching completion. To start with, there was a half million dollars or so spent in a beautiful long, low, cut-stone dam that was soon abandoned. Later owners laid out a higher dam lower down on the stream and a power house to contain the largest direct-current generators that had been designed. Then came a French aluminum company with a high non-overflow curved gravity-section dam and outlets for flood overflow through a couple of 60-ft. wells and tunnels. Finally appeared the present American owners with the great full-length overfall dam and record-breaking turbine units now under construction.

Designers will be interested particularly in the dam with its many contraction joints about 50 ft. apart, simply sealed by a multitude of tar-painted key grooves, and in the great pains taken to secure the completely grouted heel and fully vented base. The enormous yardage of concrete (525,000 cu.yd.) almost equals the record established at the Elephant Butte dam in New Mexico (600,000 cu.yd), although it is still much under the 850,000 cu.yd. in the Olive bridge (Ashokan) dam and the million odd yards at Kensico. The Yadkin dam appears, however, to be by a good margin the highest long overfall dam yet built anywhere.

Each case of the use of such enormous hydraulic turbines as employed here (27,000 hp. or 31,000 hp., according to the method used in rating) is always interesting and significant, but is not to be taken as an indication of a universal increase in the size of hydraulic turbines that are being commonly used. The field for smaller units is as great as ever. It is not the height of desirability in the great majority of cases to concentrate the station capacity in a few units of such size. Only is it warranted, where, as here, the load is extremely well sustained and the total amount of power very large, so that such machines become feasible without sacrificing flexibility of operation and high light-load operating efficiency of the plant.

The turbine manufacturers have made a notable contribution to their art—with their huge plate casing, the big cast-bronze runner, the new scheme of dismantling and the simplification of bearings. The Holyoke test efficiency is very high, approximately 91%; and if it proves possible to get a good measurement of the water flowing through the station, it may be expected that a few more points will be added to this figure.

The contractor's work illustrates among other things the application of old industrial methods that may be widely utilized with profit by such concerns—such efforts as the standardization of working equipment to simplify maintenance and to increase familiarity of the working forces with all machines engaged on similar operations; or the concentration of concrete-mixing capacity in two maximum-size units for the reduction of number of mixer-plant tracks and for the reduction of time of loading and placing, where great speed is to be developed. Had the contractor on the Yadkin work not suffered the loss of his downstream tracks by the unprecedented floods that visited North Carolina in July, it is certain that he would have set a new high record for amount of concrete placed in one day, probably reaching as high even as 4,000 cu.yd or over.

In all respects, then, in history, in size and design of dam, in station layout, in design of turbines and in the contractor's equipment and methods, the Yadkin River work is remarkably significant and worthy of the careful scrutiny of engineers in all branches of the profession who desire to study the advancement of their art. In few plants indeed have so many important advances culminated on one job.

Greater Safeguards Needed for Drawbridge Openings

The shocking disaster at Boston on Nov. 7, when a crowded street car plunged to the bottom of the Fort Point channel at an open drawbridge and 16 persons imprisoned inside the car were drowned, ought to call attention everywhere to the need of more adequate protection at such danger points. This is the most serious drawbridge accident since the wreck at Atlantic City on Oct. 28, 1906, when a train was derailed at the drawbridge across the Thoroughfare just outside the city.

The investigation in the Atlantic City case promptly revealed the fact that the protection to the drawbridge opening was inadequate and did not conform to good practice in the art. Many years earlier, railway signal engineers had definitely established an equipment of home and distant signals interlocked with derailing switches and with the bridge operating mechanism as the standard protection for drawbridge openings on steam railways. The lack of this protection at Atlantic City cost the lives of 61 persons for whose deaths the railway was held financially responsible in a very large sum.

It may as well be frankly confessed that the prote tion of drawbridge openings on electric street railwa is sadly deficient almost everywhere compared with stea railway practice. In many cities it has been taken f granted that because a street railway car normally ru at slow speed, a more or less flimsy gate at the dra bridge opening with a red lantern hung on it at nig is all that is required to safeguard street cars and oth vehicles from running into the opening left when t bridge is swung to permit river traffic to pass.

The Boston disaster proves the falsity of this assum tion. The motorman did stop, according to the rule, a street corner only 75 ft. from the edge of the dra bridge opening. The gate swung across the street wh the bridge was open was 22 ft. back of the edge. Th would seem to be on the face of it no reason why t motorman should not see this gate, little more than car length ahead, with the red lantern hanging on The fact is, however, that he did not see it in time apply the brake and stop the car before it plunged o the edge

Mayor Curley promptly announced that he "wo call on experts from the Massachusetts Institute Technology to aid the Public Works Department en neers in devising a signal or mechanism which will m it virtually impossible for even violators of the sp laws to go through open drawbridges."

There is no need, however, to invent new devices accomplish this end. Methods and apparatus that h been long in use are ample to furnish the most c plete protection that can be desired at such openi Doubtless the best protection of a drawbridge openin the use of the double bascule type of bridge, in wh each half of the bridge when open stands erect and fo a substantial barrier across the opening.

For the protection of steam railway traffic across dr bridges, the derailing switch interlocked with the sig indicating the position of the drawbridge has been established in steam railway practice as the stand protection by which every drawbridge opening shoul guarded. For those who object that to derail a t at the back of a drawbridge opening is substitutin small risk for a large one, there is open the use of sand track, in which the derail, instead of throwing train onto the ties, turns it onto a stretch of track w rails are covered with two or three inches of sand. gives the same protection and practically eliminates risk.

For the protection of street cars which are run at speed and as single cars instead of trains, such pr tion of drawbridge openings by derailing switch comparatively easy. Some provision must be mad course, that the car when thrown off the rails shall its speed effectually checked by a sand track or its e alent in some form of paving that will absorb the en of the car rolling over it.

Such safeguarding of drawbridge openings gives tection not merely against the careless motorman fails to see the signal placed against him, but also ag the risk that the motorman through sudden paraly similar cause may fail to apply the brakes at the p time, and also against the risk that through some ure of the brake apparatus it may prove inoperat the car approaches the opening.

The Longest Railway Tunnel in the World

In this issue of *Engineering News*, Gen. Henry M. Chittenden, of Seattle, describes the project which he has worked out with much painstaking detail for building a railway tunnel 30 miles in length under the main range of the Cascade Mountains. The building of this tunnel would enable the railway traffic between Puget Sound ports and the interior, which now has to be lifted vertically to an elevation of 2,500 to over 3,300 ft. in crossing the Cascade range by the present railway lines, to pass under the main range at an elevation of only 1,200 ft.

It is not merely the waste of the energy required to elevate this traffic, amounting to over 60,000 tons daily, to a height of 1,300 to 1,800 ft., which the tunnel would save. A much more important advantage, as General Chittenden points out in a graphic manner, is the elimination of the expense and risk involved in the maintenance of the large mileage of steep grades on the present railway lines across the mountains. The extent to which this huge mountain barrier hinders commerce and intercourse between the great fertile agricultural section on the eastern side of the mountains and the commercial centers on the coast, is hardly realized in the East.

Perhaps the most striking illustration of the advantages of the proposed tunnel route over the present mountain lines is the statement that the time of passenger trains would be reduced, between the east side and the west side of the mountains, from the present schedule time of 3 hours to 40 minutes, and the time of freight trains from 10 hours to 1½ hours.

The estimated cost of the proposed tunnel and approaches is $50,000,000, and this in itself a few years ago would have been sufficient to compel the dismissal of the project as chimerical. At the present day, however, railways are investing sums in the improvement of their facilities which would have staggered the imagination of financiers a quarter century ago. Announcement has just been made that the Great Northern Railway Co. proposes to expend in this very region probably a third of this amount to convert its lines from steam to electric traction, encouraged thereto doubtless by the success of the very large investment for the same purpose made by the Chicago, Milwaukee & St. Paul on its lines in Montana and Idaho.

Among other notable instances in recent years of heavy outlay for reconstruction of existing railways, are the building of the Central Pacific Ry. across Great Salt Lake to avoid the heavy grades over Promontory point, the work done by the Union Pacific in the improvement of its main line in Wyoming, and on the eastern side of the continent the two great pieces of reconstruction work undertaken by the Lackawanna R.R. to improve its main line in western New Jersey and eastern Pennsylvania.

When any of these large works of railway reconstruction are compared with the Cascade tunnel project, it is at once evident that what each of them accomplished in the improvement of grades and alignment is insignificant compared with the advantages which would result from this great tunnel enterprise. By way of illustration, take the Rogers Pass tunnel now nearly completed on the Canadian Pacific Ry. This work has involved the building of 18 miles of new railway line and a 5-mile tunnel. The summit elevation is reduced 540 ft. and the length of snow sheds from about 5 miles to less than 1 mile, but the maximum grade on the line is still 2.2%, and of course the maximum train load that can be hauled is unchanged. To effect this improvement the Canadian Pacific has deemed it worth while to carry out work involving a total expense of probably not less than $8,000,000, while the traffic affected is only that of a single railway line.

In comparison with this the 30-mile Cascade tunnel projected by General Chittenden would lower the summit elevation on the Great Northern Ry. 2,166 ft.; would save 48 miles of distance on its line to Tacoma; would reduce the maximum grade from 2.2% to 0.6%; and would eliminate curvature amounting to 6,855°. Most important of all, the tunnel would be available not for the traffic of a single railway, but for the traffic of all the railways terminating on Puget Sound.

In his paper in this issue General Chittenden briefly outlines the computations which indicate that the proposed tunnel would pay a large return on its cost. Of course, for a complete determination, the matter would have to be gone into in far more detail than is possible within the limitations of space in a technical journal. Such rough comparisons as that suggested above, however, and similar ones which any engineer can make for himself, as well as the figures given by General Chittenden, indicate that the traffic benefits resulting from the tunnel would yield an ample return on its cost.

To understand this, it must be borne in mind that the tunnel would be used almost wholly for through traffic, and this means of course that the traffic through it would be concentrated in very long trains. The Chicago, Milwaukee & St. Paul on its electrified lines across Montana and Idaho is handling freight trains weighing 3,000 to 3,500 tons behind the tender on grades up to 2%. On the Cascade tunnel line, with its maximum grade of only 0.6% and its freedom from sharp curvature, there should be no difficulty whatever in handling trains of this length or greater. Passenger trains through the tunnel would be chiefly the through transcontinental express trains. Eventually some local traffic between the east side and west side of the mountain may develop, but is never likely to become considerable. Operating through this tunnel on the absolute block system, with its light grades and with its long tangents, trains could safely be spaced much closer together than they are on the present outside lines over the mountains.

Another factor of great importance in considering the capacity of such a tunnel is that it should be possible to operate it with an approximately uniform flow of traffic through the 24 hours of the day. On an ordinary railway, the traffic has often as sharp peak loads during the 24-hour period as the load curve of an electric-lighting station. Such load peaks are necessary in handling local passenger and suburban traffic, and to a considerable extent in local freight traffic. They are not necessary, however, in handling through traffic. The Chicago, Milwaukee & St. Paul, in installing electric operation on its Idaho and Montana division, put in operation, probably for the first time in the history of American railroading, the plan of so distributing its train movements as to give an approximately uniform train movement throughout the day. It was necessary to do this in order to purchase electric power at a favorable figure, and in the movement of the through traffic, which constitutes the chief business of the line, no great difficulty appears to have been found in putting the system into operation.

It is self-evident that where traffic can be thus equally distributed, the capacity of a double-track railway is enormous. With trains spaced no closer together than 10 minutes and uniform train movement through the 24 hours, 144 trains per day each way can be moved. Taking in connection with this figure the enormous tonnage of freight now handled in a single train, it is evident that the traffic capacity of the Cascade tunnel would be ample to take care of all the business tributary to it for as long as can be foreseen. Furthermore, that traffic promises to be enough to make the tunnel profitable.

Some questions may be raised as to the practicability of successfully operating a tunnel of such unprecedented length, although such questions will be raised by laymen rather than engineers. If it is practicable to operate the Simplon tunnel, 12 miles long under the Alps, which has now been in use for a dozen years, it would be practicable to operate a 30-mile tunnel under the Cascades.

Ventilation need present no more difficulty with the longer tunnel than with the shorter. On the Cascade tunnel there will doubtless be at least two intermediate shafts which can be used for ventilation as well as for construction purposes, and there is abundance of water power going to waste to provide forced ventilation if that were necessary. It is likely that when the traffic became sufficiently dense to make the question of ventilation important, then natural ventilation would result through the heat developed by the electric motors in the tunnel, which would cause the ventilating shafts to act like huge chimneys. In the cool climate of Washington, the air drawn in would always be at low temperature.

Train movements need offer no more difficulties in a 30-mile tunnel than in a 12-mile tunnel. General Chittenden's estimate in fact provides for sidings at intervals along the tunnel line to enable a disabled car o locomotive to be got out of the way temporarily without blocking the main line for any great length of time.

General Chittenden's paper is not only interesting from its review of the possibilities of the Cascade tunnel, but because it calls attention anew to the possibility of very long tunnels to improve railway operating condition elsewhere. Up to the present time electric traction o steam railways has had its chief application in the operation of city terminal lines and in the operation of existing tunnels where the smoke from steam locomotive became seriously objectionable. It has hardly as ye been realized outside the engineering profession that th electric locomotive in combination with the present da possibilities in fast and economical tunnel driving ha shown a way whereby radical reconstruction could b undertaken on the summit divisions of some main lin railways with the prospects, at least, of large profits

The advances in tunneling practice, too, have give a different basis for computing problems of railway relocation involving the use of long tunnels. The nex decade or two, therefore, may witness not alone the realization of General Chittenden's great scheme, but of th driving of a long tunnel by the Pennsylvania to lowe the summit of its main line across the Alleghenies, from its present elevation of about 2,200 ft.; or the Lackawanna or the Lehigh Valley may undertake a long tunne to save part of the long climb now necessary to lif the anthracite coal from the Wyoming Valley over th mountains on its way to markets at tidewater.

Letters to the Editor

Concrete Buildings Are Free from Depreciation

Sir—Referring to the comparative costs of factory buildings of standard mill construction and of reinforced concrete, published in your issue of Nov. 9, p. 884, the writer from long experience in constructing both types of buildings would say that in general, a slow-burning mill construction building can compete with a reinforced-concrete building when the floor loads are light and the spans are short. With heavy loading and long spans on the other hand, the reinforced-concrete building has a decided advantage.

The question of comparative costs is also dependent on the number of skilled contractors available for reinforced-concrete construction in the locality as well as the restrictions of union labor.

A great many insurance companies do not make the difference in rating between slow-burning construction and absolutely fireproof construction that should be made. Many owners have spoken to the writer about this matter saying that they can not see why insurance men rail at the American public for building burnable building when they make no inducement in insurance rates whic will compensate an owner for the increased expense of non-burnable building. A properly designed and properl constructed reinforced-concrete building, however, is n only fireproof, but is subject to little or no depreciatio On the other hand, a slow-burning mill construction buil ing does depreciate with time, and the depreciation wi more than wipe out the difference in first cost in te years.

ERNEST MCCULLOUGH,
Fireproof Construction Bureau,
Portland Cement Association.

Chicago, Ill., October 19, 1916.

* * *

Land Surveying in Texas

Sir—J. M. Howe's article on "Land Surveying i Texas," in *Engineering News*, of Oct. 19, arouses mem ories of rough surveys in my native state, where my fath was for some years in the General Land Office at Austi There he had charge of and issued state patents on su veys, filed with so-called land script. Subsequently, as member of the firm of Booth, Duval & Creuzbaur, he surveyed millions of acres of wild lands in more or less extended expeditions.

The Federal Government had no lands in Texas; and as Mr. Howe states, there were many misfits and vacancies between the old Spanish and other liberal grants located to cover the most valuable ground irrespective of sectional layout. Large areas were found between lines run from bases at opposite points of the compass; and as he says, the rough assumption of magnetic variation seldom allowed surveys to close on parallel lines. In one instance my father filed on 2,700 acres of exceedingly rich bottom land on the Colorado River (good for two bales of cotton to the acre, without fertilizer, for 50 years) in a case of this kind, where surveys had been run, I believe, from the Houston base, and surveys from the northerly base had been supposed to close and leave no vacancy.

In my early boyhood, as a volunteer, I have dragged chain on an 8-mi. compass course, run to locate the corner of an old Spanish league, where we carried our line over a precipice by the simple expedient of rolling a log over the top and resuming chaining at this dropped log after a wide detour to reach the bottom. On the other hand, I have a lithograph of a survey by R. Creuzbaur, April, 1855, in which I take a great pride. The high class of work done, with local magnetic variation and complete notes, is fully illustrated in this plat of the Maxmillian survey. On one side there was a typical wedge-shaped vacancy, 10,000 yd. in length filed upon and still owned by the surveyor's estate.

R. W. CREUZBAUR,
Consulting Engineer.

New York City, Oct. 27, 1916.

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Definitions of Sewerage and Sewage-Disposal Terms

Sir—The report of the Committee on Sewerage and sewage Disposal of the Sanitary Section of the Ameri-an Public Health Association, dealing with definitions, uotations from which appear in your issue of Nov. 2, rep-esents a work of great value and one deserving of high ppreciation among sanitary engineers. The subject is ne also that will benefit to an unusual degree by complete discussion, and to this end the following suggestions re offered:

Cage Screen—There would seem to be no advantage in estricting this name to a screen composed of bars or ods. The term might better be used to define the form f screen regardless of the screening element.

Hydrolytic Tank—As defined by the committee, this ecomes a generic term including septic, Travis, Imhoff nd other tanks of like nature. While this is not the sual use of the term, it is certainly desirable to have uch a generic term. In the interests of precision, however, "biolytic" is to be preferred to hydrolytic. The latter means "a decomposition brought about by water" Encyclopedia Britannica). Such a reaction is illustrated the inversion of cane sugar. While the term biolytic, the corresponding sense, has not yet reached the dictionary, its similar meaning, "decomposition brought bout by living matter," is obvious and definitive.

Colloidal Matter—The definition given is approximately accurately for what the chemist knows as "colloidal solution." Although no single property is in general sufficient to distinguish colloidal solution from suspensions, on the one hand, and true solution, on the other, the committee has adopted as criteria the two simplest and most comprehensive points of distinction—namely, non-settleability and non-diffusibility respectively. Colloidal matter, according to W. Ostwald, includes in addition to matter in colloidal solution the so-called hydrogels, or settleable colloids, as seen in a concentrated aqueous boiled-starch suspension. This separates into two layers, the true colloidal solution above and the gel below. Unfortunately for the work ot definition this class of substance is common in sewage.

The writer has always questioned the advisability of using the term colloids in sewage chemistry. It is a difficult term to use even under the conditions of experimental laboratory work and impossible of being used with even approximate accuracy in connection with sewage. The partial definition of the committee (and this is certainly the best that can be done) illustrates the impracticability of the term, since the diffusion test is hardly capable of routine laboratory application. Were the test practicable, it would serve to define a class of matter the definition of which has little or no practical bearing. Matter in neither colloidal nor in true solution will separate spontaneously by gravity, and both kinds of matter are capable of precipitation through chemical reaction. Colloidal solution may well be classed therefore as true solution so far as sewage is concerned.

Similarly, hydro-gels, being capable of sedimentation, may be classed with settleable solids without sacrificing any information of value. The writer is determining settleable solids for various periods of sedimentation from 15 min. to 24 hr. by reading the approximate volumes of sediment in a conical settling jar. The relation between volume and dry weight is determined once for all by comparison of settleable and non-settleable solids determined in the usual manner. For reasons similar to those urged above he believes that filtration, which separates the sewage matter into two artificial groups having no relation to purification processes, the line of demarcation in addition being indefinite according to the character of filtering medium used, furnishes no useful information; and results showing matter in solution and in suspension, respectively, by this classification should not be reported.

Disinfection—It would seem more satisfactory to allow this word its full meaning so as to include ordinary water purification, for example, among the disinfecting agents, for sand filtration of either water or sewage is as truly a disinfecting process as is the use of bleaching powder. The writer has used this conception in his lectures for some years and has always qualified that which the committee defines, as chemical disinfection. There is also to be considered (although not in sewage work) disinfection by such agents as ultra-violet light, which is truly disinfection, but would not be included within the committee's definition. The same remarks apply to the term sterilization.

In anticipation of criticism from others of the term trickling filter, the writer wishes to register his approval of this term as being most descriptive of the essential feature of this type of treatment. He also wishes to commend the committee for the satisfactory completion of a somewhat arduous task.

EARLE B. PHELPS.

United States Public Health Service,
Washington, D. C., Nov. 7, 1916.

Fire or Explosion Wrecks Part of Concrete Warehouse

A fire in and around the seven-story reinforced-concrete storage warehouse of Mullen & Buckley, in Far Rockaway, N. Y., in the early morning of Nov. 10, damaged the contents of that building and, either by direct contact or through the medium of an explosion, destroyed at least two floor panels and wrecked one large column with adjoining beams and girders. The building was ordered vacated during the progress of the fire for fear it would collapse and is still barred to general visitors. The wrecked portions and the fire débris prevent a full exploration of the structure but enough could be seen on Nov. 13, when the accompanying views were taken, to show a most interesting condition.

The warehouse is a seven-story and basement building, 52x90 ft. in plan, of the usual column, girder and slab construction. It is divided by the columns into two cross panels, 15 ft. 6 in. by 26 ft. and into five main lengthwise panels and these in turn are subdivided by transverse beams into 7 ft. 9 in. by 26 ft. panels. The columns are square and reinforced with straight rods tied together only with wire spacers; the beams and girders with straight rods and attached stirrups; the slabs with wire mesh. The walls are of concrete, and the fire stops, around the one stairway and the elevator shaft, are of hollow tile. These openings are well guarded with automatic closing fire-proof doors and the window openings are provided with casement steel sash and wire glas There were no sprinklers. The contents were of the u ual storage-warehouse type, some stored in fireproo rooms, but mostly in the open unpartitioned floor.

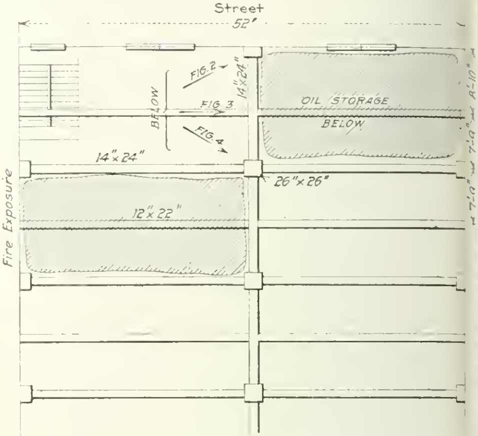

FIG. 1. FOURTH-FLOOR PLAN OF REAR OF WAREHOUS

considerable amount of furniture and furniture materi increased the combustibility of the contents. The grav concrete appears to be of acceptable quality.

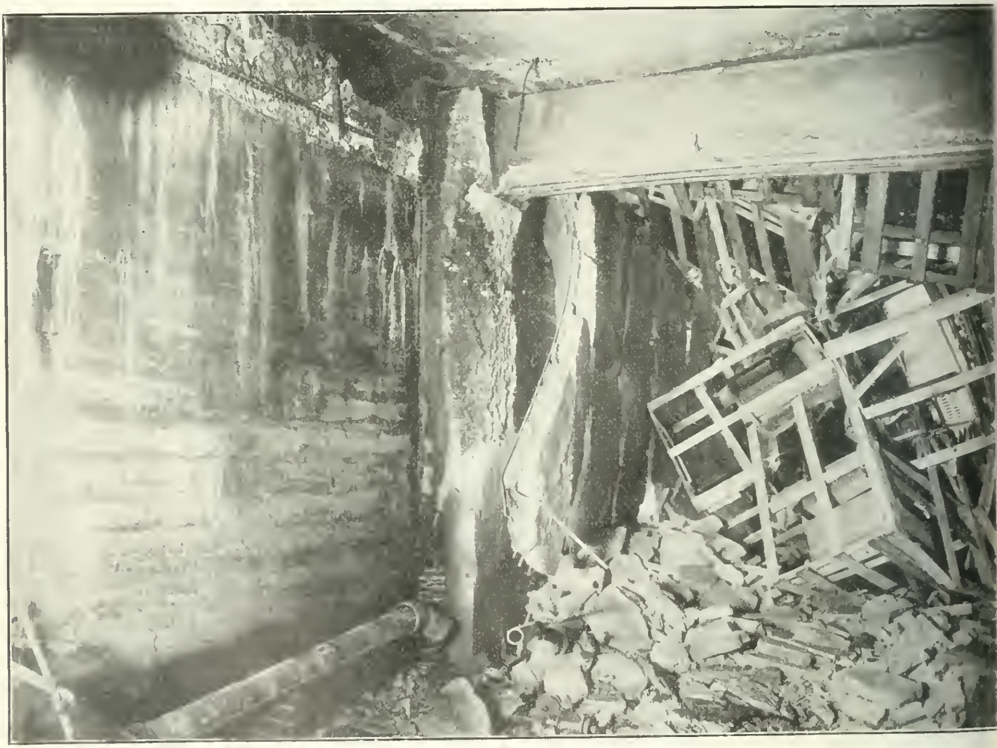

FIG. 2. REAR WALL END OF THIRD-FLOOR BAY WHERE COLLAPSE TOOK PLACE

Outer wall on left. Oil-storage room in rear

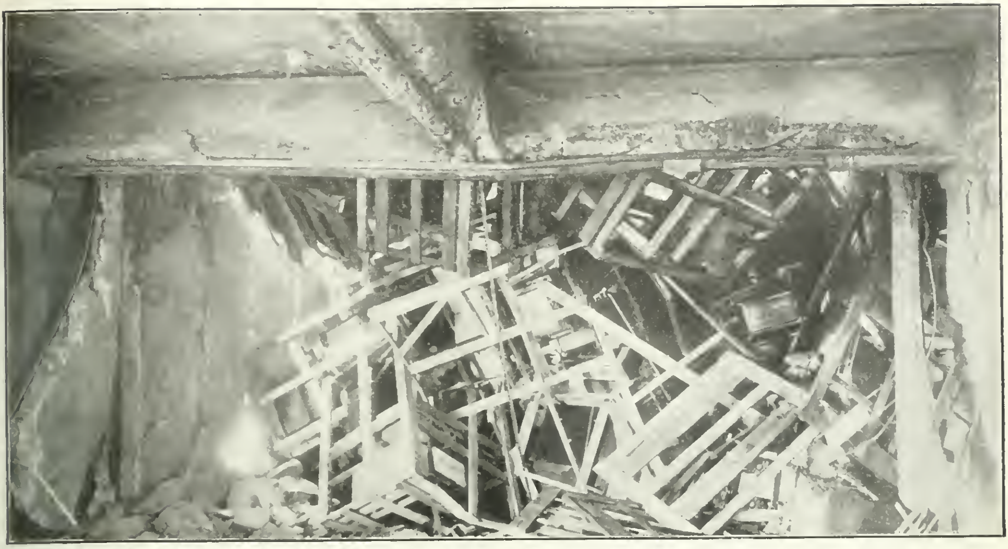

FIG. 3. LOOKING TOWARD OIL-STORAGE BAY WITH COLLAPSED FLOOR
The cross-beam is the beam common to views in Figs. 2 and 4. Outer wall at left. Collapsed column at right

On the west side of the building it was connected to a three-story frame structure used as a cabinet shop by the firm owning the warehouse and the two buildings were in communication on three floors by openings guarded with automatic closing fireproof doors. On this same side were also some windows (steel sash and wire glass) above the frame building. Other windows inside the frame building were blocked off with interior brick walls.

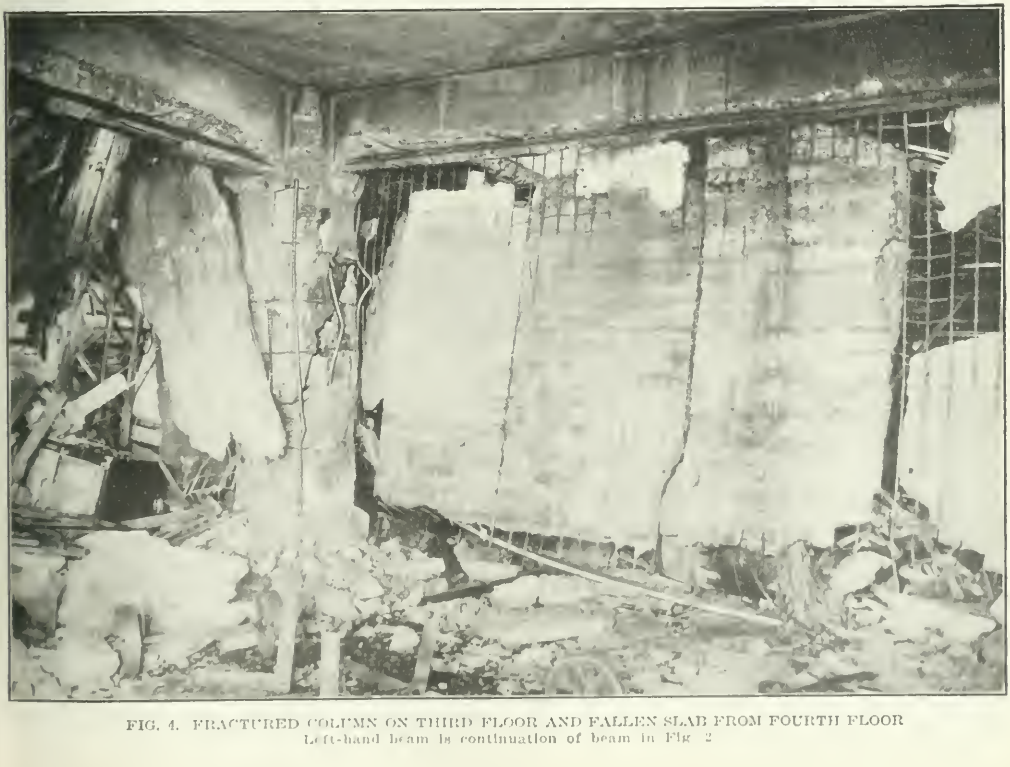

FIG. 4. FRACTURED COLUMN ON THIRD FLOOR AND FALLEN SLAB FROM FOURTH FLOOR
Left-hand beam is continuation of beam in Fig. 2

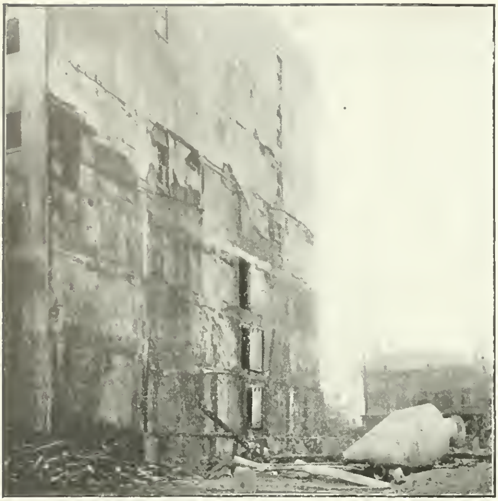

FIG. 5. EXPOSED WALL OF WAREHOUSE
Dark area marks location of destroyed frame building. Note doors connecting two buildings and that upper (third floor) door is missing

The progress of the fire is at present uncertain. It started in the frame shop about midnight and in the high wind prevailing soon brought a great number of fire companies who were mainly occupied in preventing the spread of the flames to an adjoining thickly settled frame building area. Apparently the possibility of fire in the adjoining concrete building was not seriously considered until flames appeared on some of the floors of that building. Just where these flames entered is not known. It may be noted from Fig. 5 that the two lower firedoors on the exposed side are open but in place; inside evidence shows that there was no entry of flame at either of these openings. The third-floor door, however, is gone and fallen floors inside do not permit of investigation of conditions there. It is possible that this door was open and that the fire entered here. Other possible points of entry are windows, either on the street fronts or on the exposed side, which may have been open or subjected to such heat as to break the wire glass.

The fire was not put out until the frame shop and an adjoining residence had been destroyed and the concrete warehouse apparently gutted. An inspection of the warehouse later showed that the contents' destruction was very scattered. In several of the upper floors hardly any damage had been done and in no place was there complete combustion or evidence of very high temperature. Horizontal separation was very good.

In one section of one floor abnormal conditions prevailed. This section is on the third floor at the north, that is the back, end of the building. Here the northeast bay was separated by tile partitions and was used as a storage room for inflammable oils and, it is reported, for celluloid sheets. Above this the floor was loaded with gas ranges in crates and adjoining that with screen doors. The bay west of the oil room was open and only sparsely filled with combustible material.

The views, Figs. 2 to 4, show the present condition of that part of the building. The northeast panel of the fourth floor (over the oil room) has collapsed and let down the load of gas ranges onto the third floor which is still intact. This is shown in the background of Fig. 3. The main column, 26x26-in. square with eight ¾-in. vertical bars, shown in the background of Fig. 4, has cracked clear through diagonally and has had the 1½ to 2 in. concrete surfacing nearly completely broken off the steel, which has bulged outward to accommodate the 2 or 3 in. drop in the column. The cross girder, at the right in Fig. 4, is also damaged to the extent of exposing the steel but has not apparently sagged. The fourth-floor bay just south of this girder—only lightly loaded—has also collapsed onto the third floor which still holds. The longitudinal girder, common to the backgrounds of Figs. 2, 3 and 4, has sagged appreciably and cracked as shown and its wall column support has lost most of the face concrete though no reinforcement is disclosed. No further pronounced structural damage is visible in the building, but complete exploration may reveal minor faults.

Until further examination is possible it is hardly profitable to conjecture on what happened at this end of the building. It appears at present as though the fire entered from the front of the building toward the rear of the third floor and raised the oil and celluloid there to an explosive temperature, the ensuing explosion blowing down the partitions and subjecting the ceiling and column to such intense heat as to cause local failure and subsequent collapse. This fire was probably soon extinguished because the wooden crates now in what was the oil room are hardly scorched, which also may indicate that the collapse occurred subsequent to the intense heat in that compartment. The failure of the diagonally opposite bay (see diagram) must have been due to the sudden drop of the column and consequent shock to the floor-beam as neither above nor below are evidences of much heat.

The building department became fearful of the safety of the building and are now considering its future disposition. An examination of the other parts and the apparent stability of the third floor under the falling fourth floor would seem to indicate that the fear is unfounded and that, like the Edison buildings at West Orange, the warehouse can cheaply and readily be restored to a safe condition.

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Water Losses in City Systems*

By F. A. Barbour†

In entirely metered systems, or in systems where the metered services exceed 85% of all the services, at least 20% of the water furnished is, on the average, unaccounted for. The question arises as to whether we should be content with such a condition.

This 20% loss is not based on a comparison of pump records with the water sold, but on the figures furnished by water-works superintendents as to the water unaccounted for in their systems. These figures presumably include corrections for such items as pump slippage. It would seem that a loss of 20%, due to leakage from mains and services or to under-registration of meters, which undoubtedly represents the best conditions, is sufficiently sizable to justify careful consideration of possible remedies.

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*Abstract of a discussion at the meeting of the New England Water-Works Association, Boston, Mass., Nov. 8.

†Consulting Engineer, Boston, Mass.

We all know that the total unaccounted-for water in unmetered systems is enormous; presumably we all agree that metering is the great remedy, and yet, as reported by the United States Department of Commerce, only 40% of the services are metered in 201 cities, containing 26,000,000 people and having an average per capita consumption of 139 gal. per day. This total loss is not the subject of our immediate discussion, but as a means of calling attention to present standards of management a few figures may not be amiss.

The total population in the United States supplied with water from public works may be taken, for present purposes, at 50 million people, and the average amount of water furnished per day at 100 gal. per capita. The total water supplied daily by public works is, therefore, in round figures, 5,000 million gallons. It is probably a safe statement that 50% of this quantity is wasted, and assuming the actual cost of furnishing the useless 2,500 million gallons to be $25 per million gallons—and this is an extremely low figure—the cost per day of the water wasted is equal to $62,500 or $22,800,000 per year, which is equal to the interest on an investment of $500,000,000. Figured in this rough way, the results do not speak very well for our present-day standard of management of water systems. If it should be answered that it is not practicable to prevent this loss, a reasonable reply would be that at least we should know more about its causes than apparently is known at the present time.

As already stated, metering is the great means of reducing the total waste on which the previous figures are based, but there remains the fact that in the fully metered systems, on the average, at least 20% of the water furnished is unaccounted for, and probably if more accurate data were available, this percentage would be shown to be materially greater. The late Emil Kuichling estimated 2,500 to 3,000 gal. per mile per day as the leakage from well-laid mains; the late Dexter Brackett estimated a leakage of from 10,000 to 15,000 gal. per day in the Metropolitan District; and John R. Freeman stated that his best guess of the underground leakage in New York was from 25 to 35 gal. per day per capita, equal to from 20,000 to 30,000 gal. per day per mile of pipe.

In six cities, with 95% of the services metered, reported by Brackett in 1904, 36% of the water was unaccounted for, equal to an average loss of 11,300 gal. per mile of pipe. James H. Fuertes, in the 1906 Report to the Merchants Association of New York, presented statistics from 13 cities, where on the average 82% of the services were metered, which showed that 31% of the supply was unaccounted for, equivalent to approximately 18,000 gal. per mile of pipe.

What part of these losses are chargeable to the mains is unknown, but from the results of such leakage surveys as have been made, and from the reported actual losses discovered in some cities, it is probable that 7,500 gal. per mile of pipe per day is a conservative estimate of the water lost by leakage from the 60,000 mi. of mains now in use in the public supplies of this country, or 450 million gallons daily. At $25 per million gallons, this is equal to a daily loss of $11,250 or $111,000 per year, or the interest on $100,000,000.

In the light of this economic waste it would appear that the subject of leakage from mains is worthy of careful consideration. The Committee on Water Consumption of the New England Water-Works Association reported in 1913 that "in general it may be said that if in a well-metered system the water unaccounted for does not exceed 25% of the total pumpage, the practice is good." Doubtless this should be interpreted to mean that a 25% loss is good compared with the average present practice, but is it good compared with the standard which should be set up in this age when we hear so much about conservation? Should we complacently accept a loss of 25% as inevitable, and if this loss cannot reasonably be much reduced in the systems already constructed, what about the possibility of better methods of construction in the pipe to be laid in the future?

It is, of course, out of the question to consider the relaying of present systems or to do more than make leakage surveys and check the larger losses, but in the light of present knowledge, is it not time to seriously undertake an analysis of the causes responsible for the present large percentage of water unaccounted for? If these losses are chargeable to under-registration of meters, then this should be definitely made known, and consideration given to the possibility of developing more sensitive or more accurate measuring apparatus.

Are we taking sufficient care in testing pipe for water tightness when laid? About 60% of those replying to the circular of the Committee stated that the pipe is tested when laid, and all but six make the test before backfilling. In the writer's experience, testing before backfilling in the ordinary work of laying distribution systems is rare, and it is undoubtedly from the practice of simply turning on the water without any test that a considerable part of the present leakage develops. The standard of those who test, as indicated by the replies received, is "absolute tightness," but in the writer's experience this result is not easy to obtain, and only possible where the joints are gone over several times after the pressure is applied.

Where pipes are backfilled before testing, the allowable leakage, as determined by such test, has varied greatly in different specifications. John H. Gregory at Columbus made the limit 500 gal. per inch-mile per day. At Akron 200 gal. per inch-mile per day was specified, while actual results at Akron showed about 70 gal. per inch-mile per day. E. G. Bradbury, in his paper before the New England Water-Works Association in 1914, proposed 100 gal. per inch-mile per day as a reasonable standard for the allowable leakage in testing after backfilling. He figured that the difference between 500 and 100 gal. per inch-mile per day, estimating the cost of the water at $25 per million gallons, would equal a yearly cost for water lost in a city of 100,000 people, of $5,256; or in other words, the city could afford to spend $470 per mile in order to save 400 gal. of leakage per inch-mile per day.

Again, are the present jointing methods the best qualified to maintain tightness after periods of use? Who knows anything about the comparative leakage when laid and after several years?

In this latter connection the history of the work at Grandview, Ohio, is of interest. As reported by Mr. Bradbury, the supply is measured by a tested meter and all service pipes are metered. The 5.5 mi. of pipe originally laid were tested before backfilling and the leakage before any connections were made amounted to 31 gal. per inch-mile per day, or in other words, the system was practically watertight. Subsequently 0.9 mi. of additional mains were laid, and gradually in the four years since the date of original construction the services have increased to the present number of 205. Either by less careful work in the extension or by depreciation of the original work, or by under-registration of the gradually increasing number of meters, the unaccounted-for water has increased until at the present time it averages about 150 gal. per inch-mile per day.

An interesting feature in connection with these records is that the unaccounted-for water, based on three years' observations, averages 60 gal. per inch-mile per day during the six months from October to April and 213 gal. during the six months from April to October. In other words, the records indicate in this system that the unaccounted-for water is three times as great during the summer as during the winter months. Whether some local explanation can be found for this result, or whether it is a reasonable result of temperature changes is not known, but data from other systems showing the unaccounted-for water during periods of varying temperature would be of considerable interest.

Any information of definite tests of leakage from observation of mains after periods of use or of the effect of temperature on leakage or the results of tests of leakage from lead joints with different shapes of bell and spigot or of other types of joints will be of value to the New England Water-Works Association Committee on Leakage, and it is hoped that if any one has such information he will forward it to the Committee.

News of the Engineering World

Water-Supply Losses Discussed; Meter Rates Adopted

The regular monthly meeting of the New England Water-Works Association, held in Boston, Mass., Nov. 8, was devoted chiefly to the report of the committee on meter rates, water loss by leakage, non-registration of meters and otherwise. The aggregate amount of and the economic features of water waste caused by leakage and non-registration of water meters were clearly set forth by F. A. Barbour.

The report of the committee on meter rates and water loss, presented by Allen Hazen, consulting engineer, New York City, chairman, contained a great deal of new and interesting matter. In a way it was a discussion of Mr. Barbour's paper on leakage, presented at the recent Portland convention of the association. The committee has collected statistics as to the use and loss of water, and allied matter, from a number of completely metered systems.

Returns were received from 35 water-works systems. These systems had 524,364 services and 520,719 meters. The total daily output was about 300 million gallons or 575 gal. per service. Of this quantity about 140 gal. per service was not accounted for. The majority of these systems measured their total output by venturi meters.

The amount of water unaccounted for averaged 27% of the total output. For the several systems the water not accounted for ranged from 12 to 49%. The loss of water was attributed: (1) Leakage from mains; (2) leakage from service-pipes between mains and meters; (3) under-registration of meters; (4) water used for various purposes, not metered or estimated, as flushing sewers, etc.

About half of the total number of services passed less than 100 gal. per day; and there are few meters which register a steady flow of as little as 100 gal. per day. Therefore it is possible for much water to be wasted by plumbing leaks which will not be metered. The larger sized meters pass much larger amounts without registration. About 86.6% of all the meters in the systems studied were ⅝-in. size.

The report of the committee gives much data on the classification of different consumers by quantity of water used, and on the quantity of water delivered by meters of various sizes.

The committee decided that with complete metering and with meters carefully tested it is possible to reduce the unaccounted-for water to 20% of the total output, or to from 60 to 80 gal. per service.

As to service charges where meters are installed the committee decided that they should be based in a general way on their carrying capacities. A table of relative capacities of the different sizes of meters is included in the report. The report of the committee embodying this charge for a ⅝-in. meter was adopted: (1) A charge of 10% of the average investment of the works in the service pipe and meter; (2) a charge of $1 per annum for reading meters, billing and collecting; (3) a charge of $2 per annum for the probable value of unregistered water.

The form of meter rate schedule presented to the Association by the committee and printed in the "Journal" of the Association, Vol. 30, p. 361, was adopted. The committee believes this form of schedule flexible enough for all water-works. The committee made no recommendations for or against a uniform or sliding scale of rates. Mr. Hazen, however, personally favored a sliding scale in which the following elements would be considered: (1) Cost of supplying 1,000 gal. (should be uniform); (2) service charge (more for larger sizes); (3) distribution cost (less for larger sizes of services).

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Minneapolis Wins Filter Suit

After years of litigation and defeat in the lower court, the City of Minneapolis has established its right, and the right of other cities as well, to the use of the central control of operating valves and also to the use of a screen between the sand and the gravel in mechanical water filters. The United States Circuit Court of Appeals declares that central control is not only "common, familiar practice in other branches of industry" but was covered in patent No. 561,474, dated July 21, 1896, on central closing of bulkheads, doors, hatches, etc., on ship board. The patent claim for a screen between filter sand and gravel was anticipated, the court holds, by a half dozen patents granted to Hyatt, Peterson, Weiderman, and Hefel years ago. Of the claim that the screen prevented the gravel from rising up into the sand, the court declares that it does not think that "rises to the dignity of invention. It would naturally occur to a person ordinarily familiar with such work." The decree of the lower court is ordered reversed and the bill dismissed.

The decision of the lower court was handed down in August, 1915. The two contested claims were printed in *Engineering News* of Sept. 9, 1915. These claims were claim 1 of patent 649,410 on central control of filter operations, and claim 14 of patent 649,411 on the use of a screen between the sand and gravel, granted to Ira H. Jewell on May 8, 1900. In the earlier decision there was also considered patent 649,409 for a combination of a filtered-water chamber beneath a filter bed with columns supporting the bed from the bottom of the chamber and means for forcing the water up from the chamber through the bed. This patent was thrown out by the lower court. Comment on these and some other recent patent decisions may be found in the editorial columns of this issue.

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Reorganizing Public Roads and Rural Engineering Office

In accordance with the terms of the Federal Aid to Road Construction Act, the Secretary of Agriculture has delegated the responsibility of supervising the Federal aid roads to the Office of Public Roads and Rural Engineering. To enable the office to carry out this responsibility, a new organization was put into effect on Nov. 1, which is shown in graphical form herewith.

As the chart makes clear, the two main branches of the office are: (1) Engineering and (2) Management and Economics. The Chief Engineer, P. E. St. J. Wilson, has charge of the Engineering branch, reporting directly to the Director of the Office, Logan W. Page, and becoming Acting Director in Mr. Page's absence. The heads of the divisions of Rural Engineering, Drainage, Irrigation, and Road Materials report directly to Mr. Wilson, and he himself has charge of the work of object-lesson road construction and maintenance investigations authorized in the Agricultural Appropriation Act, and also of the Federal aid roadwork, including the building of roads in forest reservations.

The ten field districts established, as shown on the chart, will each be in charge of a district engineer to look after the Federal aid roadwork in his territory, and also such object-lesson roads and experimental work as may be built in his district. The organization also provides, as shown by the chart, for two general inspectors whose duty it will be to inspect field operations upon instructions from the director, reporting directly to him.

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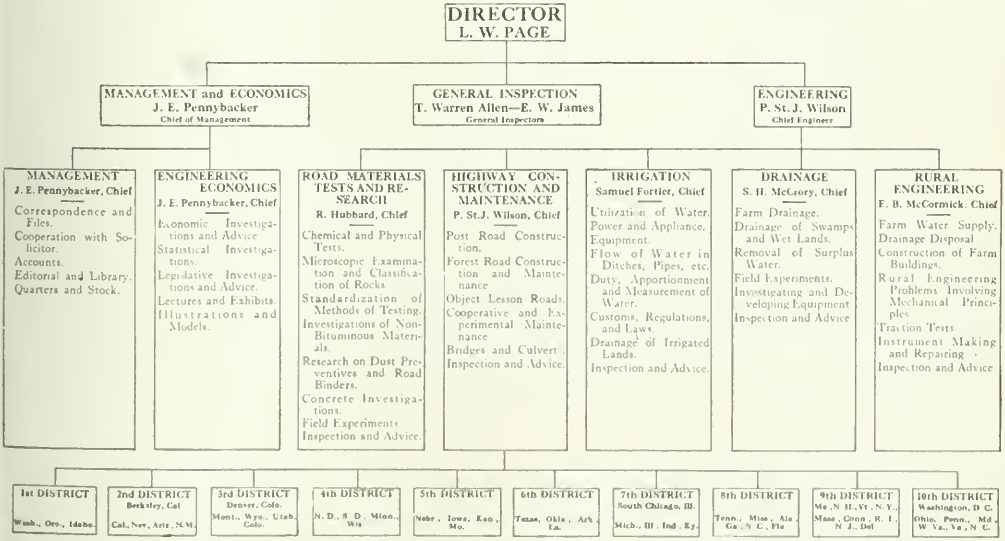
Concrete Dock Patent Upheld in Court of Appeals

United States Patent No. 1,089,405, granted to W. S. Ferguson and assigned to J. D. Carey, for a "reinforced-concrete dock or pier," was upheld on Oct. 13, 1916, in a decision handed down by Judges Warrington, Knappen and Sessions, of the United States Court of Appeals, sixth circuit. The case before them was the Detroit Iron and Steel Co. against James D. Carey and was a review of the decision of July 17, 1915, by Judge Tuttle, of the United States District Court, in which he decided that the company infringed the Ferguson patent in the construction of a reinforced-concrete dock at Detroit, Mich.

The Ferguson patent, now owned and exploited by the Cleveland Dock and Engineering Co., Cleveland, Ohio, of which Mr. Carey is president, is essentially on an L-shaped reinforced-concrete wall extending out over a waterway, with the outer end supported on spaced piles and the inner end on or alongside of a tight wall of



PLAN OF ORGANIZATION OF THE OFFICE OF PUBLIC ROADS AND RURAL ENGINEERING, DEPARTMENT OF AGRICULTURE sheetpiling. The patent was granted Mar. 10, 1914, but the patentee swore the invention back to July 10, 1906.

The lower court decided, first, that the dock wall in suit was an infringement of the Ferguson design, and, second, that that design was not anticipated either by previous patents or structures. The Court of Appeals affirmed this decision and furthermore stated that even though every element in the design was old—a contention of the plaintiff in appeal—"invention would still exist if by the combination of these old elements there is produced a new and useful result, or if the result is effected in a new and materially better way, as in the case here."

Primary Unit for Marine Terminal at Bayonne

On Nov. 14 the engineers for the proposed new marine and industrial terminal at Bayonne, N. J., presented the recommendations for the first unit of the terminal to the Board of Commissioners of Bayonne. As described in *Engineering News*, July 13, 1916, p. 90, the terminal is to be the joint project of the city and of a company headed by Irving T. Bush, and is to resemble the famous Bush terminal in Brooklyn in that it will contain warehouses and factories, with ample railway entrance and pier accommodation. The first unit is described by the engineers as follows:

> The installation will provide on upper New York Bay dockage for 30 modern freight ships in addition to lighters, barges, etc., a railroad yard with facilities for classifying and assembling freight with a capacity of 1,000 cars, a ferry terminal for a Bayonne-Manhattan vehicular and passenger ferry, four miles of bulkhead platform, 1,350,000 sq.ft. of one-story bulkhead sheds and 7,770,000 cu.ft. of second- and third-story bulkhead sheds, and over 200 acres of land for industrial buildings together with trolley and highway connections, railroad sidings, float bridges for railroad cars, etc.
>
> The total estimated cost of this installation is $7,234,545, of which $2,121,673 is for dredging, bulkheading and reclamation, and $5,112,872 for the other facilities. These estimates provide for interest on the cost during construction and provide for 35 ft. depth of water.

These plans are embodied in a detailed report which has been prepared under the immediate direction of B. F. Cresson, Jr., Chief Engineer of the New Jersey State Board of Commerce and Navigation, and F. Van Z. Lane, Engineer of the Bayonne Chamber of Commerce.

Electrical Engineers Discuss Appraisal and Depreciation

The regular November meeting of the American Institute of Electrical Engineers, in New York City, Nov. 10, was given up to a discussion of the subject of appraisals and depreciation. The opening paper was by Philander Betts, Chief Engineer, New Jersey Public Utility Commission. It was entitled "Effect of Recent Decisions on Work of Inventory and Appraisal." This was an argument that appraisals must be sufficiently detailed so as to give their results with a very small percentage of error, and cited a few cases leading up to a disclosure of the necessity of classifying property as to use and degree of use in various classes of service.

The second paper, entitled "Continuous Inventories, Their Preparation and Value," was by H. E. Carver, Assistant Engineer, New Jersey Public Utilities Commission. It disclosed first the many uses for a continuous inventory in addition to the benefits secured by operating companies in promoting efficient operation and keeping down unit costs of doing work—the gains being in having data always available for answering complaints as to charges, being prepared for cases involving increases on account of increased cost of labor and material, possibility of immediate presentation of property value for basis of security issues, possibility of checking accruing renewal funds, having immediately available data for satisfying labor investigations, ability to make more accurate distribution of charges, etc. It was found that all the requirements for accomplishing the running inventory resided in the work-order system generally used by companies under various terms like "authorizations for expenditure." A single additional step was required: An allocation of the cost of each piece of construction or property acquired had to be made in detail when the work was completed. Specific forms were exhibited to illustrate how such a system was built up.

The third paper, entitled "Growth and Depreciation," was by Julian Loebenstein, Junior Engineer, Public Service Commission for the First District, State of New York. This was a study of the effect of growth of a utility plant in capacity as to its effect on depreciation and renewals (assuming that the various pieces of equipment followed perfectly definite and fixed lengths of life). It appeared from graphical analysis that the condition of the property at any time was dependent upon the rate of growth as well as the amount of maintenance. The author argued that in rate cases a return should be allowed on reserves for renewals, provided that depreciated value of the property was also employed. The sum of renewal reserve and depreciated value gives the original value, which many desire to employ.

The oral discussion on these papers was meager.

Kittitas Irrigation Project

Life has been put into the irrigation project of the Kittitas Reclamation District embracing about 70,000 acres of irrigable land near Ellensburg, Wash. It is reported that Twohy Bros. Co., of Portland, Ore., has an option extending to Dec. 1 for the purchase of bonds and construction of the proposed works. The district was formed in 1912. Surveys and plans were made at an expense of about $60,000 and a bond issue of $5,000,000 was authorized. For various reasons it appears to have been impossible to dispose of the bonds and so the project has remained dormant. R. H. Thompson, of Seattle, and J. R. Holman, of Portland, have made a report on the project, and have recommended changes in the plans which it is expected will make a material saving.

The water supply for the project would be from storage in the Government reservoirs on the headwaters of the Yakima River. Water would be diverted from the river near Easton to and through about 92 mi. of canal. Special features of the project are several siphons across creeks and cañons tributary to the Yakima River, and a large siphon by which the north branch canal would cross the Yakima River under a head of 295 ft. The estimated cubic yardage of various sorts is as follows: Earth, 1,683,500; gravel, 896,000; hardpan, 407,300; loose rock, 128,800; cemented gravel, 292,000; solid rock, 198,900; concrete, all classes, 95,000. Steel requirements (in pounds) are: Structural, 1,745,300; pipe, 1,113,400; reinforcing bars, 2,557,000; pipe bands, 2,690,800. About 3,400,000 ft. b.m. of lumber would also be required.

Results of Fire-Prevention Work in some of the larger cities in the country are summarized by the National Board of Fire Underwriters in a recent bulletin. New York City had 1,010 fewer fires in 1915 than in 1914, and its aggregate fire losses were $2,460,000 less. Chicago in 1915 had 1,238 fewer fires than in 1914, and its fire-loss total was reduced $1,006,000. Cincinnati had 430 fewer fires in 1915 than in 1914, and its losses were reduced nearly 50%. Milwaukee had 682 fewer fires in 1915 than in 1914 and reduced its fire loss $291,000. All the cities above named have been doing effective work for fire prevention.

Union Pacific Improvements to cost several million dollars were announced in a press dispatch from Omaha, Nov. 9, quoting Judge Lovett, Chairman of the Board, as stating that a new tunnel would be driven under Sherman Summit, Wyoming, where the road crosses the Continental divide. Official information has since been furnished that the proposed work involves the completion of the double tracking over Sherman hill between Hermosa and Buford, about 12 mi., which will involve a new 1,800-ft. tunnel parallel and adjacent to the present Sherman tunnel. While the proposed work is under consideration, it has not yet been definitely decided on.

Progress on the Four East River Tunnels under construction for the New York Rapid Transit System was reported by the Public Service Commission under date of Nov. 13. The tunnel which is being driven between Old Slip, Manhattan, and Clark St., Brooklyn, is the farthest advanced. The headings of the north tube for this tunnel are now in solid rock and only 190 ft. apart. It is expected these headings will meet about Dec. 1. The headings of the south tube for the same tunnel are about 300 ft. apart. The tunnel farthest south, that between Whitehall St., Manhattan, and Montague St., Brooklyn, has its headings about 1,000 ft. apart, and it is expected they will be joined about May 1, 1917. For the two northern tunnels, which are to extend under the river from 14th St. and 60th St., Manhattan, the shafts are now being sunk.

PERSONALS

Frank M. Williams, M. Am. Soc. C. E., has been re-elected State Engineer of New York on the Republican ticket.

F. L. Beal, Jun. Am. Soc. C. E., Valuation Engineer of the Louisiana & Arkansas Ry., Stamps, Ark., has been promoted to be General Manager of the company.

Malcolm H. Crump has resigned as County Road Engineer of Warren County, Kentucky, effective Jan. 1, 1917, and will devote his whole time to private practice.

A. P. Wyman, formerly Assistant Engineer of the Maine Central R.R., Portland, Maine, has been appointed Civil Engineer of the Texas Steamship Co., Bath, Maine.

Edwin G. Foster, Assistant Engineer of the Buffalo, Rochester & Pittsburgh Ry., has been promoted to be Valuation Engineer, with headquarters at Rochester, N. Y.

C. G. Lunday, Superintendent of the Louisiana & Arkansas Ry., Stamps, Ark., has been promoted to be General Superintendent in charge of operation and maintenance.

J. L. Lee, Assoc. M. Am. Soc. C. E., of San Francisco, Calif., has been appointed Valuation Engineer of the Sierra Railway Co. of California, with headquarters at Jamestown, Calif.

Winfield A. Haller, M. Am. Inst. E. E., formerly with Sanderson & Porter, New York City, has organized the firm of Haller & Krumbhaar, engineers and contractors, New York City.

E. K. Morse, M. Am. Soc. C. E., whose appointment as Rapid Transit Commissioner of Pittsburgh, Penn., was noted in last week's issue, has had his appointment confirmed by the city council.

Arthur T. Clark, Assistant Engineer with Robert E. Horton, Consulting Hydraulic Engineer, Albany, N. Y., has been appointed Resident Engineer in charge of the new water-supply of Herkimer, N. Y.

Mason D. Pratt, M. Am. Soc. C. E., has resigned as Chief Engineer of the United Railways & Electric Co., Baltimore, Md., to resume private practice as a consulting engineer, with offices in Roland Park, Md.

John Hulst, Chief Mechanical Engineer of the Carnegie Steel Co., Pittsburgh, Penn., has been appointed Consulting Engineer of the United States Steel Corporation, with headquarters at New York City.

H. S. Thayer, Assoc. M. Am. Soc. C. E., recently with the Inspiration Consolidated Copper Co., Miami, Ariz., is now with engineering staff of the Tallassee Power Co., Alcoa, Tenn., on the construction of the Cheoah dam.

Clarence W. Marsh has established an office at 101 Park Ave., New York City, for private practice in plant design and construction of industrial, chemical and electro-chemical enterprises and for engineering investigations.

R. G. Clyne, M. Am. Soc. M. E., has resigned as Mechanical Engineer of the Western Cartridge Co., East Alton, Ill., to engage in business on his own account, designing and building special machinery. His headquarters will be in St. Louis, Mo.

Sidney Dillon, Mechanical Engineer of the Edgar Thomson Works of the United States Steel Corporation, has been made Chief Mechanical Engineer of the Carnegie Steel Co., Pittsburgh, Penn., succeeding John Hulst, promoted, as noted elsewhere.

C. P. Collins, Assoc. M. Am. Soc. C E., whose resignation as Sanitary Engineer of Johnstown, Penn., was noted in these columns of Nov. 2, p. 866, has adjusted the disagreement between the city council and his department and has withdrawn his resignation.

J. R. Sherman, Assoc. M. Am. Soc. C. E., has resigned as Assistant Engineer, United States Reclamation Service, Meadow Creek, Wash., to become Engineer in charge of construction of a large dam near Rancagua, Chile, for the Braden Copper Co.

B. A. Brennan, formerly Contract Manager of the Westinghouse Machine Co. of Pittsburgh, recently Vice-President of the Mercantile Trust Co., St. Louis, Mo., has been elected President of the Citizens Co., Baltimore, Md. The Citizens Co., Inc., is an investment banking institution.

Edwin Higgins, M. Am. Inst. M. E., Chief Mine Inspector of California, has resigned to become Assistant Safety and Efficiency Engineer of a group of important mines in California. He is temporarily succeeded by **H. M. Wolfin**, M. Am. Inst. M. E., Mining Engineer, United States Bureau of Mines and the California Industrial Accident Commission.

Norman L. Warford, recently in charge of the Powdered Coal Department of the Anaconda Copper Mining Co., Anaconda, Mont., is now Engineer in charge of construction of the Powdered Coal Engineering & Equipment Co., Chicago, Ill. Mr. Warford installed at Anaconda what is claimed to be the largest powdered coal plant in the United States. It utilizes approximately 1,000 tons of pulverized coal daily.

Walter C. Allen, Assoc. Am. Inst. E. E., Electrical Engineer of the District of Columbia, Washington, D. C., has resigned to become Executive Secretary of the District Public Utilities Commission, succeeding Maj. Julian L. Schley, who has been assigned to the United States Engineer Office at New Orleans, La. Mr. Allen is a graduate of the University of California and has been in the service of the District for the last 22 years.

Carl J. Rhodin, M. Am. Soc. C. E., recently Civil-Hydraulic Engineer, San Francisco office of the J. G. White Engineering Corporation, has opened offices in the Alaska Commercial Bldg., San Francisco, Calif., for private practice. He was graduated from the Royal Technical University of Stockholm, Sweden, in 1900, and came to this country two years later. He was engaged in bridge and structural work with Eastern engineering firms until 1906, when he went to San Francisco. For a short time he was with the California State Highway Department. He has been with the J. G. White Co. since 1911.

Melville Fiske Clements, M. Am. Soc. C. E., whose appointment as Bridge Engineer of the Northern Pacific Ry. was noted in these columns of last week, was born in Iowa in 1875. He was graduated from the State University of Iowa in 1899, and the same year began his railway experience with the Burlington, Cedar Rapids & Northern Ry. Subsequently he spent four years with the Chicago, Rock Island & Pacific Ry. and a year as Engineer with the Clinton Bridge and Iron Works. He joined the Northern Pacific engineering staff in 1907 as an Assistant Engineer and recently has been in charge of grade-crossing elimination work at Spokane, Wash.

Edgar F. Robinson, M. Am. Soc. C. E., formerly Chief Engineer of the Buffalo, Rochester & Pittsburgh Ry., has been made General Manager. He was born at Earlington, Ky., in 1874 and was graduated from Rose Polytechnic Institute in 1894. His railway experience began in 1895 as a masonry inspector with the Cleveland, Cincinnati, Chicago & St. Louis Ry. He was with the maintenance-of-way departments of several Middle West railways until 1901 when he was made Superintendent of Maintenance of the Butte, Anaconda & Pacific Ry., at Anaconda, Mont. He returned East in 1902 to become Engineer of Track of the Buffalo, Rochester & Pittsburgh Ry., and in 1907 he was made Chief Engineer of the company

OBITUARY

John T. Williams, a well known civil engineer of California, died Nov. 1, at Quincy, Plumas County, from pneumonia. He was Chief Engineer in charge of construction of the Indian Valley R.R., a branch of the Western Pacific R.R.

George R. Brown, formerly General Superintendent of the Fall Brook Coal Company's R.R., and the originator of "Brown's discipline," died at his home in Rochester, N. Y., Nov. 5. His system of discipline of trainmen and other railway employees, without resorting to suspensions, was widely adopted in the nineties.

ENGINEERING SOCIETIES

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16-17. Annual meeting in New York City. Secy., D. H. Cox, 29 W. 39th St.

ELECTRIC POWER CLUB.
Nov. 15-17. Annual meeting in Hot Springs, Va. Secy., C. H. Roth, 1410 W. Adams St., Chicago.

KANSAS GOOD ROADS ASSOCIATION.
Nov. 16-17. Annual meeting in Lawrence Society headquarters in Kansas City.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 16. Annual meeting in Atlanta, Ga. Secy., A. J. Merrill, P. O. Box 1205, Atlanta.

CITY MANAGERS' ASSOCIATION.
Nov. 21-23. Convention in Springfield, Mass. O. E. Carr, Niagara Falls, N. Y.

NATIONAL MUNICIPAL LEAGUE.
Nov. 23-25. Annual meeting in Springfield, Mass. Secy., C. R. Woodruff, 705 North American Building, Philadelphia.

American Society of Mechanical Engineers—The excursion to New London, Conn., to inspect the plant of the Electric Boat Co. and to witness an exhibition of United States Navy submarines, carried out under the auspices of the American Society of Mechanical Engineers, Nov. 11, was highly successful from the point of view of attendance. There were fully 1,600 engineers from New York and various New England cities—a crowd which proved beyond the capacity of the hotels and larger than could be accommodated on the vessels available to take the visitors to the site of the submarine exhibition. Some of the excursionists were unable to get aboard the naval vessels, and a large number of those who did get aboard the vessels were unable to visit the Electric Boat Co. plant. Besides members of the American Society of Mechanical Engineers, members of the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, the Boston Society of Civil Engineers, the Brooklyn Engineers Club, the New York Engineers Club, the Providence Engineering Society, the Philadelphia Engineers Club, the Engineering Alumni and students of Brooklyn Polytechnic Institute, Brown University, Columbia University, Massachusetts Institute of Technology, New York University, Stevens Institute of Technology, Worcester Polytechnic Institute, Yale University and other organizations of engineers were present.

Appliances and Materials

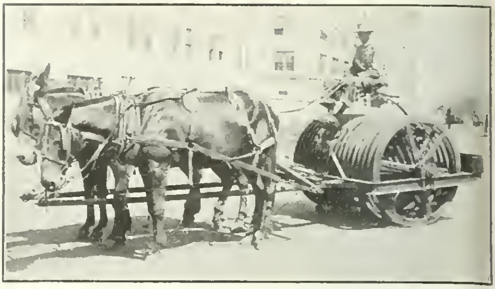
Carbon Grounding Cone

An improved low-resistance nonmetallic electrode for use as an electric grounding-line terminal, and given the trade name "Burn-Boston Carbon Cone," is being put out by Hickey & Schneider, 61 Broadway, New York City. The device is a long cone formed by a hard carbon pencil, 1.5x23 in., surrounded by a thick porous moisture-absorbing carbonaceous jacket. A copper lug and lead wire are sealed into the top.

* * *

Multiple-Disk Road Roller

An improved design of road roller has just been marketed by S. E. Finley, of Atlanta, after having been experimentally developed in connection with the "Finley Method" of laying bituminous-bound stone roads. One is shown in the accompanying view. Two sizes are made; the larger has eighteen 54-in. cast-iron wheels 1 in. wide with 2½ in. clear separation. The holes in the wheel hubs are 1 in. larger than the axle, so that the roller adjusts itself to the crown. The weight of the roller can be adjusted by loading sand or gravel into a long box across the rear. When rolling on a hard smooth surface the load is about 325 lb. per sq.in. (1x1-in. contact for each wheel). The scheme of this type of roller is to have the wheels penetrate the loose stone as spread, packing it at the bottom first and gradually consolidating the whole course. The larger machine sells for $600. The smaller weighs 5,000 lb., has 42-in. wheels and sells for $500.



FINLEY'S MULTIPLE-DISK ROAD ROLLER

* * *

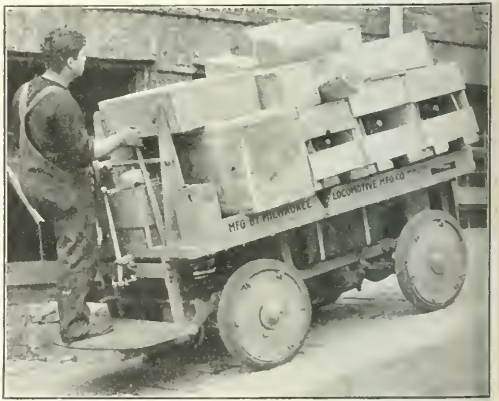
Self-Aligning Lighting Fixtures

A special suspension fixture for factory lamps—one that always hangs vertical—is being made by the Central Electric Co., of Chicago. The important part is a cast-iron canopy fitting a standard 4-in. outlet box and inclosing a ball-and-socket joint that permits a fixture to swing through a 25° angle. This canopy and joint replace the usual stud, crowfoot and box cover and cost about the same as the replaced equipment.

* * *

Small Gasoline Industrial Truck

A new type of gasoline truck and tractor—for freight handling at railway terminals, docks, warehouses, etc., and for transferring material in manufacturing establishments—has been brought out by the Milwaukee Locomotive Manufacturing Co., of Milwaukee, Wis. A steel frame supports a 48x78-in. loading platform; this can be tilted about one end to expose the engine and transmission. The truck steers by the front wheels which are attached to the front axle by steering knuckles as in automobile construction. There is a vertical steering wheel at the rear, where the operator rides on a platform. The wheels are of disk construction and are rubber tired. Power is furnished by a 10-hp. four-cylinder four-cycle vertical engine running at 1,000 r.p.m., and is transmitted by a bevel-gear differential and external drive axles. There is an electric starter. The transmission (selective type with multiple-disk clutch) permits speeds of 2.4, 4 and 7.6 miles per hour forward and 2 miles reverse. Internal expanding brakes act on drums on the drive wheels and are set by a hand lever and by the clutch-pedal release. The engine is cooled by pump circulation through the jackets and to a honeycomb radiator.



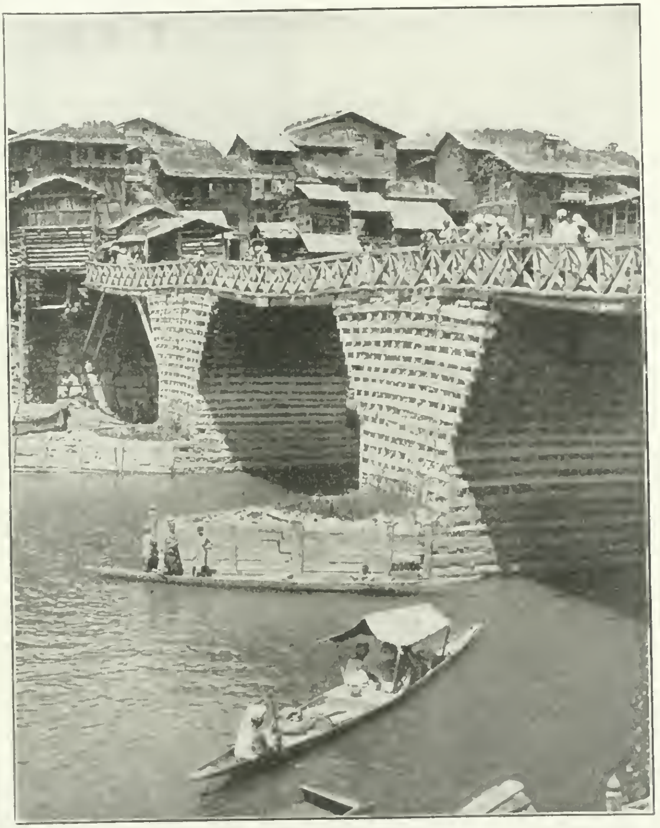
GASOLINE INDUSTRIAL TRUCK AND TRACTOR

Engineering News

VOLUME 76 NOVEMBER 23, 1916 NUMBER 21

Primitive Timber Bridge in the Vale of Cashmere

Such structures as the one shown in the accompanying view as a rule have only a pictorial or historical interest, but this particular one would seem to hold a suggestion, at least, for a temporary bridge even in civilized countries, or at least as an expedient in some location where carpenters are scarce or cut timber difficult to obtain. The bridge is across the Velasla River at Srinagar, in Cashmere. As may be noted, its novelty consists in the corbeled piers which reduce the clear span to such an amount as to permit the use of single timber girders for the main spans, in effect producing a cantilever bridge of the simplest type. The piers are made up of cribwork filled up to the beginning of the corbeling with riprap or stone. Above that point apparently no filling is used, but the floor is carried on the cribbing itself. The cut-waters, also of filled cribbing, which form pier footings, extend up to high water in the river. What is presumably the same bridge is illustrated by a sketch in Tyrrell's "History of Bridge Engineering," but the view there shows the roadway covered with small frame buildings similar to those in the background of the view herewith. It is stated that these are used as stores and the structure is locally known as "the bridge of shops." Possibly these buildings have since been removed for they do not appear in this later view.



TIMBER CRIB CANTILEVER BRIDGE ACROSS THE VELASLA RIVER IN CASHMERE, INDIA

In considering the design of this unique structure it is well to bear in mind that the Vale of Cashmere is located high in the remote fastnesses of the Himalaya Mountains. The lake into which the Velasla River empties is over 5,000 ft. above sea level. In this distant region, manufactured articles of iron and steel are of course exceedingly expensive and difficult to obtain. The designer of this bridge, therefore, appears to have utilized to the best of his ability the local materials, timber and stone, which were most readily available. One does not have to go more than a century and a half back in European civilization even, to reach a period when engineers were almost as closely limited in the materials available for construction and in the tools for handling them as was the designer of this bridge. Except for the masonry arch structures, therefore, some of the bridges built in civilized countries a hundred and fifty years or more ago, were almost as crude in design, according to our present-day notions, as this bridge in the Vale of Cashmere. In masonry arches, of course, the present has little advantage over the past.

Park Grading by Day Labor

SYNOPSIS—Artificial topography on a flat park site, the work including steam-shovel and elevating-grader work with both dump-wagons and dump-cars. All done by the forces of the West Chicago Park Commission.

A grading job of 271,000 cu.yd. is involved in the layout of Columbus Park, Chicago. This is a new park established in vacant land on the outskirts of the west side, with a rectangular area of about 154 acres.

The site is flat, and the grading is for the landscape-engineering work, including excavation for a large lagoon and open-air swimming pools. The excavated material is being banked up around the sides of the park so that, with the trees and shrubbery upon this fill, the surrounding buildings will be largely concealed and the interior of the park given a rural appearance. The West Chicago Park Commissioners decided to do all the excavation and grading with their own forces and equipment. The design of the park, with its buildings, etc., and the carrying out of the construction work are under the direct charge of A. C. Schrader, Chief Engineer and Superintendent of the West Chicago Park Commission.

The surface is a thin cover of black soil over a bed of stiff blue clay. Test pits 3 ft. square were dug in order to determine the material to be handled. The black soil is stripped and saved for spreading over the golf grounds and the slopes of the new fills. In this way the cost is only about 40c. per yd., while new black soil would cost $1 per yd. The stripping is done by a New Era elevating grader, which is hauled by a Reeves 12-ton 20-hp. steam traction engine, the soil being delivered into dump-wagons. Where the machine could work continuously on long stretches, as in stripping the site of the fill, it could load 800 to 900 wagons per day (900 to 1,000 yd.). This outfit is shown in Fig. 1.

The main excavation, for the lagoon, etc., is in the stiff blue clay. Very little water is encountered, and this is carried off by a ditch in the floor of the cut, while a gasoline diaphragm pump is provided at the sump. This excavation is done by two 15-ton Erie steam shovels, of the revolving type, with ¾-yd. buckets. The maximum depth of cut is 14 ft., which is made in two lifts. The steam shovels are served mainly by small dump-cars, but dump-wagons were used on some parts of the work. These shovels excavate 700 to 800 yd. per day. Fig. 2 shows one of the shovels making the first lift of the deep cut and loading the material directly into the dump-cars on the surface of the ground.

There are about 1½ mi. of track of 20-in. gage, consisting of 20-lb. rails spiked to 4x6 ties 36 in. long and spaced about 36 in. c. to c. The cars are of the side-dump type, of 1½ yd. capacity, and are made up in five-car trains, each hauled by a two-horse team. Locomotives were not considered advisable, as much of the track is on the fresh fill and would not carry heavy loads, besides which the grades are very irregular. With teams, the trains are handled easily, and the light construction makes a very flexible track layout that can be shifted readily as the work progresses.

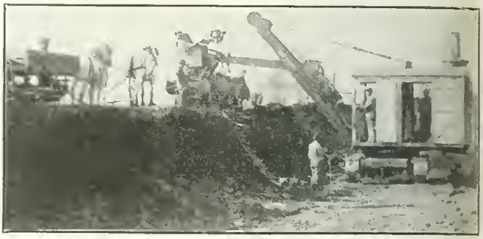


FIG. 2. STEAM SHOVEL EXCAVATING FOR THE LAGOON IN COLUMBUS PARK, CHICAGO

The grader outfit has five men at the machine—foreman, engineman, fireman, one man on the grader and one to take care of stumps or boulders. At the dump for the wagons with black earth a boss and six laborers spread and level the material. This outfit is served by 20 to 26 teams. Each steam-shovel outfit has an engineman, a fireman, two pitmen to shift the supporting platforms under the wheels and two topmen to see to the loading of the cars. At the dump (for the cars) there are 12 to 16 laborers to shovel the fill. Each shovel is served by 8 to 14 teams (each with a five-car train), depending upon length of haul.

The grader wagons average 1.12 yd. per load, and the dump-cars average 1.4 yd. Count is made of the number of dipper loads, and this is checked by the cross-

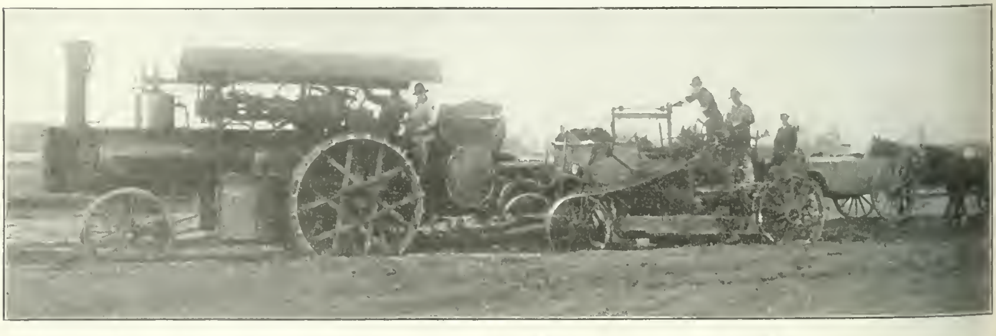
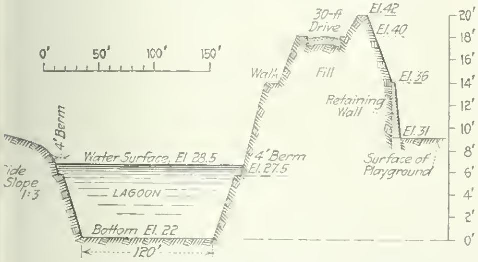


FIG. 1. STRIPPING BLACK SOIL FOR USE ON GOLF GROUNDS AND LAWNS AT COLUMBUS PARK, CHICAGO

ection measurements. The monthly record is from 12,-00 to 16,000 cu.yd. for each shovel and 16,000 yd. for e grader.

The depth of water in the lagoon is about 6½ ft. The ormal bottom width is 125 ft., and the side slopes are on 3. On each slope there is a 4-ft. berm about 12 in. elow the water. This retains a 2-ft. facing of black rth on the upper slope, thus enabling shrubbery to be rown along the water's edge, instead of leaving a bare argin. There will be a boathouse and landing, gymasium, shelter and other ornamental structures. The wimming pools will be 50x70 and 50x140 ft., and the hildren's wading pool 40 ft. in diameter with a sand ourt surrounding it.

The fill at each end of the park is about 85,000 yd. his serves to conceal the surrounding buildings, and for e same purpose the entrance driveways are cut diagnally through the fills. At the east end, where a playround is located outside the fill, space is gained by the se of a concrete retaining wall to hold the fill. Fig. 3 s a section through the lagoon, fill and retaining wall. he drives are 30, 50 and 60 ft. wide, the maximum width eing at points where it is desired to allow for the parkng of vehicles.



IG. 3. DISTORTED SECTION THROUGH LAGOON AND FILL AT COLUMBUS PARK, CHICAGO

For subsoil drainage of the golf grounds, drains of 4-in. ile are to be laid at a depth of about 3 ft. These will ad to a vitrified-pipe sewer along the north side of the ark. The city needs additional sewers in this district, nd to save duplication and expense the sewer was built f such size as to form part of the sewerage system, and he city paid a portion of the cost. This sewer was built y contract, as the cost of trenching machinery would ave been out of proportion to the amount of work.

The site is crossed by Harrison St., but the city vacated he street for park purposes, the Park Commission underaking to build a new connecting street around the south nd. A 20-in. gas main exists on the original street line, ut the gas company would not agree to shift it to the ew street location. To avoid injury to trees and shrubery, the main was uncovered and all joints were thoroughly calked and then clamped with a special gas-tight lamp. For crossing the lagoon this main had to be owered about 16 ft. for a distance of 250 ft. The new rench for this was dug by a trenching machine.

About 110 men (including teamsters) and 50 teams re employed. They work a 9-hr. day (7 a.m. to 5 p.m.). The temporary buildings on the work include an office or the superintendent, timekeeper, etc.; an office for the oreman, a storehouse, a shelter for the men in case of torms, and stables for the teams.

The Engineer as a Juror

By R. Fleming*

It is the contention of the writer that the engineer is peculiarly well qualified to act in the capacity of a juror. Trial by jury is one of the foundation stones of the English and American constitutions. It is said that the system has been abused. Few changes are likely to be made, however, in the present generation. The remedy for any abuses that may have crept into the system is to raise the standard of jurors. It is hard to do this when men of the type needed avoid service. "And they all with one consent began to make excuse" may often be said of a body of intelligent men drawn to do jury duty. The result is that decisions of importance are left to men of narrow vision and poor judgment.

"I am a roofer. I get $2.25 a day at my trade and work is dull, so I do not lose anything by serving as a juror," was the remark made in a courtroom to the writer by the occupant of the adjoining chair. The first case called for trial in that court was a suit for $50,000. Did the roofer's training qualify him to sit on a $50,000 case?

"I will not vote to convict that man if I stay here a million years," remarked one of the jurors in a criminal case before seats had been taken in the jury room. No headway could be made against his stand, and a disagreement was reported. Such a man lacks the open mind and is temperamentally unfit to serve on any jury.

Because of his training in accuracy and precision, the engineer is fitted to weigh evidence and discriminate between fact and fancy. There is hardly a case in either the civil or the criminal court in which the question of distance does not come up in some form. It is surprising what crude ideas the average witness has of distance. A suit for damages was brought by a man thrown from a wagon by reason of a depression in the street, which a contractor was alleged to have left after putting in a connection to a water main. It was important to know the depth of the depression. A number of witnesses testified to distances varying from 5 to 8 in. The last witness had measured the distance and found it barely 3 in. To the engineer on the jury the testimony of this witness outweighed that of the others. The plaintiff lost his suit.

A criminal case is fresh in mind where the first vote of 8 to 4 for acquittal was changed to a unanimous vote for conviction when an electrical engineer, who was a juryman, stated clearly and concisely his reasons for believing the defendant guilty. Subsequent events proved the verdict to be perfectly just.

A compliment was paid to the engineering profession by an able lawyer with a weak case. When he asked the men in the jury box their business, one replied, "Electrical engineer"; another, "Telephone engineer," and a third, "Civil engineer." These three, with a fourth man—the most intelligent-looking men in the box—were promptly excused from serving.

The engineer receives as well as gives in performing jury service. A jury of 12 men, all fellow citizens, usually represents a wide range of occupations and opinions. One thus gets new viewpoints and is broadened in his thinking.

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*American Bridge Co., 30 Church St., New York City.

Lowering a Tunnel Under the Chicago River

SYNOPSIS—A street-railway tunnel on a steep grade has been lowered to clear new structures built over it. A flat roof was built under the old arch and side walls were put down to the new grade; then the inclosed core was excavated and the new floor put in. The river section of the tunnel was repaired at the same time. Concrete was placed by the pneumatic system and also by dump cars. All work was done inside the tunnel by company forces.

Alterations to the Van Buren St. tunnel under the Chicago River at Chicago, Ill., have involved difficult construction work of special interest. The tunnel is owned by the Chicago Railways Co., and carries a double-track street railway.

As originally built in 1889-90 (for cable traction) the tunnel had a concrete invert and a brick arch roof springing from the floor level, the tunnel being 30 ft. wide and 16 ft. high. In 1906 the tunnel was lowered 8 ft. to enable the river channel to be deepened. This was done by cutting niches in the walls to receive steel columns standing on the old arch footing and supporting transverse girders. Concrete jack arches were built between the girders, and when this new roof was completed the old arch above was destroyed and removed by dredging. New concrete side walls underpinning the footings were then built, and the bottom excavated to the grade of the new invert.

The tunnel as thus altered was 27½ ft. wide and 15 ft. high. On the approach inclines (with grades of 7% at the west and 11.5% at the east end) the brick arch roof remained in place, the sides being underpinned by concrete walls extending down to the new grade line. This reconstruction of the tunnel was described in *Engineering News* of Sept. 13, 1906, and March 7, 1907.

The construction of the new Union Station recently made necessary the lowering of the west approach to the tunnel, in order to clear the foundations of the new station. The change was complicated by the fact that the tunnel location was governed by two fixed points, one above the roof and the other beneath the floor. At the west line of the station property the tunnel had to be lowered sufficiently to pass beneath a baggage subway below the station tracks and platforms. About 250 ft. east of this the tunnel had to pass above one of the Chicago Tunnel Co.'s narrow-gage electric freight-railway tunnels.

The plan adopted was to drop the line from the street level at Clinton St. (the west end of the tunnel) on a descending grade of 11.345% to the east till clear of the station subway. This was followed with a grade of 0.5% until the freight tunnel was passed, and the line met the existing 7% grade of the old approach. The changes in grade are made by vertical curves of 1,400 ft. radius, with a length of 150 ft. for the upper and 80 ft. for the lower curve. The length of the open part of the west approach is reduced from 300 ft. to 167 ft. The old and new profiles are shown in Fig. 1.

Reconstruction of West Approach

The general plan of construction on the inclined portion west of the river tunnel was to build new side walls within the interior line of the tunnel, and to place upon this the new flat roof. This is shown in Fig. 2. The upper part of each wall was built and the new roof completed before any of the old tunnel was destroyed. This eliminated the necessity of bracing the old tunnel during the underpinning, as the new roof acted as transverse bracing for the old tunnel. In the old invert holes 12 in. deep were drilled, in which reinforcing rods for the new side walls were placed. On the old invert, inside the forms for the side walls, was laid a lapped floor of 1-in. boards, to prevent any bonding between the new wall and the old invert. Fig. 3 shows the reinforcement and form for the top section of the new side wall. The pipe is for the pneumatic concreting plant.

Where the new work was built against the old tunnel walls, the face of the wall was blasted away to give a roughened surface and to allow a thickness of at least 12 in. of concrete. In this new surface holes were drilled about 9 in. deep and 2 ft. c. to c. Hook bolts were wedged and grouted in the holes, and longitudinal reinforcing bars were laid upon these. The holes for blasting and for the hook rods were drilled with Sullivan air-tube rotary drills and piston hammer drills. The charge for each blast hole was about half a stick of 60% dynamite.

Across the top portions of the new walls were placed 26-in. steel plate girders 28 ft. long, spaced 3 ft. apart. A roof form was then built under the girders (sup-

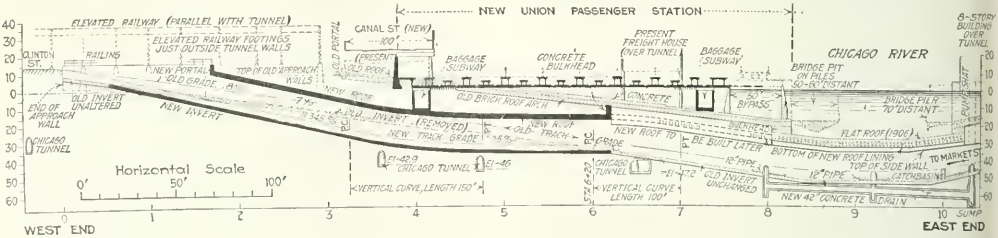


FIG. 1. PROFILE SHOWING ALTERATIONS TO THE VAN BUREN ST. TUNNEL OF THE CHICAGO RAILWAYS CO.

orted on falsework) and concrete was filled in by the neumatic system to form a flat roof 42 in. thick, in hich the girders are embedded.

After the completion of this new roof a working drift bout 6x6 ft. in the clear was driven along each side all, just below the new roof wherever the clearance etween the new roof and old invert was not sufficient r good working conditions. These drifts were timbered ith old oak ties spaced 18 in. c. to c. and lagged with -in. plank, and were about 300 ft. long, being carried bout 100 ft. farther west than demanded for clearance facilitate the removal of the core.

From these drifts the lower side walls were constructed y underpinning the upper section of the side walls alcady built. Sections or chambers 10 ft. wide were xcavated to the grade of the bottom of the walls. These ere lagged and braced, after which the form was built line, with 6x6-in. posts blocked against the adjacent ore. Then the reinforcing steel was set, the 1-in. vertical rods being made fast to the ends of the rods in he upper walls by means of two cable clamps in a plice of 12-in. length. The concrete was placed from he pneumatic mixer, the bracing being removed as the hambers were filled.

The joint between the upper and lower sections of he wall was filled tight by grouting under a head of 0 ft. This was done by placing 2-in. pipes in position the wall, and turning them up along the inside of he tunnel by means of a 90° elbow. A box was built round the top of the pipe and grout poured into this.

Fig. 4 is a view above the new roof. The men at the ft are dumping a car of concrete into the form for he lower portion of the new side wall.

All underpinning sections were put in by following prepared schedule which was kept in the engineer's ffice on the job. This schedule was arranged so that o section was put in adjacent to one already in place r at least seven days. New sections were kept as far way as possible from those in place, and at no time ere sections directly opposite put in at the same time. hese precautions were adopted to prevent settlement s much as possible. Some settlement was naturally xpected, and as much as 8 in. occurred under Canal t. where the clay was soft. This settlement (which n out in about 150 ft. each way from Canal St.) was he cause of leakage that occurred later in the new tunnel. his leakage was mostly stopped by grouting, and as the urrounding ground again compacts against the new alls it will in time undoubtedly cease.

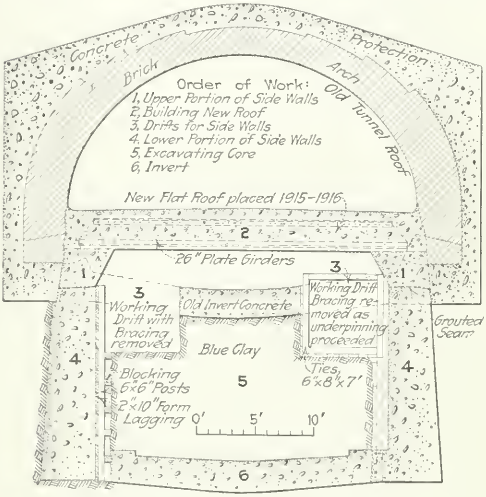
In each of the vertical joints between the 10 ft. sections a 1-in. board was placed in the center of the wall, dgewise and parallel with the face of the new wall, that half of the plank was in each of two adjacent ections. This was for the purpose of stopping leaks, being expected that the wood would swell and tighten p in the joint. This method proved very satisfactory.

When the underpinning was entirely completed, the ore between the walls was removed. Four sections were pened, working two alternately every other day, and ections 10 ft. in length were taken out. The 1-in. reinforcing bars for the invert were set by fastening them the side-wall rods with two cable clamps at each nd. Concrete for the invert was placed as soon as ossible. The typical finished section of the western portion of the tunnel is shown in Fig. 5.

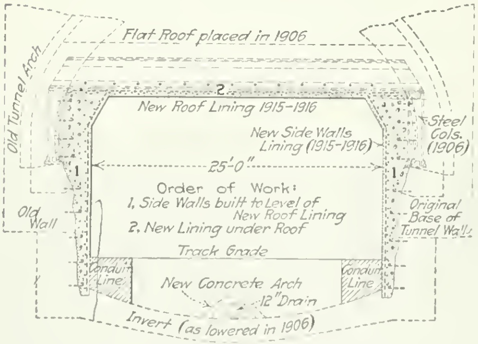
Along the 7% grade to the river, the old arch stil forms the roof. At some later time a new flat roof similar to that already described will be built beneath this as shown in Fig. 1.

Reconstruction in River Tunnel

In the river section of the tunnel the bottom flanges of the steel girders and the supporting columns have been constantly exposed to moisture since they were placed in 1906, and were scaling badly. In order to protect the steel and to reduce the leakage, which was considerable, it was decided to build a concrete lining within the existing side walls and roof. The section adopted was the same as in the reconstructed west end of the tunnel. The new lining walls were extended 213 ft east of the river section, to the old arch portal.



Section of West End of Tunnel



Tunnel Section Under the River

FIG. 2. SECTIONS SHOWING ALTERATIONS TO THE VAN BUREN ST. TUNNEL, CHICAGO

The method of reconstruction in the river section of the tunnel is shown by the lower drawing in Fig. 2. Th work was carried out as follows: The faces of the old concrete side walls were blasted away to give at least 12 in. space from the line of the new facing. The brickwork of the upper part (which was originally part of the old tunnel arch) and the faces of the concrete jack arches were roughened and clipped with a chisel attached to a pneumatic hammer. Hook bolts with longitudinal rods were then placed, as previously described. Then a rectangular reinforcement of $\frac{5}{8}$-in. vertical bars and $\frac{3}{4}$-in. horizontal bars was placed, this being 3 in. back from the new face line. The form was erected outside of this.

The side walls were then concreted to the height of the under side of the new roof protection, each side wall being completed for the entire length of the river section of the tunnel by continuous concreting. The concreting was done by hauling the mixed material in 1-yd. steel dump cars running on a track on an elevated runway alongside of the forms, and as close to the old roof as the dumping of the cars would permit. The runways extended from two $\frac{1}{2}$-yd. electrically driven Ransome mixers placed inside of the tunnel.

The roof protection was constructed next. This is shown in Fig. 7. The old concrete of the jack arches was cut away along the lower flanges of the girders, and the exposed metal was scraped clean. Holes were drilled in the jack arches for hook bolts and for longitudinal 1-in. bars placed across the lower flanges of the girders. These were spaced 2 ft. c. to c., and staggered with the bars between the adjacent pairs of girders. The flanges were also wrapped with sheets of expanded metal. From the bars a reinforcement of $\frac{5}{8}$-in. longitudinal and $\frac{1}{2}$-in. transverse bars was hung by means of hooks.

The falsework for the roof forms was then built, about 4 in. clear beneath the flanges of the girders. The concrete was mixed by the two Ransome mixers in the tunnel and hauled under the forms. There it was dumped on platforms, from which it was cast into the forms by hand and rammed solid for every 3 ft., working between two of the roof girders from the walls to the center. The form lagging and longitudinal reinforcement were placed as the concreting progressed. The final keying up in the center was done by building the form tight and forcing grout under low pressure into the void. Numerous 2-in. grout pipes were placed in the roof, and later the entire roof of the river section was again grouted under pressure. Fig. 8 is a view in the completed tunnel, showing the bulkhead above the east end of the river portion of the tunnel.

The open portion of the west approach was entirely rebuilt. On the east side many of the sandstone block of the masonry retaining walls had become badly disintegrated, and these were refaced with concrete. The disintegrated material was cut away, and a form built in front of the block, with a pipe extending to the top of the wall. Cement grout 1 : 2 was poured into the pipe, giving a head of 10 to 15 ft. on the form. The new surfaces are flat and the old joints are retained. After this work had been done, the entire surface of old stone and new concrete in this east open approach was given two coats of Trus-Con Stone-Tex waterproof paint.

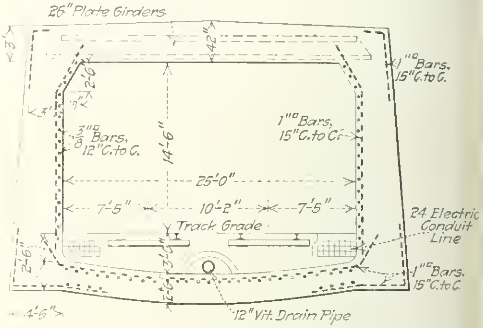


FIG. 5. TYPICAL SECTION OF WESTERN PORTION OF TUNNEL AS RECONSTRUCTED

CONCRETING AND GROUTING

Of the concrete west of station 6 + 20 (roof and side walls) about 5,000 cu.yd. was placed by the MacMichael pneumatic process. The mixer was of $\frac{1}{3}$-yd. capacity, and the pressure was from 70 to 90 lb. The maximum distance for delivering the concrete was about 350 ft. For some parts of the work the delivery pipe had a hori-

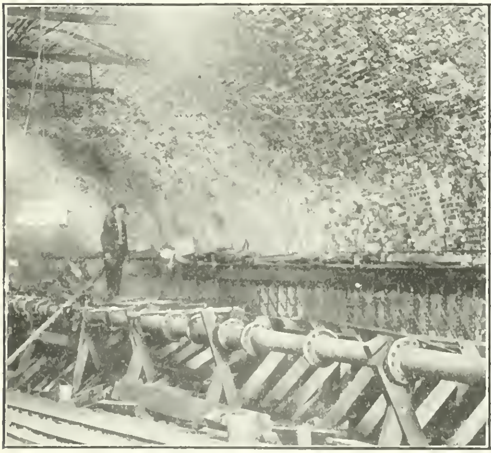


FIG. 3. BUILDING UPPER PART OF NEW CONCRETE SIDE WALL

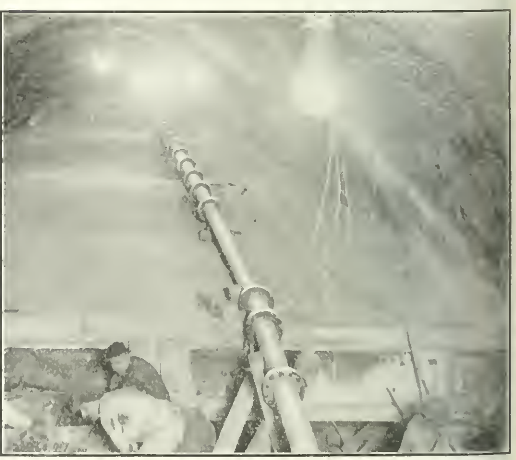


FIG. 4. NEW ROOF COMPLETED UNDER OLD ARCH

zontal curve of 180° followed by two of 45°, and a 90° discharge elbow into the forms. There was also a vertical rise of 35 ft. from the mixer to the form. For about 300 ft. of the invert, however, the concrete was mixed in the Ransome machines. These were used mainly in concreting the river section.

The concrete was a 1 : 2 : 4 mix, using stone with a maximum size of 1 in. for the pneumatically placed concrete, and ½ in. for that mixed in the usual way in the Ransome machines and distributed by the cars. In the concrete east of station 6 + 20, and in all the cement grouting, Ceresit waterproofing compound was added. No bituminous coating was used on top of the new roof.

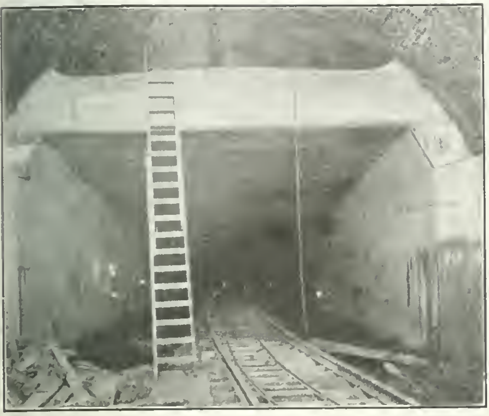


FIG. 6. END OF NEW FLAT ROOF UNDER OLD ARCH ROOF
The space above the new roof is closed by a concrete bulkhead

Pipes for grouting were placed in advance of the concreting and after 60 days, when the concrete had had time to set, the cement grout was forced in under 80 to 90 lb. pressure. Where this grouting was near the old brick arch, a temporary centering was placed under the latter to prevent any danger of collapse. The grout was composed of equal parts of cement and powdered stone. Sand was not used when the grout was forced through the wall, as it was found that the cement and powdered stone would find a passage while the sand would be segregated and clog in the 2-in. grout hose. Three Ransome-Canniff grout mixers and one Cockburn mixer of the paddle type were used in the grouting.

The finished concrete surface of the roof and side walls was dressed with the Berg portable rotary surfacing machine. This consists of a disk driven at 2,000 r.p.m. and having in the face a number of hard-steel cutter wheels with toothed surfaces. These wheels roll on the surface and chip off any fins or board marks. The operator carries a small motor slung on his shoulder, and this is connected to the surfacing device by a flexible shaft.

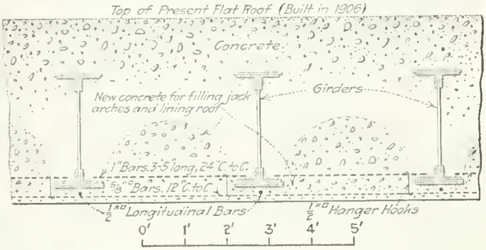

Top of Present Flat Roof (Built in 1906)
Concrete
New concrete for filling jack arches and lining roof
Girders
1" Bars. 3'-5" long, 24" C. to C.
5/8"□ Bars. 12" C. to C.
1/2"□ Longitudinal Bars
1/2"□ Hanger Hooks
0'
1'
2'
3'
4'
5'

FIG. 7. REINFORCING OF THE OLD ROOF IN RIVER SECTION OF TUNNEL

The 8-in. delivery pipe used for conveying concrete from the pneumatic mixer to the forms was taken from recently abandoned power houses, where it had been in service for something over 20 years. It was mostly extra heavy pipe and was not the best suited for the work, but was used in order to save the expense of purchasing the necessary new pipe.

Handling Materials and Power Cables

The roof girders were 28 ft. long, and weighed 1,300 lb. each. There were 112 of these to be placed, and their location and elevation were determined by small concrete pedestals formed on top of the new side walls.

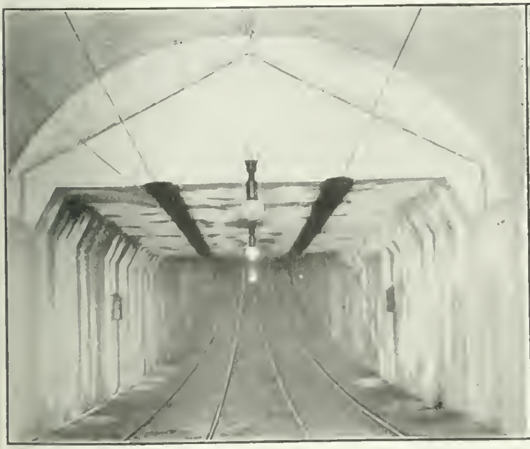


FIG. 8. COMPLETED TUNNEL AT EAST END OF RIVER SECTION, WITH BULKHEAD OVER NEW ROOF

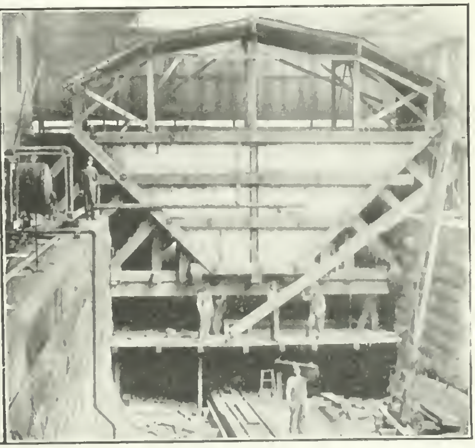


FIG. 9. CONCRETE MATERIAL BINS AT WEST PORTAL OF TUNNEL

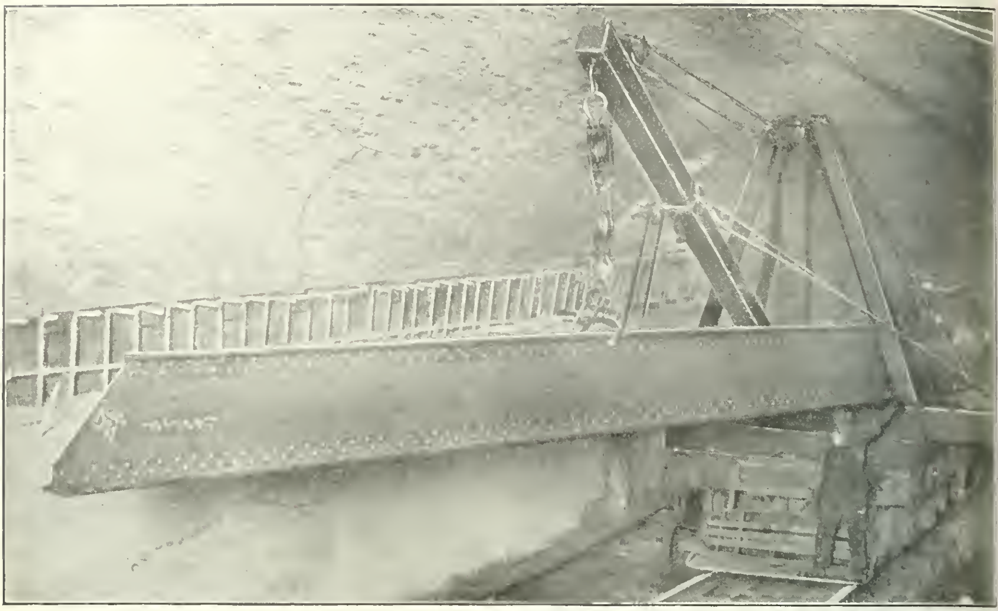


FIG. 10. HANDLING 28-FT. PLATE GIRDERS IN THE TUNNEL WITH AN ELECTRIC DERRICK CAR

For handling these girders an old motor car was converted into an electric derrick car, and a temporary standard-gage track was laid in the new part of the tunnel for the derrick car in handling and placing the girders. Fig. 10 shows this car placing one of the girders.

The railway tunnel carries about 30 large cables for power supply to the business district, and these had to be kept in operation during the work. They were placed originally in conduits at either side of the tunnel, but were shifted temporarily to a wood box in the center of the floor. This box was of heavy construction, to protect the cables and the work, and the narrow-gage track was laid upon it.

The cables remained in this position during the work on the roof and side walls. When the reconstruction of the floor was undertaken the cables were attached to timbers bolted temporarily to the new roof in the tunnel, and to slotted vertical posts bolted to the side walls of the open approach.

In the completed tunnel the cables are placed in conduits at either side of the track. These are covered with concrete and form sidewalks, manholes being provided at intervals. The cables were cut and spliced twice, and shifted five times, during the progress of the work.

TRACKS, DRAINAGE AND OTHER WORK

The tunnel tracks were laid with 100-lb. T-rails welded together. These were cut into lengths of 350 ft. and hauled out on the east approach until the work was finished. Then they were hauled back, relaid and welded.

The river section of the tunnel as altered in 1906 had an 18-in. tile sewer below the invert and leading from a sump in the invert to a pump shaft at the east end. This sewer was found to be nearly stopped up. A 12-in. concrete sewer was built, therefore, beneath the invert, with a sump in the center and at each end, and a drain from the east sump to the pump shaft. The material beneath the tunnel was found to be so hard that blasting was required in excavating for the sewer. Drainage of the tunnel is provided for by a 12-in. vitrified pipe laid on the invert and covered with a segmental concrete arch over which the track ballast is filled.

FORCE AND MANAGEMENT

During the main part of the work, the force worked three 8-hr. shifts daily. The work was all done by company forces, as it was not well adapted for letting by contract, and the presence of the live cables would have been a hazard for men not accustomed to electric railway work. The tunnel was closed to traffic in June, 1915, and reopened in May, 1916. The work was designed and executed under the direction of John Z. Murphy, Electrical Engineer of the Chicago Surface Lines; J. W. Harris was Tunnel Engineer; Roy W. Emmert was Assistant Engineer and John J. Casey, Superintendent.

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Activated-Sludge Experiments at University of Illinois

BY EDWARD BARTOW, F. W. MOHLMAN AND J. F. SCHNELLBACH*

The first series of activated-sludge experiments at the University of Illinois, begun Nov. 1, 1914 (*Engineering News*, Vol. 73, p. 618, 1915) was constructed in 3-gal. bottles. The second series was conducted in a tank 9 in. square and 1½ ft. deep. The third series was conducted in four tanks each having an area of 10 sq.ft. and a depth of 9 ft. (*Engineering News*, Vol. 74, pp. 166, 1096, 1915). Experiments in the first three series were carried on by the fill-and-draw plan. At present, for the fourth series, a continuous-flow plant is being successfully operated. This series is conducted in the septic tank designed by Prof. A. N. Talbot (*Engineering News*, Vol. 42, p. 111, 1899) in 1897 for the City of Champaign. Early in 1916 this tank was placed at the disposal of the State Water Survey, and was reconstructed with the expectation that 200,000 gal. of domestic sewage be treated daily.

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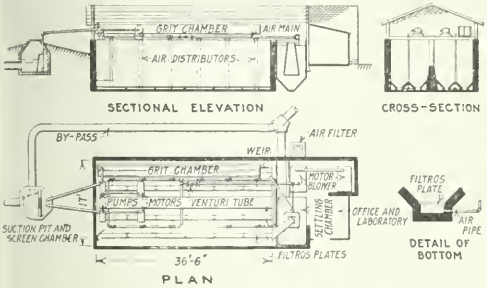
*Illinois State Water Survey, Urbana, Ill.

Design of Plant

The plant (see accompanying illustration) contains a screen chamber and pump pit, a grit chamber, an aëration chamber, a settling chamber, a blower room and a laboratory. A sludge-drying bed and a pond into which the effluent from the process may be discharged are also provided. Plans have been made for the installation of sludge-drying apparatus.

The sewage is drawn from the main outlet sewer of the City of Champaign. The daily flow is from 1,000,000 to 1,500,000 gal. The manhole nearest the septic tank was modified to serve as a screen chamber and suction pit for the pumps. A weir was placed in the outlet to raise the sewage level and provide suction for the pumps. Vertical bars spaced with ¾-in. openings prevent coarse material from reaching the suction of the pumps. The sewage is pumped to a grit chamber by two centrifugal pumps, one with a capacity of 75 and the other of 110 gal. per min. Each pump is belt-connected to a 3-hp. electric motor. The grit chamber is 31 ft. long, having two compartments each 1 ft. wide. At the outlet is an adjustable weir through which the sewage must flow and where its rate can be measured.



ACTIVATED-SLUDGE PLANT DETAILS, CHAMPAIGN, ILL.

The sewage flows from the grit chamber into the aëration chamber, a rectangular concrete tank 17x36¼ ft. in plan and 9½ ft. deep, having a capacity, after allowances are made for the baffle walls and the sloping bottoms, of about 36,000 gal. The chamber is divided longitudinally by three baffles into four compartments through which the sewage travels a distance of about 140 ft. The lower part of each compartment has sides sloping toward the center, to a channel 10½ in. wide and 1 in. deep, extending lengthwise through the tank. Above this channel filtros plates are supported on T-bars that have been embedded in the concrete. The channel below the filtros plates was divided into sections for six filtros plates with the expectation that each set of plates would be separated from all the others and that the supply of the air to the plates could be regulated by an air pipe and valve for each set. Owing to the porosity of the sloping concrete sides it has been found impossible to regulate independently each set of plates. The aëration tank should be capable of treating 144,000 gal. of sewage and sludge per day if aërated during a period of 6 hr.; 170,000 gal. if aërated 5 hr., 216,000 gal. if aërated 4 hr.

The treated sewage and sludge flows from the aëration chamber to the settling chamber. The settling chamber is 6x10½ ft. in plan and 10½ ft. deep at the lowest point. It has a capacity of 3,700 gal. This would give a retention period of 24, 31 and 37 min. with a flow of 4, 5 and 6 hr. respectively, through the aëration chamber.

In order to assist the settling of the sludge, the liquid is passed down through the center and up around the edges of a hollow wooden pyramid placed in the center of the settling basin. The pyramid is 15 in. square at the top, 3 ft. square at the bottom and extends to within 3½ ft. of the bottom of the chamber.

From the settling tank the effluent flows over a weir to the creek or into the pond. The pond is formed by two dams placed across the abandoned bed of a small stream. It covers about 0.1 acre and is 3 ft. deep in the deepest part.

The sludge is withdrawn from the settling chamber by an air lift and can be discharged into the raw sewage where it enters the aëration chamber, or can be diverted for experimental purposes, or to the sewer. Some sludge has been dried on a sand bed having an area of 256 sq.ft. and a depth of 8 in. The drying of sludge on the sand bed is not considered a success.

Air is supplied for aëration and for the air-lift by a rotary positive-pressure blower having a rated capacity of 300 cu.ft. per min., driven by a 15-hp. electric motor. The air is filtered through cheese cloth spread over a wire box before it enters the blower suction pipe. The air is measured through a venturi meter.

Performance of Plant

The plant has been in continuous operation for twelve weeks (on Oct. 1, 1916) prior to which time it was operated intermittently for periods of from one to three weeks. No special effort was necessary to build up activated sludge. The plant has simply been put into operation, allowing the effluent from the settling chamber to escape while pumping back the sediment. From the start 90% of the suspended matter was removed and after 13 days of operation stable effluents were obtained.

The results achieved have been very gratifying. Purification is indicated by the presence of from 5 to 8 parts per 1,000,000 of dissolved oxygen and the stability to methylene blue of from 5 to 15 days. The effluent is odorless and generally clear though at times, because of the insufficient capacity of the settling chamber, it contains small particles of sludge.

The plant has been run to obtain a clear effluent. Owing to the insufficient size of the settling chamber the actual rate of operation has been less than one-half of its rated capacity. Additional settling chambers are to be installed.

After satisfying ourselves that the plant could be run satisfactorily at a rate suitable to the capacity of the settling chamber, the rate has been increased to 150,000 gal. per day even though some sludge escapes with the effluent. At this increased rate, using 2 cu.ft. of air per gallon of sewage, stable effluents have usually been obtained. Owing to the presence of sludge in the effluent, the effluent was allowed to settle in glass cylinders 30 min. longer before taking samples for analysis.

Sensitive Water-Level Recorder

By E. J. Hoff*

After unsuccessfully searching the markets for instruments of a type sensitive enough to record minute variations of the water level in evaporation experiments, the Irrigation Investigations branch of the United States Office of Public Roads and Rural Engineering undertook to provide its own instruments to meet the requirements. This "evaporimeter" was planned to record continuously and accurately the lowering of a water surface by evaporation to 0.01 in.

The method adopted is to use a reasonably large evaporation tank of sheet iron about 6 to 8 ft. in diameter, and some few feet from it a small float tank of a diameter not less than 3 in. larger than the float. The tanks are connected near the bottoms by a small pipe. They are placed with the rims at ground level, as shown in Fig. 1.

The float tank is especially protected against evaporation by a cover that has but a small hole for the float wire to pass through. Hence, we can assume, in case the float tank is very small and the evaporation tank large, $E = E' + \frac{sE'}{l}$, when E is the true evaporation, E' the recorded evaporation, s the float-tank area, and l the evaporation-tank area.

If this relation of tanks does not exist, it will be wise to determine (by means of hook-gages) the evaporation losses in both tanks separately, when the communication pipe is closed. This also will demonstrate the influence of heat-conducting metal floats upon the water that is not exposed to the air. To eliminate this latter factor a glass bottle might be used for the float.

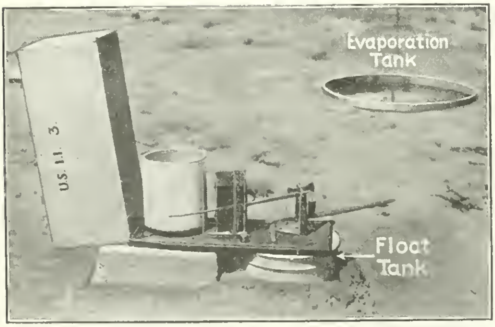


FIG. 1. "EVAPORIMETER," IRRIGATION INVESTIGATIONS, U. S. OFFICE OF PUBLIC ROADS AND RURAL ENGINEER

The evaporimeter resembles the usual type of recording instrument. A large clock-driven cylinder is provided to carry an 8x24-in. record sheet, and a lever connected with a float by a fine brass wire transmits the float motion to a pen placed at the end of a long pen-arm. The pen-point movement is ten times that of the float.

A pressure on the pen required to accomplish continuous recording would put a heavy load upon the float, which in consequence could not move gradually as the water does—the record of which we want. To eliminate this serious objection an additional arrangement is provided, which we call the rocker-arm.

The duty of this rocker-arm is to move the pen-arm from its normal position, in which the pen does not touch the record sheet, toward the cylinder at regular intervals. For this purpose the rocker-arm is connected to the clock by cams and levers. Every five minutes the rocker-arm moves the pen against the paper, where it makes a dash as the cylinder moves. When the rocker-arm's motion is reversed, the pen-arm returns to its normal position, but the rocker-arm retreats still farther, leaving the pen-arm free.

By means of the rocker-arm we have introduced two periods: One when the rocker-arm engages the pen-arm and causes the pen to record; and the other when the pen-arm is left in its normal position entirely free, subject only to the float's action. The records indicate the gradual lowering of the water surface and show precisely when extraordinary changes in water level occur.

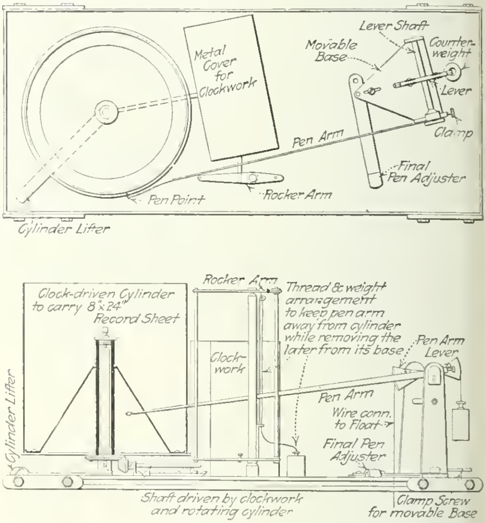

Metal Cover for Clockwork
Lever Shaft
Movable Base
Counter-weight
Lever
Clamp
Pen Arm
Final Pen Adjuster
Pen Point
Rocker Arm
Cylinder Lifter
Rocker Arm
Thread & weight arrangement to keep pen arm away from cylinder while removing the later from its base
Clock-driven Cylinder to carry 8"x24" Record Sheet
Clock-work
Pen Arm Lever
Pen Arm
Wire conn. to Float
Final Pen Adjuster
Cylinder Lifter
Shaft driven by clockwork and rotating cylinder
Clamp Screw for movable Base

FIG. 2. DETAILS OF "EVAPORIMETER," WHICH RECORDS VARIATIONS OF WATER LEVEL TO 0.01 IN.

The only remaining friction consists of the pressure (exerted upon highly polished pivots of small diameter) by the combined weight of the lever, pen-arm and double counterweight, all of which have been reduced to a minimum; therefore, the friction may be considered negligible. The employment of knife-edge bearings might have reduced this factor, but for practical reasons the pivot bearings are preferable.

For convenience and ease in operation several provisions are made. The record-sheet holder is a slit metal cylinder, which by its own elasticity or spring holds the record sheet. The cylinder is centered upon a platform that is especially mounted upon a point bearing about 5 in. above its base, thus securing the most stable support and the one easiest moved by the clock to which it is connected through a train of gears. The cylinder makes one revolution every 12 hr., or moves 2 in. per hr.

When the mounted record sheet is placed upon the platform, it can be disengaged from the gears and clock in order to allow free rotation, which is necessary for time setting. When the proper time as marked on the record sheet is near the pen point, a lever or cylinder lifter at the base of the cylinder is moved toward the left, which lowers the platform and engages the gears. A finer and final setting is made by adjusting the base of the lever by means of a clamp and slow-motion device.

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*Mechanician, Irrigation Investigations, United States Office of Public Roads and Rural Engineering, Berkeley, Calif.

While the preparatory work is going on, the pen is not in the operator's way, for it is not wise to disturb the lever and float. A spring is attached to the rocker-arm support, which by means of a small weight draws the pen-arm away from the cylinder, thus clearing the field for the operator. After setting, the weight is lifted and placed upon the instrument base, and the pen-arm resumes its normal position.

According to reports, this instrument has given satisfaction in every detail, and we seem justified in looking forward to a successful solution of a very difficult problem.

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Method of Making Drainage and Improvement Assessments

By Percy A. Cupper*

A board of appraisers assessing benefits and damages in drainage or other improvement districts has a thankless job, and unless guided by past experience and good judgment the appraisal is apt to result in a hopeless muddle. Even under favorable conditions an appraisal of this nature is on a par with judging a baby show. Discretion is the better part of valor, and escape before the result is announced is the only safe course.

Most of our drainage statutes provide for an assessment of both benefits and damages and also provide that if the damages, which include the cost of the works, are in excess of the benefits to be derived the improvement shall not be made. This makes it necessary in addition to securing an estimate of cost and assessment of damages to fix also the amount that the improvement will be worth. It is practically impossible to view one tract after another and fix in dollars and cents the proportional part of the total cost that each tract should bear, and almost endless adjustments are sure to result. The use of abstract figures eliminates much of the difficulty.

Factors To Be Taken Into Consideration

There are many factors to be taken into consideration in fixing the benefits to be derived by any particular tract of land from the improvement: Its condition prior to improvement, or the extent to which it requires improvement; its location; the productivity of its soil; its topography, elevation, accessibility—all of which may be expressed by the value of the land after improvement.

For example, one tract of land in a proposed drainage district may be already 50% drained and producing, while another tract may be marshy and valueless. While both may be of equal value when drained, the drainage would be worth twice as much to the second tract as to the first. Again, consider the result if the first tract when drained should, on account of its soil condition, location, etc., be worth twice as much as the second when drained. It is obvious that the relative advantage accruing to the owners of the two tracts would be as 4 to 1.

So it may be said that the benefits—the increased productive value of the land—may properly be considered under two heads: First, the relative condition of the land before and after drainage and, second, the value of the land after drainage. By using abstract numbers to represent these two elements that go to make up the benefits and by taking the acre as the unit the relative amount that should be assessed against each tract is easily determined. If we fix 100% as the maximum improvement and maximum increase in value due to drainage, then the product of these factors gives the percentage of maximum acre benefit to be assessed against the tract. The damages may be estimated directly, as the amount of damage is not fixed, as is the total amount to be raised. As a basis for further discussion the accompanying tabulation is submitted.

Explanation of Tabulation

The area in column 3 should include only the acreage in the tract that will be benefited. In column 4 is given the percentage of maximum benefit per acre. Valueless marshy land would receive the maximum benefit and would be marked 100% under this column, while land under cultivation, though requiring some drainage, would receive less benefit and would be marked correspondingly less. The same is true of the percentages of maximum value in column 5.

If two tracts of land are in the same condition relative to drainage requirement, yet after drainage one tract is worth twice as much per acre as the other, it is obvious that one receives twice as much benefit per acre as the other. By taking the product of the percentage of maximum improvement and of maximum value (columns 4 and 5) we get what may be termed the percentage of maximum benefit per acre (column 6); and if this is multiplied by the number of acres in the tract, we get a corresponding figure for the tract, column 7.

In the tabulation the amount of money to be raised by assessment is $6,494, and the damages amount to $220, making a total of $6,714, which amount must be taken into account in fixing the sum each tract shall be assessed. The figures in column 7 represent the proportion each tract shall bear, and by dividing the sum of these figures—namely, 236.2—into $6,714, the gross amount

FORM FOR USE IN MAKING ASSESSMENTS OF BENEFITS AND DAMAGES FOR IMPROVEMENTS*

1 Name	2 Land Description	3 Area in Acres	4 % of Maximum Improvement	5 % of Maximum Value	6 Product of Columns 4 and 5	7 Product of Columns 3 and 6	8 Gross Assessment	9 Net Assessment	10 Net Benefit	11 Acres Damaged	12 Value	13 Other Damage	14 Total Damage
J. N. Brown....	NW¼ NE¼ 30-19-23...	38	100	90	90	34.2	$972.14	$952.14	$1,690	2	$15	$5	$20
E. R. Wilson..	E½ NW¼ Sec. 5	75	80	75	60	45.0	1,279.13	1,199.13	2,170	5	55	25	80
C. J. Evans ..	NE¼ Sec. 6 ...	155	90	80	72	111.6	3,172.23	3,122.23	5,530	5	50	..	50
C. J. Evans..	NW¼ NW¼ Sec. 5	20	100	100	100	20.0	568.50	548.50	980	2	20	..	20
S. V. Lent	SW¼ NW¼ Sec. 5 ..	40	60	50	30	12.0	341.10	341.10	600	..	..	..	..
L. H. Mun	..N½ NW¼ Sec. 6 ..	56	30	80	24	13.4	380.90	330.90	622	1	30	20	50
Totals		384	..	..	..	236.2	$6,714.00	$6,494.00	$11,592	15	$170	$50	$220

*Amount of money to be raised by assessment, $6,494, estimated maximum benefit per acre, $50, factor (28.425) obtained by dividing sum of figures in column 7 into amount of assessment plus damages.

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*Assistant State Engineer, Salem, Ore.

involved, the quotient is 28.425. Now if each number in column 7 is multiplied by this quotient, the result is the gross assessment against each tract, as shown in column 8. After deducting the damages the net assessment is given in column 9.

In order to determine the benefits the appraisers should fix the maximum benefit per acre that will accrue to any tract in the district. In the tabulation this has been fixed at $50 per acre. On this assumption, by multiplying the figures in column 7 by 50 the result is the gross benefit, and by deducting the damages we get the net benefits, as shown in column 10. It is then seen at a glance that the net benefit is $11,592 and exceeds the cost plus damages by $6,714—a fact that is necessary to establish in the financing of most drainage districts. A certain area of land is rendered valueless for agricultural purposes by the construction of ditches, etc., and it is upon this area that damages are assessed, as shown in column 11. The total damage from this source is given in column 12, while any other damages, as for example, inconvenience due to the construction of a large ditch, may be listed in column 13 and the total damage in column 14.

It must be borne in mind that most of the columns in this tabulation are to facilitate computations, only a very limited number being for recording field observations. The advantage in this general plan of assessment lies in the fact that the proper proportion is assessed against each tract without considering it in money, and the total assessment is bound to equal the amount to be raised.

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Cable Inclines on the Sao Paulo Ry. in Brazil

By F. A. Molitor*

The Sao Paulo Ry., in Brazil, although only 86 mi. in length, is one of the most notable railways of South America. Its engineering features are of particular interest because it makes the ascent of the abrupt slope of the mountain range known as the Serra do Mar by a cable incline. Sao Paulo is on a high plateau at an elevation of 2,000 to 3,000 ft. above sea level. The maintenance-of-way conditions, due to the steep sidehill location of the main part of the line, deserve special attention by American engineers. Part of the information given below was obtained by the writer during a study of the railway systems of Brazil.

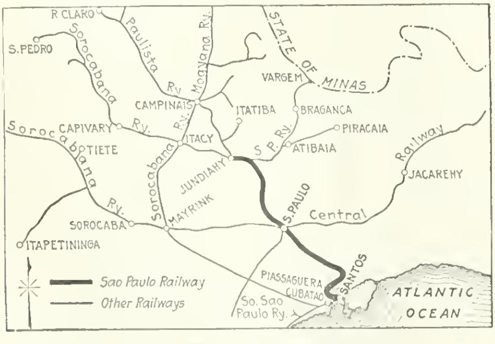

FIG. 1. MAP OF THE SAO PAULO RY. (BRAZIL) AND CONNECTING RAILWAYS

The railway is a double-track line with a gage of 1.6 meter (5 ft. 3 in.). It runs from the port of Santos to Sao Paulo, 79 km. (49 mi.), and Jundiahy, 139 km. (86 mi.). In spite of this small mileage it enjoys the distinction of being one of the most profitable railways in the world. In 1913 its gross earnings were equal to $136,000 per mi., and as the operating ratio was 65.8% the net earnings were $46,400 per mi. This includes a liberal allowance for maintenance: $21,220 per mi. upon the track and $18,600 per mi. upon equipment. A map of the railway and its connections is shown in Fig. 1.

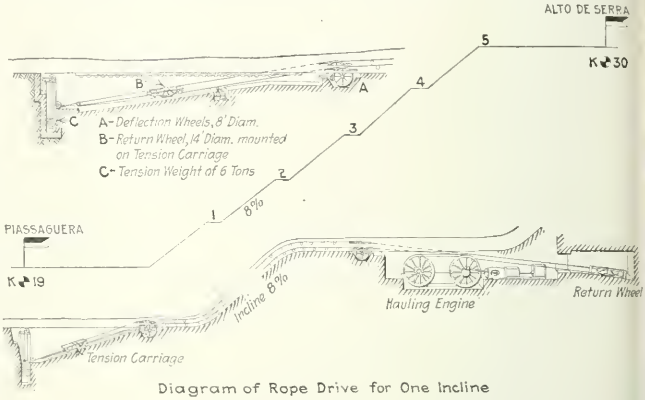
ALTO DE SERRA
K 30
5
4
3
2
1
8%
PIASSAGUERA
K 19
B
A
C
A- Deflection Wheels, 8' Diam.
B- Return Wheel, 14' Diam. mounted on Tension Carriage
C- Tension Weight of 6 Tons
Incline 8%
Hauling Engine
Return Wheel
Tension Carriage
Diagram of Rope Drive for One Incline

FIG. 2. PROFILE OF THE CABLE INCLINES OF THE SAO PAULO RY. AND DIAGRAMS OF THE CABLE MACHINERY

The railway was opened in 1867, the ascent of the Serra, or range, being by four inclines of 10% grade worked by rope haulage on the "tail-end" system. The duplication of the entire line was commenced in 1895 and completed in 1901. For the steep ascent a new route was chosen, with five inclines of 8% grade, also worked by rope haulage on the "tail-end" system. The old line is kept in condition for use in case of trouble and for aid during the heavy coffee traffic movement.

The railway is divided into three distinct sections. The first section, from Santos to the foot of the range, 19 km. (11¾ mi.) is practically flat, on marshy ground, and is operated by locomotives in the usual way. The second section overcomes the great difference of level which has to be surmounted to reach the high table-land. A rise of 2,600 ft. is accomplished in a distance of 10 km. (6.2 mi.), which necessitates a ruling grade of 8% from the base of the slope to its summit. The third section extends from the top of the inclines, at 30 km., to Sao Paulo and Jundiahy. It is operated in the usual manner.

At Piassaguera (at the foot of the incline) the locomotive is cut off and the cars are moved to the foot of the first incline. Each incline is operated independently, and has a cable composed of six strands of steel wire on a hemp core. This has a breaking strength of 108 tons when new and 72 tons when worn, and as the maximum working load on the cable from all sources is 18 tons, the factor of safety varies from 4 to 6. The cable is supported and guided on the inclines by small wheels placed between the rails, and at the bottom it enters an underground chamber where the tension carriage is located, as shown in the profile, Fig. 2.

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*Consulting Engineer, 35 Nassau St., New York City.

The track on the inclines has 103-lb. T-rails (46.2 kg. per meter). In order to suit the relative paths of the up and down sides of the rope the track is formed of three rails, except that at the passing places and heads of the inclines two separate tracks are laid to permit trains to pass. A grip car attached to the train has mechanism for picking up and gripping the cable, which is driven by a stationary engine placed at the top of the incline. This car has also powerful brakes, including a track brake.

The five inclines, each with its separate hauling plant, work simultaneously; that is, there are always five trains ascending and five descending when the inclines are working, the vehicles on one side of the cable being balanced by those on the other side. The paying load may or may not be equal in both trains. The average unbalanced load is small and the larger load moves down the incline.

The winding engines, each of approximately 1,000 hp., are of the two-cylinder condensing type. The cylinders are 32x60 in., fitted with Corliss valves operated by the ooch link valve-gear and a special trip gear. Each power station has four Lancashire boilers 7½ ft. diameter and 27 ft. long. They have the Vicars stoker and Green economizer, and supply steam at 100 lb. pressure.

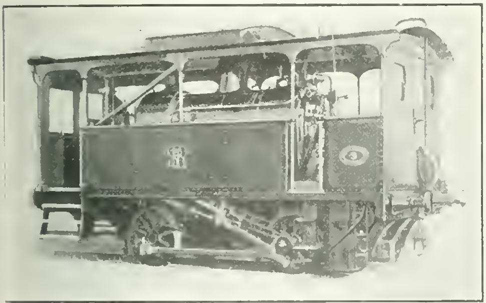

FIG. 3. GRIP CAR FOR THE CABLE INCLINES OF THE SAO PAULO RY. (BRAZIL)

There are two parallel shafts carrying cable drums and 25-ft. flywheels, the latter connected by a rope-drive of 16 cotton ropes, so that both the crankshaft and second shaft are driven by the engine. The cable entering the engine house from the up line makes four turns around the drums, passes to a 14-ft. horizontal reversing sheave, and thence out to the down line.

The maximum weight of train which can be hauled on the inclines is 145 tons; this train is composed of six loaded cars weighing 114 tons and the grip car which weighs 31 tons. Of this weight 78 tons is paying load. The time necessary to run a trip is eight minutes, so that 7½ trips can be run in an hour. This means that 585 tons per hour can be delivered at the top and at the bottom of the inclines, and in ten hours over 5,000 tons of merchandise can be handled in each direction.

With the endless-rope incline system the dead load is always balanced, the ascending train on one side being balanced by a similar train on the descending side. The duty of the stationary engine is to overcome the excess or unbalanced load, whether arising merely from friction or from difference in the weight of the two trains. The speed of the trains is controlled by the brakes on the hauling engine. A train may be run on only one side of the rope, as there is a constant tension caused by the tension weight. In this case the unbalanced load is the total weight of the train.

Special devices are applied to prevent trains becoming detached from the rope. The entire rolling stock is fitted with the quick-acting vacuum brake, which (with the rail grip on the grip car) provides ample power to hold a train should it become detached.

The maintenance expenses have been criticized as being very high. Every care must be taken, however, to prevent slides on the mountain, and as the formation is treacherous it is good practice to carefully pave wherever the original surface of the ground has been disturbed, or where there is any chance of water eroding it. The long experience of the English engineers upon this mountain line, and their national training in well-maintained railways at home, has prompted them to special care in the details on this difficult line, and with satisfactory results. Certainly the results of operation with a heavy business speak well for it. Both the technical and physical conditions of the property are good.

The length of double-track main line is 86 mi., and sidings aggregate 113 mi. Tangents represent 58% and curves 42% of the length; while 76% is on grades and 24% is level. The maximum grade (exclusive of the inclines) is 2%, and the sharpest curves are of about 7°. There are 16 bridges, some of masonry and others of steel, aggregating about 4,600 ft. and having spans of 33 to 250 ft. The 13 tunnels are 200 to 850 ft. long, and aggregate 4,430 ft.

The original cost of the line was about $43,000,000, or $497,000 per mi. (U. S. currency). The original concession provided a guarantee of 7%, which was paid by the government, between 1867 and 1873, in the amount of about $2,600,000. In 1874 the guarantee ceased and the company commenced to divide with the government (in accordance with the concession) the net earnings in excess of 8%, and up to 1890 it had paid the government about $1,672,000. The company is now independent of the government except in respect to operating and traffic regulations.

In 1912 (no later records are available) the railway carried 2,968,810 passengers, with an average haul of 23.4 mi. The freight handled was 2,737,820 tons.

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A Change in the Channel of the Mississippi River at St. Paul was urged by the St. Paul Commercial Club in a recent hearing before a board of Army Engineers. The club proposes to follow out the general plan prepared by Lieutenant-Colonel Shunk, of the Corps of Engineers, diverting the river as far as possible toward the west-side bluffs and utilizing as a harbor for water traffic the east end of the old channel not filled, so far as it is not required for railway terminals. The project is based also on a report as to the commercial needs presented by M. G. Barnes, Consulting Engineer. The total cost of the improvement is estimated at $4,935,000, which may be raised to $5,600,000 by a possible increase in certain items. Some of the possible sources for providing the funds to carry out the improvement are, first, a Federal appropriation; second, an assessment upon property specially benefited, and third, the proceeds of the sale or rental of the lands reclaimed by filling in the old channel. It is claimed that about 180 acres of this new land, lying near the present railway terminals, could be sold at a price sufficient to pay the entire cost of the improvement.

Monolithic Brick Paving for Wide Streets

By William Robert Paige*

SYNOPSIS—A special feature of the work described is the use of a novel type of expansion joint and the laying of bricks in header courses on each side of these joints. The bricks are laid on a 4-in. base of green concrete, no sand cushion being employed.

A monolithic brick pavement 33 ft. wide is being constructed by the writer on Main St. at Marshall, Ill., a city of about 5,000 inhabitants. Main St. is a part of the old National Road from Cumberland, Md., to St. Louis, Mo., and is 100 ft. wide, 20 ft. having been added to the original width when the town of Marshall was platted. Six years ago, four blocks of this street through the business section were paved by the writer with brick on a sand cushion and concrete base. The roadway is 60 ft. between curb lines (with 9-in. crown) and 57 ft. between gutter lines, a combined curb and gutter being used. This paving is in excellent condition.

It was decided last spring to extend this pavement east and west to the city limits. The first plans submitted called for a boulevard having a 20-ft. parkway through the center, with a 20-ft. drive on each side and a 20-ft. space for parkway and sidewalk on each side of the road. This made the curb lines of the new proposed paving continuous with the curb lines of the 60-ft. roadway and would have divided the street into five equal parts. The expense, however, was found to be greater than the property owners felt they could afford, and the boulevard idea was abandoned. A central roadway 36 ft. in width was substituted, the combined curb and gutter making the actual width of the brick roadway 33 ft.

The monolithic type of brick pavement (in which the bricks are laid directly upon the green concrete) had been used successfully on highways having narrow widths, and the writer believed that the same type could be successfully used in wide streets by following somewhat different methods. The combined curb and gutter was first constructed along each side of the roadway. Then the excavations were made, first the rough and then the finishing grading, using a templet to shape the subgrade accurately, which was then rolled with a steam roller.

The concrete is mixed in a portable batch-mixing machine, with a boom and traveling bucket for placing

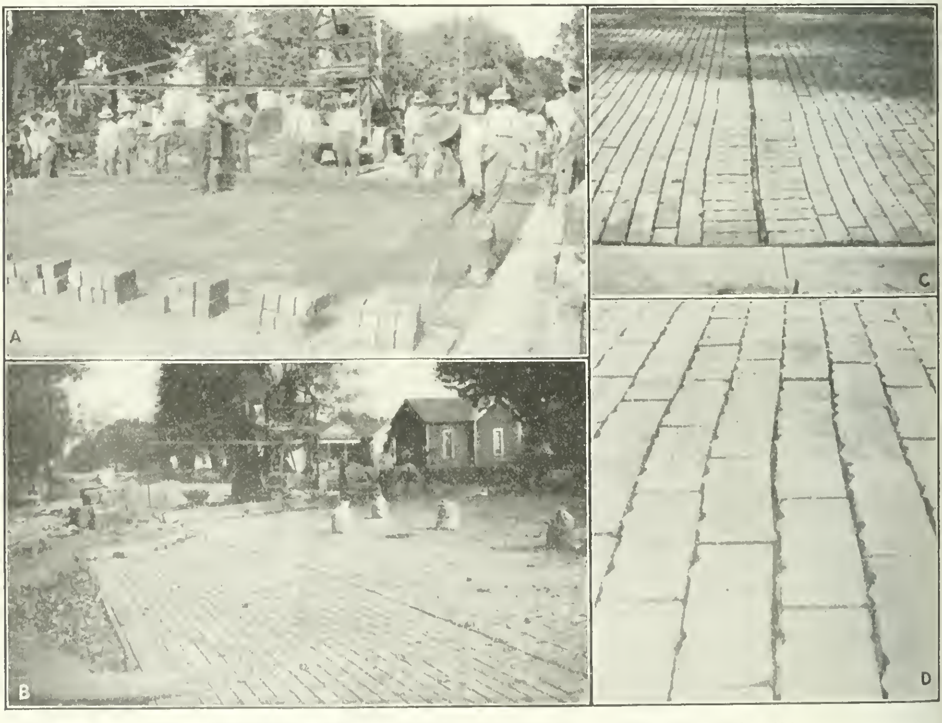

FIG. 1. MONOLITHIC BRICK PAVING ON WIDE STREETS AT MARSHALL, ILL.

A—Finishing the concrete base with templet. B—Brick laid, showing expansion joints. C—Expansion joints with header bricks. D—Lug bricks laid and ready for cement filler the concrete. The concrete is spread out uniformly to a slightly greater depth than that required, and a Roughen templet is drawn over it several times to obtain a true surface of uniform depth.

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*Civil and Consulting Engineer, Terre Haute, Ind.

The contractor was instructed before commencing the work to obtain a templet that would be as nearly rigid as possible. In order to prevent the templet from rolling over the concrete, three men ride it, one in the middle and one on each side. The templet rolls on wheels on the concrete gutter and has a contrivance for raising it when running back over the concrete for the next drag. The templet is pulled by hand by the mixing crew, while the engineman moves the mixer forward. The pulling is done with five ropes—at the center, the quarter-points and the ends.

After the concrete has been properly shaped (which sometimes requires five or six drags), the templet is again drawn back and a mortar cushion spread in front of it by shovels. The templet is drawn over this without changing its height, forcing the mortar into the voids of the concrete. This operation is repeated until the surface presents a true surface for laying the brick, as shown at *A* in Fig. 1. A man with a hand tool corrects any irregularities.

The surface is then ready for the bricklayers. The carriers deliver the brick by walking on boards placed over the brick already laid, the boards being moved forward as the laying progresses. The brick are sorted outside of the pavement, an attempt being made to have the correct face of the brick up, but owing to the haste of the men this is only partially accomplished. A man placing bats keeps the rows completed, and a sweeper cleans the pavement so that the inspector can readily go over the surface. The brick are quickly turned and culled and are immediately rolled with a hand roller weighing approximately 900 lb.

Occasionally a brick fails to go down to its proper place and is driven by hand with a wooden tamp. Water is also sometimes used to assist in the proper rolling. The brick are then grouted with a cement filler, the usual methods being pursued. The paving is of Dunn wire-cut-lug brick manufactured at Albion, Ill. This construction requires a brick to be very uniform in size. At *D* in Fig. 1 is shown the joints between the brick, ready for filler, the joints being open to the full depth of the brick.

Street intersections, where the templet cannot be used, are put in by hand, stakes being set at intervals sufficient to give the proper cross-section. The mortar cushion is shaped by hand tools, and while it is not possible to secure as accurate shaping of the concrete and mortar cushion as where the templet is used, the results are entirely satisfactory. The total amount of work to be done under the present contract is 15,060 sq.yd. of 33-ft. width, 5,130 sq.yd. of 25-ft. and 3,320 sq.yd. of 20-ft. width. The 20-ft. width is for alleys.

The base is 4 in. thick, with 3¾ in. of concrete and ¼ in. of mortar cushion. The concrete is a 1 : 6 mix, using bank gravel. The mortar cushion is 1 : 2, using clean sharp sand. The grout filler is mixed 1 : 1. The mortar top is mixed in boxes by hand, but a small batch mixer would be very advantageous for this part of the work.

Prepared asphalt expansion joints 1 in. thick are used between the brick and the gutter, and two transverse expansion joints 1 in. thick are used in each block, approximately 165 ft. apart. Joints are provided between the concrete base and the gutter by means of a 1x4-in. board, which is removed after the concrete is placed and shaped, and the space then filled with sand. Transverse joints are made through the concrete by cutting with a spade after the brick are laid up to the place where the joint is required. This cut is filled with sand and the concrete tamped into position.

The transverse joint has a special feature that is original with the writer. When the location of the joint is made, a trench 2 ft. wide (12 in. on each side of the location) is cut to a depth of 3 in. This trench is filled level full with concrete and covered with building paper. The concrete base is then placed and shaped over this support. The joint is afterward cut through to the paper and filled with sand, as above described, care being taken not to break the paper. This gives a solid base for the joint to rest upon, and on which it may freely move. This prevents settling of the base, which might be caused from water seeping through and softening the subgrade at these joints. Fig. 2 shows the construction of this joint.

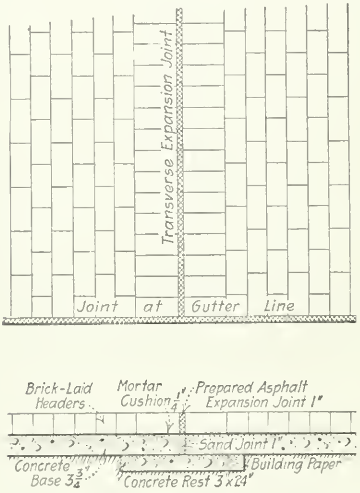

FIG. 2. SPECIAL JOINT FOR BRICK PAVING AT MARSHALL, ILL.

Another special feature of the joint is the laying of the brick as headers, with the prepared joint between the heads, as shown in Figs. 1 and 2. Laying the brick as headers at the end of all street intersections, which takes the place of marginal curbing, is another special feature. This is shown at *B* in Fig. 1. The theory for this arrangement is that the weakest point in the pavement, and the point most exposed to traffic, is at the joints and at the end of the intersections. By laying the brick as headers a longer bearing is given for resisting the impact from vehicles and from horses' hoofs.

Difficult construction was encountered in building the extension of the 60-ft. roadway from the property line to the curb line of the intersecting street, which was put in on the monolithic system. This had to be done by hand, using the method above described for building street intersections, and excellent results were obtained

The most difficult construction encountered was in extending the 60-ft. pavement to connect with a diagonal street and also a street at right angles, the center line of the diagonal street and the right-angled street being 11 ft. apart.

From the contractor's point of view there is one feature that is of particular interest in this type of monolithic construction; namely, the work can be done under the supervision of one general foreman. This is for the reason that the work is all kept together, and when the day's work is done the contractor has a completed pavement.

The advantage to the municipality is that the street can be opened to traffic within two weeks after the street is completed, instead of waiting seven days for the concrete base to set and then waiting ten days after the brick are laid and slushed before opening the street. The pavement is also noiseless in comparison with the sand-cushion type, the difference being very noticeable on West Main St. where the old paving joins the new.

The contract is being executed by the H. Pfizenmayer Construction Co., of Terre Haute, Ind., under the direction of Paul Meredith, superintendent and member of the firm. L. E. Grammer is principal assistant for the writer.

METHOD OF OBTAINING COST DATA

An accurate account of the construction cost is being kept. The cost of the labor is divided among the mixing and placing of the concrete base and mortar cushion, bricklaying, and slushing or grouting. The overhead charges, being constant, are divided equally among these three branches of work; these charges cover the foreman, timekeeper and water boy.

The crew for mixing, placing and shaping the concrete and mortar was as follows: One engineman, one sub-foreman, four wheelers, four shovelers, nine men on the mixer and spreading, and three men mixing mortar. For bricklaying: Two brick setters, twelve carriers, two rollers, one sweeper and one batter. The crew used for slushing or grouting was made up from the bricklaying and mixing crews. This is a general statement of the number of men used in the crews, which of course varied from day to day.

Accurate account was kept of the cement used for slushing and for the concrete base. The cost of each day's work was kept separate and the result tabulated. By this method the cost per square yard for each division of labor was obtained and the material required per square yard was determined.

Restoring Flood-Wrecked Well and Pumping System

By A. C. Francis*

Among the extensive repairs to the San Diego waterworks necessitated by the flood damage of January, 1916, is the reconstruction of the Mission Valley pumping station, a 5,000,000-gal. plant put in use in December, 1914, as an auxiliary to the mountain storage-reservoir system. This reconstruction is just being completed under the direction of F. M. Lockwood, Manager of Operation of the City of San Diego.

From Jan. 25 to 29, 1916, it was a night-and-day battle with the flood waters of the San Diego River to save the main pumping plant from destruction. As it was, a portion of the concrete sump was wrecked, the pipe lines from the wells to the main pumping station were washed out, the field pumps and motors were carried downstream, and the chief pump engineer's cottage, together with his garage and automobile, were swept away by the flood.

Although nature wrecked the field plant, still nature, assisted by the ingenuity of the men in charge of the flood work, undoubtedly saved the main plant. The main pumphouse and sumps are located just below an immense gulch in which had been placed a 30-in. concrete drain pipe to carry the storm water from the residence district on the mesa high above the plant. This drain discharged near the pumphouse, and the water from it was cutting in very close to the concrete sumps. At the same time the river was washing up nearer and nearer to the main plant, and for a time it looked as though nothing would save it. As something of an experiment, a force of men was sent up the gulch to the mouth of the drain with orders to shovel rock and dirt into the pipe. The drain carried the material down to the plant and deposited it just below the discharge end of the drain, where the water was cutting in near the sump. As the deposit filled up the cut to the end of the drain, the pipe was broken off length by length to allow the fill to be made farther back. In this way a solid earth and rock fill was made in the cut, and the flood waters were turned away from the plant.

The work necessitated by the flood was the recovery of as much of the old field plant as was possible, the drilling of nine new wells, alterations to the main plant, the installation of a complete new system of water delivery by air lift from the wells to the main plant, and protec-

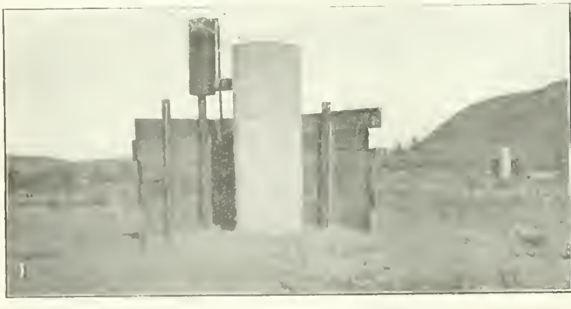

FIG. 1. GENERAL VIEW OF TWO WELLS, SHOWING INTERIOR OF WEDGE PROTECTION

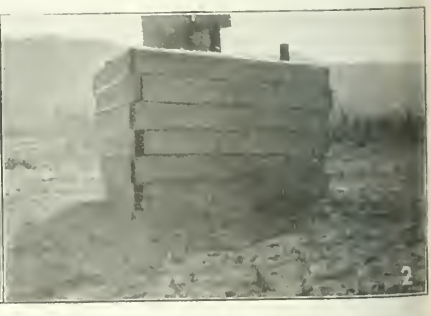

FIG. 2. EXTERIOR VIEW OF PROTECTING WEDGE, SUPPORTED BY OLD STEEL RAILS

tion of the field plant from future destruction by flood waters.

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*City Hall, San Diego, Calif.

The cost of the entire job was close to $26,000. The work of recovery of the old field plant and general reconstruction will run approximately $5,700; the air-lift system of transmission from wells to plant cost $11,270; the new wells completed cost $8,069: a survey of the property, $356; and the protection of the field plant, about $700.

The pumping plant as originally constructed consisted of 12 drilled wells, in depth from 40 to 90 ft., from each of which the water was lifted by means of a small two-stage centrifugal type of pump driven by a 10-hp. belted electric motor. The water was driven from the pumps to a concrete standpipe and thence to concrete reservoirs through steel force mains. From the reservoir the water was lifted to the University Heights reservoir by two direct-connected four-stage centrifugal pumps driven by two 250-hp. motors.

The field plant suffered flood loss severely, only three of the wells, five of the pumps and six motors being recovered after the waters had receded.

Owing to the failure of the Lower Otay dam and of both the Otay-San Diego and the Bonita pipe lines in the Sweetwater Valley, it was of vital importance to place the Mission Valley plant in operation.

Accordingly a temporary sump, 30x80 ft. in plan and about 12 ft. deep, was dug and boarded up about 35 ft. east of the concrete settling basins and sumps. Two electrically driven pumps, one a 7-in. and the other a 10-in., were placed on the bank and pumped from the river sand into the concrete basins from which the main plant lifted the water to the University Heights reservoir.

This temporary supply was first delivered on Feb. 18, just 22 days after the big flood had wiped out such a large portion of San Diego's water system. The plant furnished an average of a little over 4,000,000 gal. daily until July 9, when the Otay-San Diego pipe-line repairs were completed and the water turned in from the Upper Otay reservoir.

During this period an effort was made to recover the 12 wells in the field of the old plant, but only three of the wells could be located. These three wells were cleaned out and contracts let for the drilling of nine new wells. The wells just drilled are each 100 ft. deep. The three old wells that were recovered run from 58 to 80 ft. in depth. The water stratum is about 15 ft. thick and is found between the 40- and 60-ft. levels. The wells are 12 in. in diameter to a depth of 60 ft., or through the water-bearing stratum, and 8 in. below that level, the continued depth giving submergence for the air-lift system.

For some time prior to the flood that made reconstruction necessary Mr. Whitmore, the master mechanic of the City Operating Department, had been considering the air-lift system as a means of delivering the water from the wells to the main pumping plant. His investigations gave him reason to believe that this method would be less expensive both in operation and maintenance than the field pumps and motors.

As the field plant had been completely destroyed, it was decided to put in the air-lift system. The lift installed is the plant of the F. J. Kimball Co., Los Angeles, and consists of two 17x10x14-in. Ingersoll-Rand air compressors, of a guaranteed capacity of 900 cu.ft. of free air per minute for each compressor against a 30-lb. pressure, and with a speed of 185 r.p.m.; two 75-hp. 440-kv.-a. 60-cycle 900-r.p.m. motors; and 12 patent air-lift apparatus with a guaranteed capacity for each apparatus of 500 gal. per min. with a submergence of 60% and a guaranteed efficiency of 30% for power delivered to the belt wheel of the compressor.

The air-lift system, when tested out, proved to be satisfactory from the start. There is no field trouble to care for, and the saving effected in salaries of pump operators alone is $370 per month, to say nothing of the saving in the maintenance of the field pumps, which was running close to $130 a month.

Furthermore, under the old system of field pumps and motors it was impossible during stormy weather to operate the field plant, as most of it was under water. With the air-lift system the plant may be operated just as long as the wells and transmission lines remain intact, as the whole plant is operated from the main pumphouse by one man.

Alterations were also made in the arrangement of the main plant. Before the flood the main pumps had to operate through a suction line, in which there were nine bends. Mr. Whitmore abandoned this suction line and drove a tunnel from the sump to a point under the pumphouse directly below and between the two pumps. Here he made a concrete-lined pit 6x8 ft. in plan and 16 ft. deep, into which the tunnel from the sump discharges by gravity and from which suction pipes with only one bend lead to each of the main pumps. This change increased the pump capacity just 100,000 gal. per day. The plant has a total capacity of 4,000,000 gal. daily when delivering the water over the aërating table at the University Heights reservoir, and 5,000,000 gal. when discharging direct into the main.

The 12 wells are connected to the sumps by 10-in. branches, and 412 ft. of 20-in. and 1,600 ft. of 24-in. mains, all of steel.

In order to protect the wells from being torn out during stormy weather by floating débris the department has placed a wedge constructed of heavy timber and railroad iron in front of the wells, with the nose pointed upstream. Three 30-lb. rails were driven to a depth of about 21 ft. in the sands, and the wedge was constructed around these rails out of 3x12-in. planks 12 ft. long. The wedge extends 6 ft. below the surface of the sand and 6 ft. above, the upward extension being for the purpose of protecting the wells not only from floating débris, but also from shifting sands under the surface of the water.

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Proposed Highway Commission of Texas—The passage of the Federal-aid road bill has been influential in bringing the largest state in the Union to consider state road construction. The committee recently appointed by Governor Ferguson of Texas to draft a bill creating a state highway commission has completed its work, and the bill will be presented at the next meeting of the legislature in January. If carried, the law will provide for three highway commissioners, only one of whom will reside at the capital and devote his whole time to the work. His salary will be $4,000 per annum. The other two members will be paid on a per diem basis not to exceed $1,500 per annum. It is proposed to raise a state highway fund of about $2,000,000 a year by a state tax on automobiles, from a minimum of $7.50 to a maximum of $15 per vehicle, according to horsepower. One-third of this fund would be returned to the counties for the maintenance of state highways under the supervision of the State Highway Department. The other two thirds would be used for construction of state highways

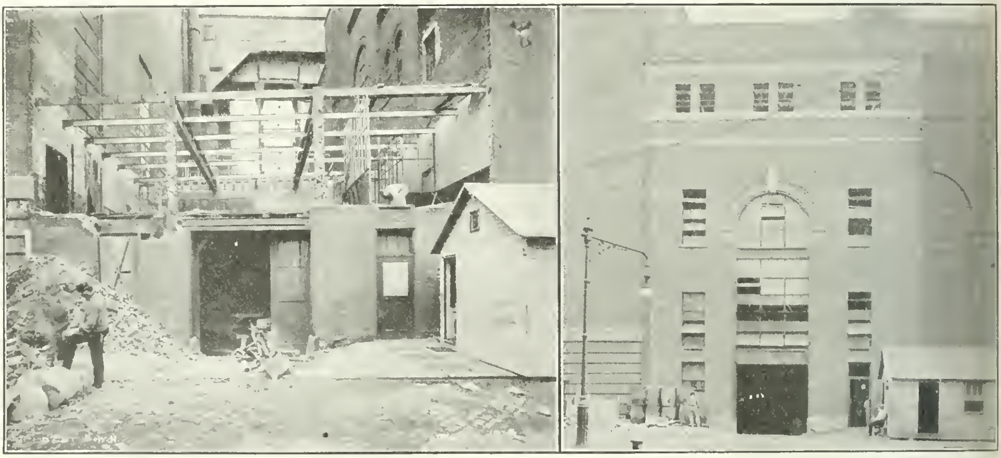
Underpinning with Hollow Piles Driven with Point

By G. L. Knight*

SYNOPSIS—Two-story building underpinned for unit load of 600 lb. per sq.ft. and increased to four stories. Special piledriver drove hollow steel piles 25 ft. with lower ends closed by a special projectile-shaped point.

In the fall of 1915 the necessity for further extension to the Gold St. power house of the Edison Electric Illuminating Co., of Brooklyn, N. Y., involved the construction of additional electrical galleries for switch and bus compartments and additional quarters for plant-efficiency and laboratory work and for operating and construction offices.

On the site required for the addition the company had erected in 1910 and 1911 a two-story building 40x97 ft., to act as quarters for storeroom, machine shop and locker and toilet rooms for the employees of the plant. This building was erected between the end of the operating room and the south boiler house, as shown in Fig. 1. Although the soil on which the foundations for this building were placed is of very poor quality—consisting of deep fill throughout the entire area, where a dock once stood—the loads carried were light and necessitated only spread concrete footings.


FIGS. 1 AND 2. BEFORE AND AFTER RECONSTRUCTING THE SHOP AND WASH HOUSE, BROOKLYN EDISON CO.

The new demands, however, required the construction of a four-story building over half the area occupied by the first building and with very heavy loads—600 lb. per sq.ft.—due to the masonry switch and bus compartments on the upper two floors. These loads, together with the heavy structural work and concrete and the necessity of maintaining a driveway from the street through part of the grade floor, required a very careful location and as few columns as possible and made the loads unusually heavy on each. Fig. 3 shows the plan of the floor, the location of columns and the loads on each.

A study of conditions and test borings showed that piles would be required. The choice lay between wood, driven or jetted, hollow steel piles driven open-ended and dredged out, or the same driven closed.

Pits Dug and Hollow Piles Driven with Point

Previous experience in the immediate vicinity showed that serious difficulties were to be expected in driving, as the fill was full of stones and boulders where was formerly the old beach. The borings led to the conclusion that a stratum of boulders was likely to be encountered, large ones at the undisturbed beach line and smaller stones in the cribwork and fill. Such conditions eliminated from consideration wooden piles. The sectional tubular-steel closed pile driven with a point, being much the cheaper, was chosen. In order to prevent these piles from being stopped by boulders it was determined to excavate each pit in open sheathing to as deep a point as water conditions would permit, removing the boulders and stones as the excavation progressed. This method proved entirely feasible and was so satisfactory in the case of the first pier that it was carried on throughout.

The new foundation work was made especially difficult by the fact that the existing building had to be shored and maintained throughout the progress of the work, the front wall and roof being the only parts removed.

The contractor was required to build a temporary wooden roof and make it water-tight before the roof concrete and structural steel could be removed to provide for the construction of the additional stories, and to build temporary partitions back of the front wall to afford like protection.

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*Designing Engineer, Edison Electric Illuminating Co., 360 Pearl St., Brooklyn, N. Y.

As the headroom for piledriving was extremely limited, the contractor constructed a special set of ways for his driver, in the design of which provision was made for changing the position of the ways both as to angle and height, as described in *Engineering News*, Sept. 7.

Two-inch tongue-and-grooved sheathing braced with 4x6-in. timbers 4 ft. apart vertically were used for each pit, and the excavation was carried down an average of 13 ft. below basement-floor level. The steel-pile sections were 12 in. in diameter, with a 3/8-in. shell. The first section was 20 ft. long and was fitted with a cast-steel point especially designed for and used the first time on this job. The piles were driven to an average depth of 35 to 50 ft., which means a penetration of 22 to 27 ft. below the bottom of the excavated pit, in some cases going as far as 30 ft.

In driving, sections were used according to the expected lengths at which the pile would bring up, the intention being to cut the piles off at the proper height for concreting under the foundation pier. Where the

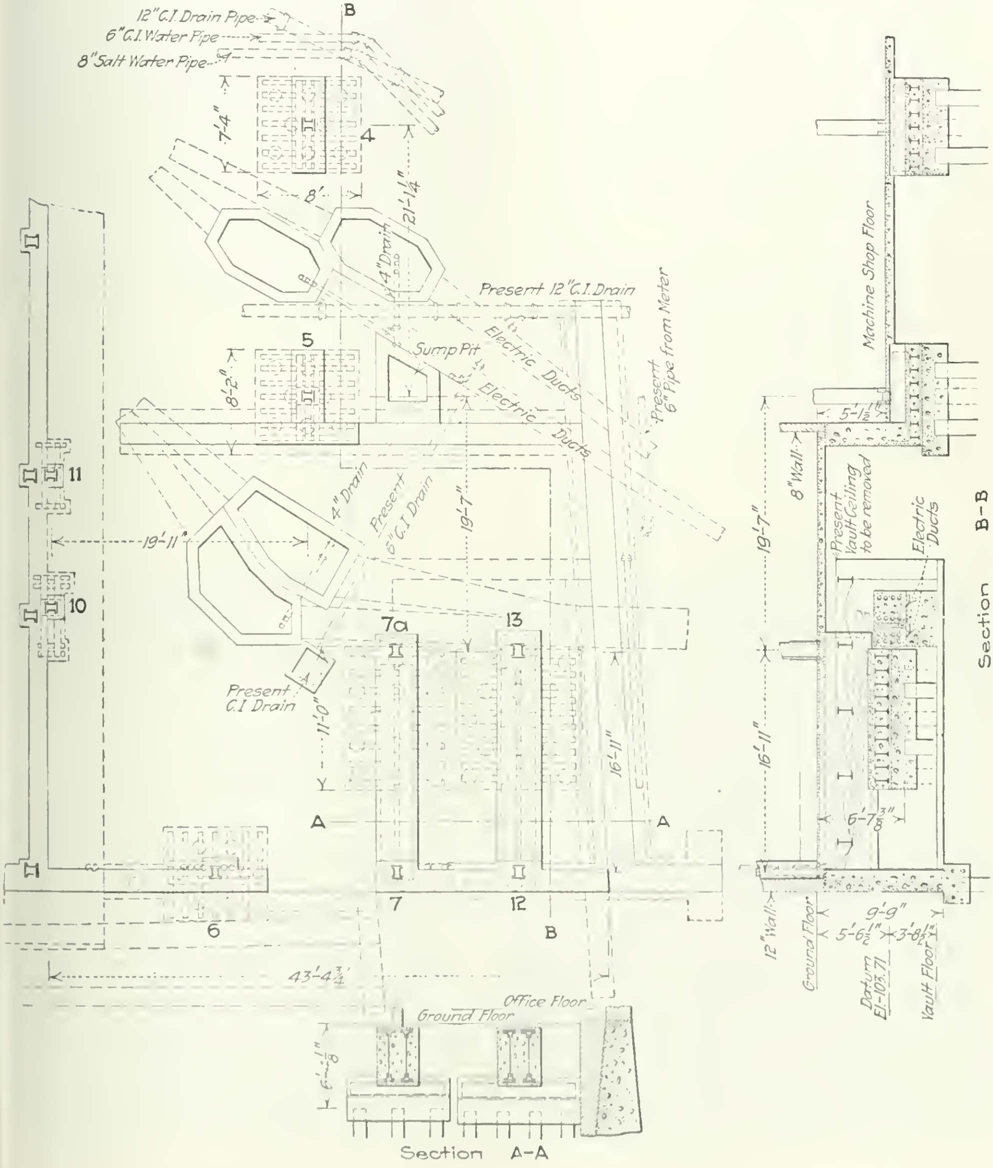


FIG. 3. FOUNDATION PLAN OF REMODELED BUILDING

length of the top section was too great at refusal, the piles were cut off with a hacksaw. Where a joint came in the excavating pit, concrete was placed around the joint to act as additional reinforcement.

Each Pile Inspected Inside with Electric Lamp

As the driving finished on each pile, an incandescent light was lowered to the bottom of the pile to ascertain that the pile was in perfect condition, before concreting. In a few cases the joint between the point and the first section had opened slightly and water came in, but in most of the piles the light lowered to the bottom of the point showed a perfectly dry, clean shell. The sleeves between sections were of the cast-steel inside type.

When all the piles had been driven in one pit and cut off at the proper height, they were filled with concrete, and the entire pit was backfilled to mean tide level, below which they would be permanently wet and therefore little subject to corrosion. The fill was left 6 in. below the top of the pile, and the concrete pier foundation for the columns was installed from this grade to grillages, as shown in Fig. 3.

In the large double piers at the front of the foundation, marked 12 and 13, a mattress of boulders was encountered that occupied practically the entire area, one boulder being about 10 cu.yd. in volume and another nearly as large. It might be asserted that with such a condition it would have been better engineering to put concrete in the hole from that point up, but after the boulders were removed the piles went down easily to a depth of 25 ft. below the boulders, and the condition of the soil below the boulders was of such consistency that no confidence could be placed in its bearing capacity. Following are the details of the work in each pier:

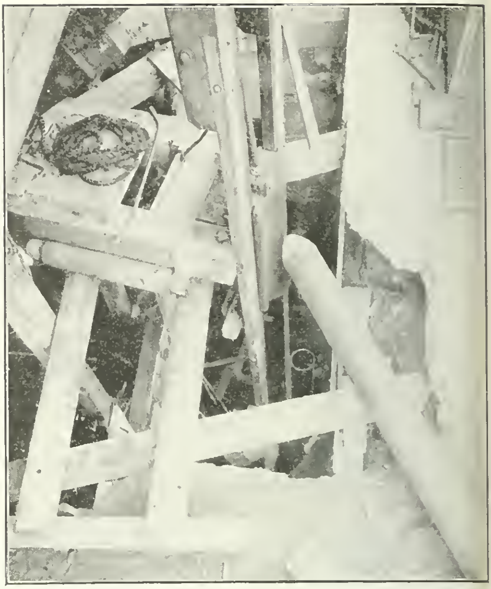
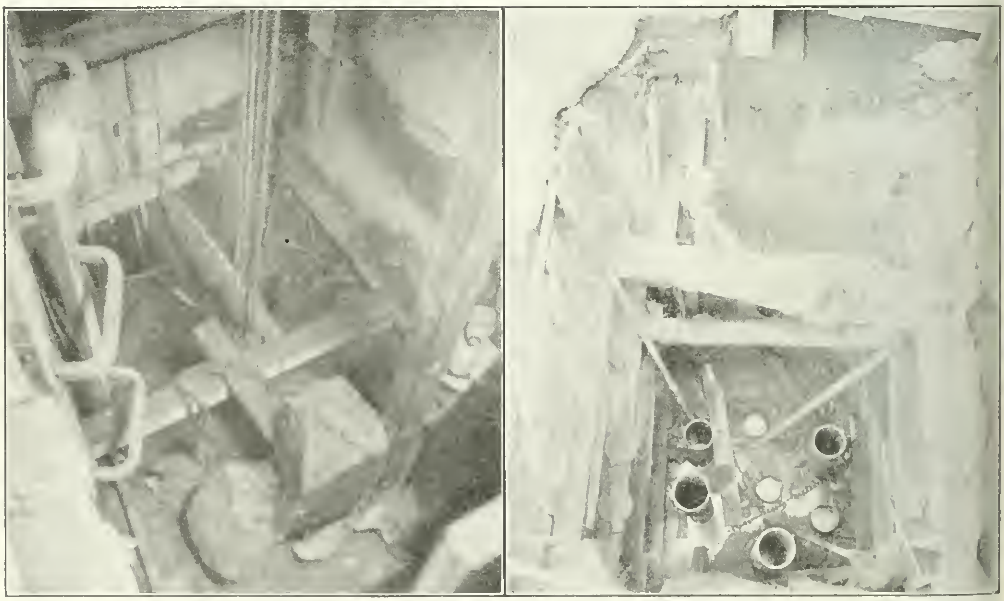


FIG. 6. SHOWING PILEDRIVER LEADS IN AN EXCAVATION, AND A HOLLOW PILE WITH POINT ATTACHED

No. 4 Pier—The concrete pier under the previous column was found to extend about 5½ ft. below the floor line. Stone fill (one-man stone) and mud was found to extend from bottom of concrete to a point 8 ft. below the floor line, where the bottom of an old crib was uncovered. The bay uncovered was one that had been decked over to anchor in place of the crib of round logs. This timbering was cut out, and from the bottom of it (9 ft. below the floor line) to a point 12 ft. below the floor line mud and an occasional stone were found.

When the excavation was completed to this depth, the ground was sounded with a bar and, as no stones were found, driving was started. The first four piles went down comparatively easily. The next one hit an obstruction about 6 ft.



FIGS. 4 AND 5. TWO VIEWS OF A PIER EXCAVATION

below the surface of the excavation, which caused it to ride off out of position. The pile finally passed the obstruction and was driven practically to the same depth and refusal as the others. The remaining piles drove very hard, evidently due to the fact that the earth had been compressed by the driving of the previous piles. No. 6 pile also rode off a boulder and drove down out of line and very hard. Just before driving was stopped on this pile, the top of the pile under the ring crumpled up, corrugating the pile down from the top about 18 in. The same thing happened to No. 8 pile. There was no sign of a fracture of the steel in either case. Photographs were taken of these corrugated tops.

In cutting the tops of the first pile sections it was decided to use an acetylene burner so as to get a true bearing for the top section, but this was found to be not as satisfactory as the hacksaw cut with guides. When the top sections were put on it was agreed with the contractor that he should place a layer of concrete that would extend about 9 in. above and 9 in. below the joint of the first and top sections, to reinforce the joint where the metal was not continuous.

No. 5 Pier—Practically the same condition as regards excavation was found here as in the case of pier 4, except that no cribbing was uncovered and it was found necessary to go down 14 ft. instead of 12 ft. below the floor, owing to the small boulders that were found as soon as the 5½ ft. of concrete had been cut through.

Piers 7, 7-A, 12 and 13—In these piers the whole area was excavated to a depth of about 19 ft. below the driveway, or approximately the same depth below datum as pier 5, the general character of the excavated material being the same as in preceding piers.

Driving was started in the excavations for Nos. 7 and 7-A, and everything went well except that sometimes a pile would strike some obstruction and ride out of line. When driving was started on Nos. 12 and 13, however, it was soon found that there was a large boulder about in the center. This proved to be about 7x11x4 ft., and after it was removed another about the same size was found directly under it. During the removal of these boulders most of the other piles of piers 12 and 13 were driven, and consequently the five piles located in this area drove very hard, and in one or two cases the tops of the piles were crushed.

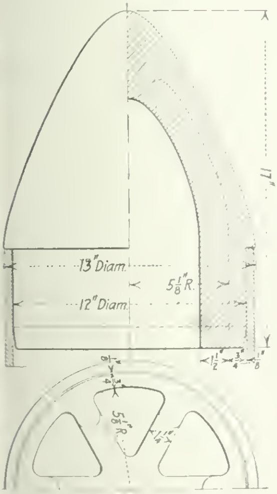


FIG. 7. CAST-STEEL POINT USED FOR PUTTING DOWN HOLLOW PILES EMPTY

Pier 6—Contrary to the conditions found in the other holes, these piles, instead of driving to a proper refusal at 20 ft., continued on down and did not fetch up until they had reached a penetration of about 40 ft. All the piles went down very nicely except No. 1. The first section driven for this pile was about 20 ft. long. When this was driven down to the bottom of the ways, it was still going easily about 12 in. in 50 blows). Another 20-ft. section was put n with a sleeve, and the driving was resumed. The penetration continued to be very even, with a difference of ot over 3 or 4 in. for every 50 blows. When the top of this econd section reached the bottom of the ways, the driving was stopped and the cap taken off the pile.

The pile was found to be full of very warm water. As it as believed that something had happened at the joint of the wo sections, because in other cases the joints had been lmost water-tight, a pump was placed in the pile and the vater pumped out to a depth of 11 ft below the top of the ile. At this point the sleeve was found embedded in mud nd sand, showing that the sleeve had collapsed and the two ections had separated. The sleeve had been driven up in the op section for a distance of 6 ft.

It was also found, when the collar was removed from the op of the pile, that the pilehead had collapsed for the disance just covered by the collar.

The contract for the entire foundation work was executed by John H. Duncan, Brooklyn, on the unit-price basis, under the supervision of G. L. Knight, Designing Engineer, and H. B. Morrison, Chief Inspector of Building Construction of the Edison Electric Illuminating Co., of Brooklyn. Bernt Berger was consulting engineer both on design and on fieldwork.

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Will River Traffic Follow River Improvement?

That river improvement for navigation will surely develop and encourage river traffic is a common argument in favor of such improvements. It remains to be seen, however, whether commercial interests will avail themselves of the opportunities afforded, and will develop traffic to an extent commensurate with the vast sums expended on the improvements. This situation was brought out pointedly at the recent meeting of the Upper Mississippi River Improvement Association in an address delivered by Thomas Wilkinson (Burlington, Iowa), the President of the association. The following is an excerpt from his address:

> Including the appropriation made this year, there has been appropriated nearly half of the $20,000,000 originally estimated as the cost of the permanent improvement of the river to obtain a permanent channel at lowest stage of water. The work has progressed so far that the river is now safely navigable for almost any amount of traffic, except at a few crossings that could easily be dredged at extreme low-water. Where are the facilities, the towboats and barges and the cargoes they should be carrying on its waters, to mark a revival of river freight transportation, and make it a living part of the great transportation system of the country?
>
> When the work is completed and the river permanently improved at the expense of the vast sum it will have cost, what use will be made of it? Any popular demand for waterway improvement is absolutely wrong unless it is intended to become and does become construction and makes the stream an actual carrier of commerce. While Congress has been liberal in responding to demands for these improvements, there is grave danger that appropriations will be curtailed, or even discontinued unless there is speedily manifested a disposition to use the improved waterway in some measure proportionate to the cost of the improvement.
>
> Attention has been repeatedly called to the indispensable factors requisite, and the things needed to be provided by the communities themselves, for a successful revival of river traffic. As one of the prime essentials, they have been urged to construct permanent wharves and install adequate terminal facilities (equipped with mechanical devices) adapted to the coördination and easy service of transportation by road, railway and waterway. Some progress is being made in this direction, but not enough. Although a number of cities have terminals under construction, none are yet completed.
>
> The establishment of through lines of freight carriers for continuous service between upper Mississippi River points and New Orleans, is a paramount necessity that must appeal to every shipper.
>
> To handle economically at the least cost of service, the amount of freight that ought to be attracted to the river, there will be needed great fleets of modern towboats and barges, designed to carry large tonnage of any class of freight offered, throughout the entire season of navigation. To transport one million tons of freight would require 1,000 barge loads of 1,000 tons each. Many millions of tons of the products of the valley ought to be carried on the river every year.

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The State Cannot Compel Railway Construction to be undertaken, according to a decision of the Supreme Court of California. In 1891 a 12-mi. line, owned by the Santa Fe R.R., between Temecula and Oceanside, Calif., was destroyed by a flood and has never been rebuilt. Last year the State Railway Commission, in response to a petition of citizens, issued an order to the railway to rebuild the line. The Santa Fe opposed the order, holding that the business resulting would not warrant the outlay of $650,000 required to rebuild the line. The Supreme Court in its decision holds that to require a public utility to devote its profits to service that it has never undertaken to render is to take its property in violation of the Federal constitution.

General Goethals on the Panama Canal Slide Critics

SYNOPSIS—In his annual report to the Secretary of War General Goethals, Governor of the Canal Zone, makes his final statement on the slides in the Gaillard Cut. The essential features of his discussion are given here.

In September, 1915, when the International Congress met at San Francisco to celebrate the completion of the Panama Canal, with General Goethals as the guest of honor, news came that the slides, which had been in a threatening condition for months, had moved down so as to block the channel entirely and suspend navigation through it two days before the Congress opened. General Goethals immediately returned to Panama to take personal charge of the work of removing the slides and restoring the canal to operating condition.

It will be recalled that the news of the serious nature of these slides started a wave of widespread public skepticism regarding the canal. Doubts were expressed regarding its permanence and success. The public opinion on the matter was pictured perhaps by the joke that became current about that time—that while the canal had been in Panama, now Panama was in the canal.

Even among well-informed engineers there was an exaggerated idea as to the effect of the slides, and suggestions were heard in various quarters that perhaps the engineers on the Isthmus might have adopted some better plan of dealing with the slides.

Just a year ago, in *Engineering News* of Nov. 25, 1915, was printed the special report of General Goethals to the Secretary of War, detailing the condition of the slides at that time and the methods being adopted for their removal. That report gave facts enough to satisfy intelligent critics; but it did not stop criticism.

The long period of seven months while the canal was blocked with slides offered a magnificent opportunity to those who desired to spread pessimistic views of the canal enterprise and to the amateur engineers who were ready to volunteer scientific theories as to the cause of the slides and propose new inventions for their cure.

Is the Cut in a Bog?

In the annual report of General Goethals as Governor of the Canal Zone, made public on Nov. 20, he replies to these critics, amateur and otherwise, in most vigorous fashion. He introduces the subject as follows:

> Although the question of the slides has been dealt with in previous annual reports and official documents, there continues to exist much ignorance on the subject. Also a great deal has been written by those whose little knowledge makes them dangerous, and to whose statements credence is given because of the position or prominence of the writers. I have concluded, therefore, to report again on the situation, even at the expense of repetition, notwithstanding the general belief that anything published in annual reports is buried in oblivion.
>
> A report emanating recently from English sources states that the bottom of the canal through Gaillard Cut is found to be a bog, which is being constantly pushed up and through which the dredges have difficulty in maintaining a channel. Further, that it is acknowledged on the part of those in charge that the canal is a failure and that American engineers are seeking information in England relative to the Nicaragua route.

General Goethals answers this story with the terse remark that such reports are false and that the bog theory is a myth. The latter part of the story may possibly have originated because of the pending treaty between the United States and Nicaragua, by which the former secures from the latter all rights for building a canal on Nicaragua territory. It would be absurd for the United States to seek information concerning the Nicaragua canal route in England, however, in view of the complete information as to that route obtained by the United States Government 20 years ago, before the Panama route was adopted.

If anyone believes that the bottom of the Gaillard Cut is in a bog, he would do well to reflect that every foot of the existing channel through it was excavated through rock so hard that it all had to be drilled and blasted.

For some unaccountable reason there seems to be a general belief that the whole Gaillard Cut, 8¾ mi. long, is affected by slides. The fact is that the only slides of importance are those at Culebra and at Cucaracha, and these have a combined length of only 4,800 ft.

Another frequent misconception is that these slides represent the slipping down of portions of a bank to reach a slope at which the material will stand. The fact is that the slides which have given serious trouble are caused by a deep subterranean movement. The underlying strata have been deformed or crushed under the weight of the overlying material, which has settled down vertically.

Scientists Volunteer Expert Advice

For a number of years the staff on the Isthmus included a resident geologist, Donald F. MacDonald. Notwithstanding this, there appears to have been considerable sentiment among geologists and mining engineers in the United States that if their wisdom was directed toward the slide problem at Panama they might be able to do better than was being done by the engineers in charge. We quote further from General Goethal's report:

> In October, 1915, the President of the United States was advised by a member of the National Academy of Sciences (which was organized by an act of Congress to give expert advice to the President and Congress on scientific matters) who stated that one of its members had made an extensive study of earth slides in tropical countries, and was convinced that there were relatively simple ways by which they could be stopped, and suggested that a committee of mining engineers and geologists of the Academy be appointed to consider his propositions.
>
> In consequence of this, the President of the United States requested that a committee be appointed by the National Academy of Sciences to "consider and report upon the possibility of controlling the slides, which are seriously interfering with the use of the Panama Canal." From the correspondence it appears that at a meeting held in New York ". . . the hope was repeatedly expressed that an effective solution may speedily be found."
>
> The coming of the committee was welcomed on the Isthmus, for so much misinformation had been sent broadcast, doing more injury to the canal than the closing of it by the slides, confidence had been upset; and it was hoped not only that a remedy would be forthcoming, but that the report of the committee would be able to restore confidence in the project, especially as those connected with the work knew that the methods adopted would overcome the difficulties for good and all, given the time and money, and that the waterway would be all that had been expected.
>
> Probably the greatest injury done the canal was through Prof. Benjamin Le Roy Miller, Ph. D., who occupies the chair of geology at Lehigh University. On returning to New York

from Costa Rica he stayed here a couple of days awaiting a steamer. He was given every facility to examine the slides at Culebra, which were then at their worst, and he is reported to have said for publication on his arrival in the United States that he had made a "thorough examination of the slides," and the conditions found were as follows—the statement appearing in quotation marks in the press item:

> At the Culebra Cut . . . cracks have formed over 1,300 ft. back from the canal, and all of the ground intervening is moving toward the Cut. There is no doubt that much rock, now apparently stable, also will move, as its support is withdrawn by the removal of loose earth and rock. Before the canal can be said to be completed and permanently opened to traffic, the amount of material that must be taken out will not fall far short of the amount already taken from the Culebra Cut.
>
> Transportation companies planning to use the canal should realize that they must not expect uninterrupted service for several years. During the dry season the canal may be opened, but it is certain to be closed during the rainy season when the earth is soaked with water and its movement toward the canal facilitated.
>
> In view of the extent of the material that has now started toward the Cut, it seems that steam shovels should again be employed. Practically all of Gold Hill and much of Zion Hill must be removed, and to wait until the earth breaks loose and enters the Cut where the dredges can attack it seems unwise, and unquestionably longer delays the completion of the project. If dredges alone are employed, as at present, the canal may be kept clear during the months when rainfall is lightened, but for many years to come the rainy season is almost certain to cause such slides as to close the canal for weeks or even months.

The "thorough examination" occupied fully three or four hours of his time. The position that he occupied in one of the leading universities of the United States gave credence to his statements, which were copied broadcast and commented upon editorially to the detriment of the canal. His dire predictions were naturally unsettling to shipping interests, which were guided by them to some extent in routing their commerce elsewhere.

It was anticipated that the committee from the National Academy of Sciences would make a more thorough examination than Professor Miller had done, and it was hoped that, as a result, the statements of Prof. Benjamin Le Roy Miller, Ph. D., would be found to be what we considered them—erroneous, unwarranted and unfair, and help restore the confidence that he had helped to destroy.

The preliminary report by the committee of the National Academy of Sciences was submitted to the President in January, 1916. ["Engineering News," March 16 and 30, 1916.] At that time they expected that their final report would be completed in April, but up to date it has not been received.

The statement made by Professor Miller, that practically all Gold Hill and much of Zion Hill must be removed, was not concurred in; and in this connection it should be remembered that a committee of this character expresses its opinions guardedly, for whatever happens they must be found on the right side. They advocated, as a matter of scientific interest, the making of an accurate triangulation of the hills in question—Gold, Contractors, Culebra and Zion—which has been done. By checks made at frequent intervals the slightest movement on the part of any of the four hills would be disclosed at once. No movement of any kind has taken place.

The committee expressed the belief that every available and practicable device for controlling the water, both on the surface and underground, should be employed, and to this end advocated covering the slopes with vegetation to prevent surface wash, closing peripheral cracks, draining undisturbed and threatened areas and draining by tunnels.

Remedies Proposed for Stopping the Slides

1. Covering the Slopes with Vegetation—Probably the most frequent remedy suggested for the Panama slides (especially by those who have never been to the Isthmus and have no conception of what the slides are like) is planting vegetation to cover the banks. E. Moody Boynton, famous 25 years ago as the inventor of the bicycle railway, has exploited in the public press (and patented!) a scheme for planting willows on earth slopes to prevent slides, which he advocated as just the thing for the canal. General Goethals' comment on the general scheme of planting vegetation to stop the slides is as follows:

> For several years the expedient of covering the slopes with vegetation has been carried on, starting under the direction of Dr. Pittier, of the Smithsonian Institution. Where the surface of the ground is in motion, as in the case of active slides, the roots are disturbed, and the steady growth of vegetation is impracticable. Trees and vegetation of all kinds growing on the surface of the ground which broke in October, 1914, were carried down the slide and exercised no deterring effect whatsoever. On sliding ground there is not sufficient time to plant anything, and no good would be accomplished. Where the banks consist of the red clay of the country, it is only after considerable difficulty that grass of any kind can be grown on them. Vegetation stops surface erosion; on this account the work above noted was undertaken and is being carried on.

2. Filling Up Earth Cracks—General Goethals remarks that this remedy may be adopted with success where sufficient earth covering is available for the use of a hydraulic grader, and this has been done at places along the canal. The smoothing off of the slope with a hydraulic grader also permits ready runoff of the water. As long as the ground is in motion, however, new cracks and irregularities are constantly developing, so that until the material comes to rest relief is temporary only. On Culebra Hill, where there is little earth covering and the cracks are wide and extend a great depth in rock, it is not practicable to close them permanently without expense unwarranted by the results.

3. Subsurface Tile Drains—In accordance with the recommendations of the committee while on the Isthmus, subsurface tile drains have been placed within an area on Culebra Hill as an experiment. As for the general effect of such drainage on the earth movements, General Goethals says:

> It is admitted that if the water could be entirely excluded the earth movements would cease, but unfortunately this is impossible. With the heavy tropical downpours the best that can be done by drainage is to carry away what falls as rapidly as possible, but groundwater cannot be eliminated. So far as concerns groundwater . . . the slides in question affect the banks for a considerable distance down, probably below the bottom of the canal, and if groundwater be primarily the cause, then it cannot be removed from the strata at which the trouble starts.
>
> So long as the slides are active and the configurations of their surfaces change as rapidly as they now do, it is impracticable to open and maintain the permanent drains recommended in the moving areas. When equilibrium is restored, and as a means of promoting permanent stability, the drains of a permanent character should be constructed and maintained.

4. Drainage by Tunnels—As noted above, this was one of the expedients for stopping the slides suggested by the Academy of Sciences Committee. The chairman, Dr. Van Hise, President of the University of Wisconsin, proposed experiments to try out this plan, and the services of Prof. Warren J. Mead, of the University of Wisconsin, were secured. Professor Mead, in coöperation with Mr. MacDonald, the Canal geologist, made tests to determine the percentage of water contained in the rock which might be drained off by a tunnel.

Tests were made on 21 samples of rock taken from below the canal water level and showed that most of the water contained in the rock was held there by capillary attraction and the maximum amount that could be removed by natural drainage would not exceed 3.6% of the total volume of the rock. Mr. MacDonald's official report says:

> These facts show that while the sliding rocks have a high percentage of pore space, the pores are mostly of capillary size and are filled with water which obeys the laws of capillarity and which cannot, therefore, be drained off. These experiments definitely established that all cures by drainage which had been offered to and urged on the canal authorities were absolutely futile, and the money which might have been wasted in worthless tunnels, wells and acres of asphalt covering was saved for the only remedy that could bring premanent cure under the circumstances—dredging.

Other Plans Tried by the Canal Engineers

The engineers on the Isthmus have not been backward in undertaking practical trials of anything that promised even a remote possibility of checking the slides. General Goethals describes these experiments as follows:

> During the excavation of the Cut there occurred 22 slides and breaks of various extent. It was believed that piles driven through the loose material into firm ground below and tied at the tops might check the movement, and this was tried at four of the slides, but without success. In some instances the piles were carried bodily down the slope; in others the underlying material, moving faster than the upper portion, inclined the piles away from the Cut, and in cases where the top surface moved faster than at the bottom, they inclined in the opposite direction. The remains of these piles can be seen at the present time in some of the areas so treated.
>
> It was thought that in case of clay slides, heavy riprap dumped on the surface would find its way through the loosened material to firm ground and check the movement; but this method was found as useless as the piling. Most of the riprap rock was taken out at the foot of the slope as the excavation proceeded.
>
> Experiments were made by concreting the face of the prism to prevent the disintegrating effect of the air on some of the softer rocks; this was done by use of a cement gun, by plastering the surface with cement mortar and by reinforced concrete, anchored to the side of the prism with pieces of rail. None of these methods was satisfactory or durable.
>
> The remnants of the French drains, which proved inadequate, were dug out at the bottom of the prism.
>
> The conclusion was reached that the only cure was the removal of all loosened material as it came into the Cut; and in case of breaks, to relieve the weight, where possible, from the upper parts of the banks by steam shovels or sluicing operations.

Other Schemes for Holding Sliding Ground

Many ingenious people have offered to show the canal engineers how to stop the slides. Some of their suggestions are reviewed as follows:

> The suggestions most frequently made have been along the line of sowing vegetation and of properly draining the area. These have already been considered. To sink a number of pipes and apply steam for drying out the subsoil would be prohibitive on the score of expense, even if it were practicable. It would be impossible to drive and hold such pipes through the material in case of motion.
>
> Pipes sunk for the purpose of pumping out the water are equally impracticable and impossible. From the experiments conducted by Prof. Warren J. Mead and Mr. MacDonald all the water could not be extracted by this method. Piling the entire area at regular intervals and tying the piles to anchors driven in the firm ground cannot be done, nor would it secure the result anticipated by the proposers of this scheme.
>
> The construction of retaining walls would require the excavation of material to secure the foundations, necessitating the removal of all the material in motion, when the need for the retaining wall would no longer exist. There is no form of construction that could be designed that would hold back the superimposed mass while the excavation for the foundations was in progress. The construction of inverts to hold down the bottom of the prism is impracticable and impossible.
>
> Wire netting rolled over the bank and held in place by stakes would not prevent the movement, but would seriously interfere with the dredges in removing the material littered up with sections of wire mesh, which would break loose with every movement of the slide. Consolidating the mass by injecting grout would also be impossible; the pipes could not be driven to firm ground below, and the earth and rock, as it now comes into the Cut, can be much more easily handled than would be the case were this material solidified by cement.
>
> It was suggested that the slopes and the surface of the ground adjacent to the Cut be covered with asphalt, tar or some preparation which would exclude water from the ground. This was also proposed by a member of the committee from the National Academy of Sciences. That the committee did not include it among its recommendations seems conclusive that in its opinion it was not practicable, and no further comment seems necessary.

Unique Theories as to the Cause of the Slide

The ingenious theory has been put forward that there exists a huge subterranean reservoir of water and it is the pressure from this that causes the slides. General Goethals remarks that since the pressure is sufficient to break the ground, the water would escape through the breaks. No such water has appeared.

Another remarkable theory is that the attraction (of gravitation?) between the earth masses on opposite sides of the cut draws them together, and still another holds that the excavation of the cut has sliced in two a huge magnet that previously existed!

An Ex-Senator Lays It to Gas

Hon. Thomas Kearns, ex-senator from Utah, declared in the New York *Sun* of June 18, 1916, that:

> The trouble is all caused by subterranean gases formed in the earth which, when permitted to escape through certain channels or breaks in the earth, carry with them eruptive material, sometimes for a long distance, to the place of the least resistance.

General Goethals comments on this delightful theory as follows:

> Coming from a man with such large practical experience Senator Kearns's paper undoubtedly carried conviction to the minds of many who read it. Since his examination was more thorough than that made by Prof. Benjamin Le Roy Miller, Ph. D., it is comforting to note from his judgment also that Gold and Contractors Hills are not likely to fall into the Cut.
>
> According to Senator Kearns's theory, gases forming somewhere in the interior of the earth in escaping carry with them eruptive material to the place of least resistance, or in this instance through the bottom of the canal. The breaks, which produced fissures several hundred feet deep, liberated no gas. With a pressure sufficient to accomplish such destruction of the structural formation of the rocks, apparently the gases returned to their storage to attempt later a forced passage through the bottom.
>
> We unconsciously endeavored to assist their efforts by digging away 110 ft. of their container, but even this did not induce the gases to come forth; thus far there has been no evidence of escape anywhere along the line of the canal, nor has there been any upheaving movement anywhere except in the Culebra district, where the slides occur. So long as there is no movement in the banks we are able to reach bottom grade and keep it. Under the circumstances, those on the work still adhere to their belief that subterranean gases have nothing whatever to do with the movements that have occurred.

What Happened at Gold Hill

The reports that the whole of Gold Hill is moving slowly into the canal should be definitely set at rest by the statements above as to the triangulation measurements The breakage of enormous masses of hard rock from Gold Hill, however, has been the source of much trouble. General Goethals says:

> Gold Hill is of basalt, thrown up in a molten state through the sedimentary deposits that already existed and poured over the deposits on either side of the stem, giving to the vertical section the general shape of a mushroom. The portions projecting beyond the stem, being left unsupported, broke when the material moved from under, and the rock thus detached came down with the rest of the material at Cucaracha. This same action occurred on the opposite side of Gold Hill within a few months after the east Culebra slide became active. . . . .
>
> The finished section from Gold Hill north left an enormous mass of hard rock on the east side and at the northwest corner of Gold Hill. When the break occurred in 1914, this mass of rock was moved slowly into the prism, but finally came to rest and seemed to hold the material back of it limiting the area of interference in the channel. It stood up boldly for nearly 100 ft. and was designated by the working force as "Gibraltar."

Except at the point opposite "Gibraltar," the width of the canal prism through the slides has now been enlarged by the dredges to a width of 500 ft. instead of 300 ft., which is the standard elsewhere through the cut. This widening was made so that even if further movements of the banks on either side did occur, there would be a good chance that the material could be dredged out as it came in, without stopping navigation.

A year ago, General Goethals estimated that the total amount required to be removed from the slides then in motion would be between 7,000,000 and 13,000,000 cu.yd. His present report gives the total work done by the dredging division in removing slides during the year as 12,695,000 cu.yd. This material was handled at an average cost of 28.2c. per cu.yd.

A great deal has been said concerning the *esprit de corps* that animated the force during canal construction. Little has been heard, however, of the spirit that has animated the men who battled with the slides during the seven months while ships waited to have the canal reopened. General Goethals says:

> The spirit obtaining in the organization during the construction period was the subject of much commendation; but looking back over the period of my connection with canal work, the spirit that animated the dredging force seems to me to surpass that which existed at any prior period. The dredges were operated 24 hr. every day, including Sundays and holidays, for a period of four months, without the least murmur or complaint on the part of anyone in the force, which reflects much credit on the officials of the division as well as on the men comprising it.

The canal was reopened to traffic on Apr. 15, 1916, and ships have been passing ever since. "So far as the Culebra slides are concerned," says General Goethals, "the worst is over; the intervals between movements are becoming greater and the quantities of material less, the only danger being at 'Gibraltar,' but it is hoped that the excavation continued along the lines contemplated will enable the widening of this section to the adopted prism line without interfering in any way with the transit of shipping. As predicted at the time the great Culebra movements occurred, the slides will be overcome finally and for all time, notwithstanding the calamity howlers and in spite of the disastrous predictions of the 'know-it-alls.'"

Organization of the Engineering Department of a Railway

Railway engineering comprises two branches—construction and maintenance, the former including surveys and ocation. The relations between these branches and the reation of the engineering department to the operation and management of a railway were discussed in a paper read before the Engineers' Club of St. Louis by V. K. Hendricks, Assistant Chief Engineer of the St. Louis & San Francisco R.R. From this paper we abstract the following review of the work of the railway engineer:

On some railways the two branches—construction and maintenance—are combined; on others they are separate, but come under one chief engineer; and on others they are entirely distinct, each having its own engineer.

Railway organization is ordinarily either "divisional" or "departmental." With the former the division superinendent has charge of all matters of all kinds which arise on his division, while with a departmental organization ach division has two or more heads (one for each department) who are wholly independent of each other, and each reports to his own superior general officer. It seems logical that the divisional organization would give the best results, as there should naturally be one supreme head on each division. Probably most railroads now have a divisional organization, except that (especially in the West and Middle West) the local engineering department frequently is not an integral part of the division superinendent's force.

On many railways, especially in the East, the maintenance of roadway, track and structures is directly supervised by a division engineer, who reports on all maintenance matters directly to the division superintendent. The Pennsylvania Lines is a noteworthy example. On that system the benefits of a technical education and training are so appreciated that the line of promotion to division superintendent is generally through the division engineer, rather than through the trainmaster or chief dispatcher, it being essential, of course, for the engineer to develop himself along broad lines and show proper executive ability. All opportunity possible is afforded him to do so. On the Pennsylvania Lines, the general manager has two chief engineers of maintenance-of-way (one for each system) who report to him in a consulting capacity on maintenance matters. The chief engineer has practically no connection with maintenance matters, his duties being in connection with new construction work, right-of-way records, leases, etc.

The Baltimore & Ohio R.R. is another instance of this type of organization. It has four district engineers of maintenance-of-way, who report to the engineer of maintenance-of-way and relieve him of much detail by passing on to him only the more important matters that have previously been fully investigated and summarized. On both the Baltimore & Ohio and the Pennsylvania Lines the engineer of bridges reports to the chief engineer, and the signal engineer reports direct to the general manager.

On the Wabash R.R. each division has an engineer of maintenance-of-way (corresponding to a division engineer), who reports direct to the division superintendent. Between the division superintendent and general manager the organization changes to departmental, as the division superintendent reports direct to the superintendent of telegraph, the general superintendent of motive power, the general superintendent of transportation and the chief engineer of maintenance-of-way on all matters pertaining to their respective departments. These officers in turn report to the general manager. The chief engineer has duties similar to those of the chief engineer of the Pennsylvania.

Still another form of organization is that of the St. Louis & San Francisco R.R. The engineering department does not have charge of maintenance, but is consulted to a greater or less extent on maintenance matters. There are four district engineers who report direct to the chief engineer. They work in close touch with the general superintendents and division superintendents, being consulted by them on maintenance matters.

The engineering department, in addition to having charge of valuation, track extensions, right-of-way records, etc., has charge of all drainage matters, standards, erection of facilities under contract, spiraling curves and general engineering matters. As on the Baltimore & Ohio R.R. and the Pennsylvania Lines, the signal engineer reports direct to the general manager instead of to the chief engineer.

For the best results the engineer should be thoroughly familiar with operating matters, which familiarity can be gained best by actual experience in the operating department. The best ultimate results for the railways will be gained by adopting such an organization as that on the Pennsylvania Lines, where the line of promotion to division superintendent is through the division engineer and thence upward. With such an organization the engineering department would best serve the railway, the engineer would receive his best training, and the railway would be further fortified by generally having its operating officials engineers.

Notes from Field and Office

Michigan pony-truss highway bridges have inside knee-bracing at every panel point—Hunting leaks in water mains—Construction features used by concrete building firm—Asphaltic-concrete paving at Fort Wayne—Tangent of compound curve—Contractor's daily reports—Station work on the Alaskan Ry.

Standard Pony-Truss Bridges for Michigan Highways

By C. V. Dewart*

The standard pony-truss designs of the Michigan State Highway Department have inside knee-bracing at every panel point. These knee-braces are connected to the vertical posts directly underneath the top chord and have a batter toward the roadway of about 1 on 6. They are connected to the web (and not to the top flange) of the floorbeam. The hand railing is connected to the battered braces as shown by Fig. 1. Many arguments have been advanced against this method of construction, but we believe we have effectively answered all. There is greater weight in the floorbeams, but only in the floorbeams. To offset this we have less weight in inside knee-bracing than there would be in outside bracing because no horizontal member is required in the brace. The added length of floorbeam provides a greater width of roadway, for although the nominal width may be only 18 ft., measured from outside to outside of curb, there is actually about 19 ft. clear width at 3 ft. above the crown of the roadway and about 20 ft. clear width at 6 ft. above the roadway.

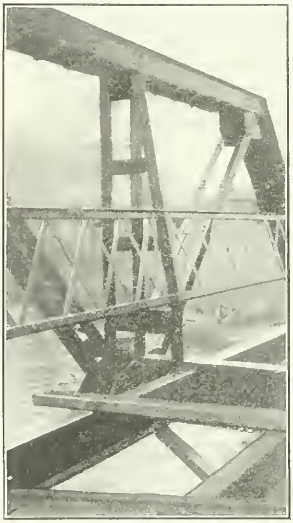
FIG. 1. MICHIGAN STANDARD PONY-TRUSS BRIDGE

It is obvious that any lateral loading and any tendency to sway in the top chord must be conducted to the floorbeams, and the more directly these stresses are transmitted to the floor beams the better. An outside knee-brace is therefore of little or no value unless it is braced through or around the lower chord and connected to both the top and bottom flanges of the floorbeams. Otherwise the floorbeam connections get all the stress and vibration transmitted from the top chord.

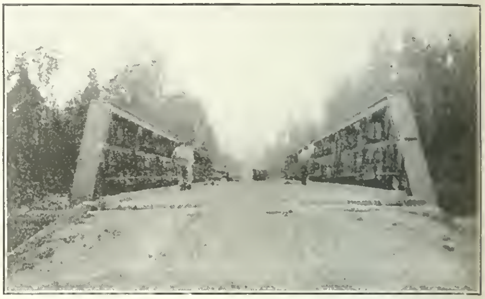
FIG. 2. PINE RIVER BRIDGE, MICHIGAN

The usual specification calls for a sufficiently increased radius of gyration in the top chord, and vertical posts strong enough, to carry the assumed lateral loading. Bridges designed in this way, however, have failed to attain the desired result. The weak spot is in the floorbeam connection. It is impracticable to construct a floorbeam connection that will transfer overturning moment, such as is delivered from the top chord to the floorbeam without knee-bracing. Does it not seem more reasonable to spread the base of the post, or in other words, the points of support of the top chord, to some proportion of the distance from top chord to floorbeam?

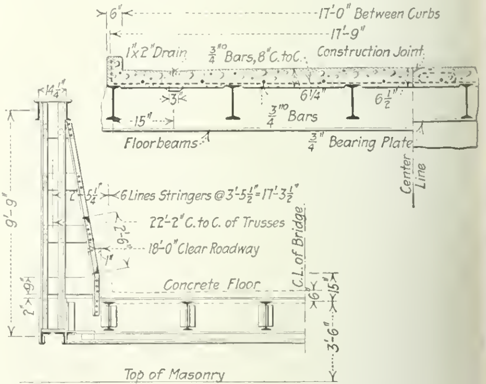

FIG. 3. DETAIL OF KNEE-BRACE

The advantages of this construction are many. Sidewalks may be added without interfering with the design. The bridge is improved in general appearance, and the cramped uncomfortable feeling of driving too close to the truss members is relieved. The lower chord and pedestals of the bridge are far enough away from the roadway so that they do not catch the drip and dirt. On account of the trusses being farther apart, they may be erected outside old-style trusses without interfering with traffic (see *Engineering News*, Oct. 26, 1916).

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*Bridge Engineer, Michigan State Highway Department, Lansing, Mich.

Finding Leaks and Weaknesses in Baltimore Water Mains

For the last few years the Water Department of the City of Baltimore has been conducting extensive investigations of the condition of underground structures along the city streets. The object is twofold: (1) To repair leaks and save water and (2) to replace old and weak pipes with new ones before improved pavements are laid.

Formerly the method was to tap a pipe at various points and with pitot tubes measure the pressure and the velocity of water flowing and thereby the volume. With all house connections closed between the points tapped the difference between the volumes determined by the pitot tubes gave a measure of the leakage.

It is now the custom to close all valves on a section of pipe to be tested and, with a triplex pump attached to the line, to subject it to a water pressure of 300 lb. per sq.in. If the pipe breaks, it is immediately replaced, thus saving the expense of ripping up improved paving a few years hence when the pipe would have eventually broken. A measure of leakage is also gained by this method by noting the drop of pressure per unit of time in the length of pipe tested.

An "aquaphone" is used to detect the location of leaks; and with this instrument, which consists of a telephone receiver attached to an iron rod, a leak can be "spotted" within 10 ft. The skin friction of water escaping at a eaky joint causes a slight hammer on the pipe, which can be heard in the receiver of the aquaphone when the end of the rod is placed on a fire plug or water box connected o the pipe. The location of the leak is detected by noting the increase of sound as the instrument is applied to the pipe along its length. Water Engineer Lee is at present working on a method whereby the location of leaks may be exactly determined, thus effecting a saving in excavation required to repair the point of leakage.

Construction Features Used by Concrete Building Firm

The Ferro Concrete Construction Co., of Cincinnati, Ohio, one of the oldest reinforced-concrete building firms in the country, has standardized methods of construction in its concrete building work. For the American Tool Works' plant new building in Cincinnati it is able to apply most of the special features that have been developed. Some of these, particularly the adjustable shores, the flexible-mat supports for slab forms, and the column forms, were devised by J. E. Hodges, one of the superintendents for the company, and were described briefly in *Engineering News,* Apr. 15, 1915, p. 730.

The American Tool Works' new plant is being erected in the low-level district of Cincinnati, directly across the street from the Pennsylvania R.R. station, a siding from which runs along one side of the lot and affords very easy communication for material. The building itself is a flat-slab structure of considerable height and ground area.

The aggregate is stored in large bins at one of the narrow ends of the building (Fig. 1). It is loaded into the bin from gondolas by a derrick equipped with a clam-shell bucket and running on a slightly raised trestle, the tracks on which extend along the whole length of the bin so that the derrick can control any one of three cars while traveling along the wide-gage tracks on the trestle. The cement is stored in a house in the middle of the plot immediately alongside of the concrete mixer and tower. The cement sacks are unloaded from cars on the siding and slid down into the house on inclined planes surfaced with rollers.

An important part of the construction equipment is the shop and sawmill located on the street side of the material bins (Fig. 1). In this shop the special forms are made, the machines being driven by a low-grade-oil engine, which

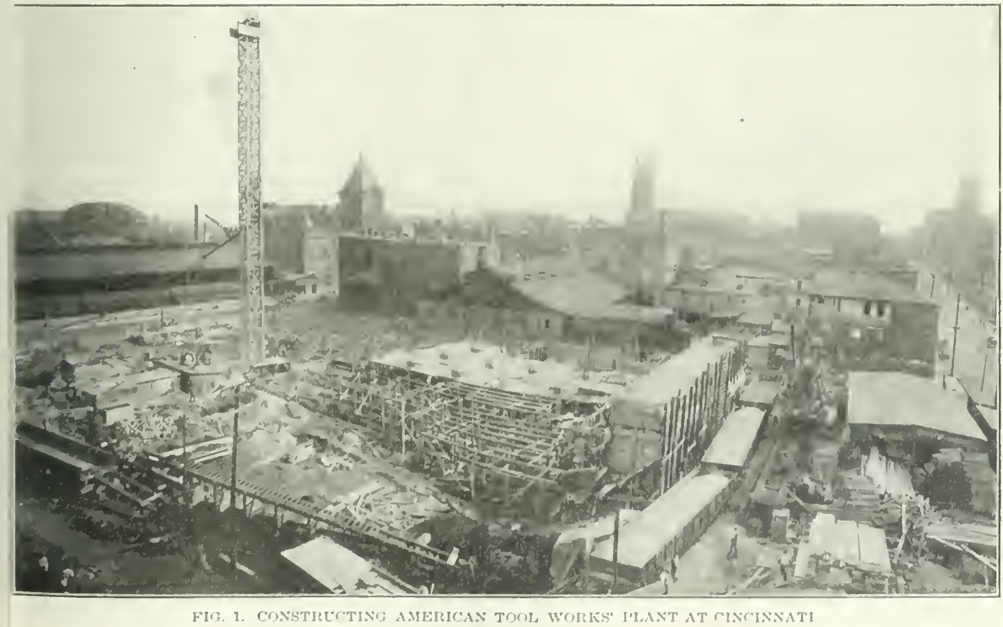

FIG. 1. CONSTRUCTING AMERICAN TOOL WORKS' PLANT AT CINCINNATI

has proved very economical and satisfactory. Inasmuch as a great deal of the formwork is standardized, as will be described hereinafter, the carpenter-shop work can be carried on continuously all during the construction of the building without too much regard for the particular stage of the concrete construction.

The formwork is extremely simple. The elements consist of adjustable shores carrying longitudinal stringers on which rest flexible mats covered with iron sheets to form the floor slabs. The strut consists of a lower single stick, about 4 in. square, sliding between two upper 2x4-in. sticks and adjustable on those upper sticks with a ratchet-jack arrangement. The shores are useful in concrete work, not only because of the ease of erection, but because of the readiness with which they can be taken from under the floor forms and placed one by one, to carry the stripped floors. The stringers are spiked to the top of the shores with double-headed nails so as to be easily removed, and on the stringers are rested the flexible mats, one of which is shown in Fig. 2. They are covered with galvanized tinplate, 30 in. wide and No. 24 gage.

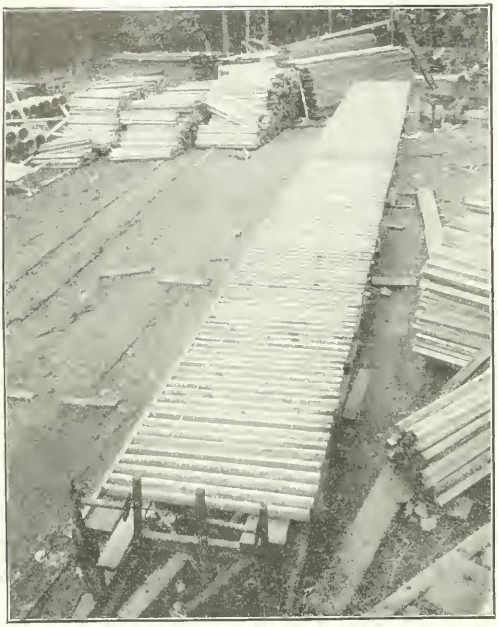
FIG. 2. FLEXIBLE MAT FOR CONCRETE FORM

The mats are made up of 2x2½-in. sticks so spaced as to permit interlocking of two adjacent mats, the sticks being tied together with wires or chains. They are made on the job or in the shop, as is shown in the view, and can be used over and over again many times. They not only can be made to fit for flat-slab work, but in some special cases they can very readily be curved to fit different types of floor construction. For instance, there is in Cincinnati a garage in which a reinforced-concrete roof is supported on steel roof trusses. The roof surface was built by laying the flexible mats on curved templets, which rested on the upper chords of the roof truss. The narrow inverts in the curves were reinforced with longitudinal rods, forming purlins integral with the roof slab.

In the American Tool Works' building the steel cylindrical column forms previously described in *Engineering News* are used. These are galvanized-iron plates held in position by two bands of round iron, one upper and one lower, drawn together with nuts.

The method of conveying concrete is very well shown in the general view in Fig. 1. The concrete mixer, driven by the steam engine, is located beside a high timber tower in the middle of the lot. Running alongside of the base of the bin and forming a loop around the far side of the concrete tower is a narrow-gage track. This track is so graded that with the aid of a short booster rope section just approaching the tower a car can make the entire round trip under gravity.

The material cars, therefore, are loaded from hoppers in the cellar of the building leading out to the material bin and proceed by gravity to the base of the short incline, where they are pulled up to dump into the concrete mixer. They then go around the tower by their own weight and proceed back to the bin, the cement being loaded directly out of the house adjacent to the tower. This system remains during the entire construction of the building, being in the open lot at the beginning of the work, as shown in the figure, and in the cellar of the building during the remainder of the construction.

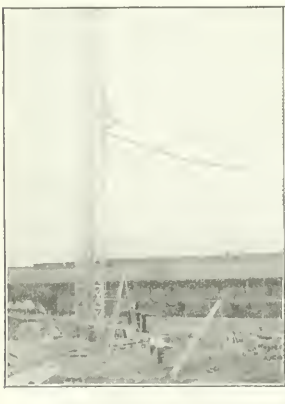
FIG. 3. CONCRETING TOWER WITH SPLIT BOOM

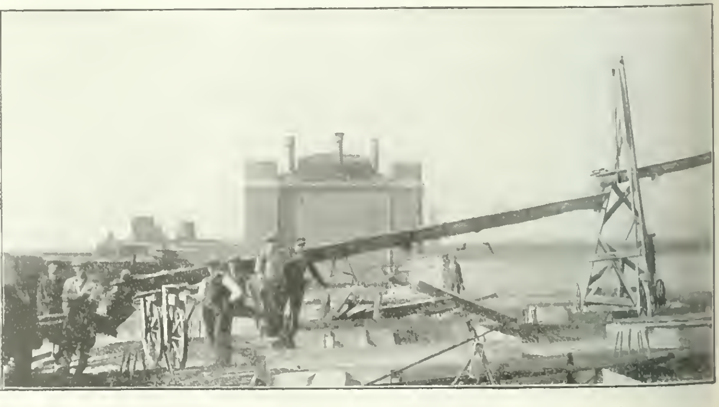
FIG. 4. TRICYCLE AND BICYCLE CARRYING EXTENSION OF CONCRETE CHUTE

Several features of interest may be noticed in the tower and chute delivery system. One of these is the special boom, which is split so as to permit the passage of the chute through it. In some of the original concrete work of this company the boom was made up of separate timbers widely spaced to permit the chute to go through: but in later work, such as the one shown here, the boom is of steel lattice construction wide enough to pass the chute. This chute is movable up and down on the tower by special clamps that fasten onto vertical timber tracks nailed on the uprights of the tower. A lower chute and the lattice boom are shown in Fig. 3. For some kinds of work it is possible, of course, to have two chutes working on the same tower.

For distribution of the concrete to far parts of the building, intermediate supports of chutes must be provided. For this purpose two special carriages have been devised, as shown in Fig. 1. One of these, the higher, which is used to hold the chute when just outside the range of the boom, is a tricycle with a frame from which a block and tackle is hung. The other, used at the extreme end of the chute, is a bicycle. It is a two-wheel truck with a truss frame immediately above the upper range of the tire on which the chute rests. These two trucks are readily movable over the forms even when the concrete reinforcement is in place, so that the chute can be quickly carried thereby to any part of the floor where concrete is being laid.

W. P. Anderson is president of the Ferro Concrete Construction Co., and the work here described is under his general direction, with J. E. Hodges as superintendent.

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Asphaltic-Concrete Paving

Specifications for recent pavement work at Fort Wayne, Ind., provide that asphaltic-concrete pavement shall be made with crusher-run stone screenings (hard limestone), of which all must pass a ½-in. screen and 90% must pass a ¼-in. screen. The aggregate must contain 5 to 11% of 200-mesh particles; and if the screenings do not contain a sufficient proportion of this fine material, it must be supplied by the addition of ground limestone or other suitable mineral matter of such density as to produce a powder having a weight of at least 90 lb. per cu.ft. At least 66% of this must pass a 200-mesh screen, and all of it must pass a 50-mesh screen. When thoroughly agitated with distilled water at 68° F., by means of an air blast (avoiding cyclonic effect), not more than 40% must subside on standing for 15 sec.

The material is heated to 300 to 350° F., and after mixing with hot asphalt in a suitable plant the mixture must have from 7 to 11% of bitumen, and mineral aggregate passing the several screens as follows: 200-mesh, 5 to 11%; 40-mesh, 18 to 30%; 10-mesh, 25 to 55%; 4-mesh, 8 to 22%; 2-mesh, less than 10%. This mixture at a temperature of not less than 250° F. is hauled to the street in dump wagons (covered with tarpaulin) and dumped at some distance from the area on which it is to be spread. It is then thrown into place with hot shovels and forks and leveled with the back of a rake ready for the rolling. The rollers weigh 8 to 10 tons and give a finished wearing surface 2 in. thick.

Over the warm surface is spread asphalt cement in sufficient quantity to fill the voids without leaving any excess, and upon this is at once spread a ¼-in. top dressing of fine crushed Wisconsin granite. This is then thoroughly rolled into the asphalt surface.

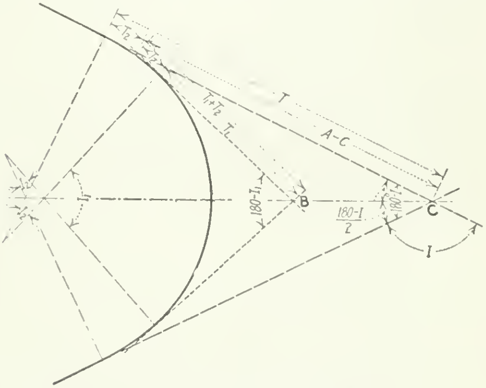
This city is using asphaltic-concrete paving extensively, and in the past three years has laid about 12 mi. The common practice is a 2-in. top layer on a concrete base the latter being made 6 in. thick on account of the clay foundation. The surface of this concrete base is left in a rough condition, so as to form a mechanical bond with the asphaltic-concrete wearing surface. This type of paving was designed by Frank M. Randall, City Engineer of Fort Wayne, Ind.

⁂

Determining the Tangent of a Compound Curve

By F. L. Beal*

In locating Y-tracks, interchange tracks and other work of a similar nature, it is frequently desirable to connect two intersecting tangents with a curve which is of a different degree than that of the lead of the switch at either end. This requires a compound curve consisting of three simple curves, one at each end from the point of switch to the point of frog and the main curve between frog points. The only difficulty in locating such a curve is the calculation of the tangent length, which it is necessary to know before the frog points can be located.



DETERMINING THE TANGENT OF A COMPOUND CURVE OF THREE PARTS

In the accompanying plan

I = Intersection angle between tangents;

I_1 = Intersection angle of the curve between frog points;

I_2 = Intersection angle of the lead or the frog angle;

T_1 = Tangent distance of the curve between frog points and is taken from a table of the functions of a 1-deg. curve;

T_2 = Tangent distance of the curve which forms the lead and is also taken from tables.

Now in the oblique triangle ABC we know the following from inspection:

$$\text{Angle } CAB = \text{the intersection angle } I_2$$

$$\text{Angle } ACB = \frac{180^\circ - I}{2} = 90 - \tfrac{1}{2}I$$

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*Valuation Engineer, Louisiana & Arkansas Ry., Stamps, Ark.

Angle $ABC = 180 - [90 - \frac{1}{2}I + I_2] = 180 - 90 + \frac{1}{2}I - I_2 = 90 + \frac{1}{2}I - I_2 = 90 + \frac{1}{2}I_1$

Side AB is equal to $(T_1 + T_2)$.

We know that in an oblique triangle such as ABC that the sides are proportional to the sines of the opposite angles, hence we may write:

$$\frac{AC}{AB} = \frac{sin\ (90 + \frac{1}{2}I_1)}{sin\ (90 - \frac{1}{2}I)}, \text{ or } AC = \frac{sin\ (90 + \frac{1}{2}I_1)}{sin\ (90 - \frac{1}{2}I)} \times AB, \text{ or}$$

$$AC = \frac{cos\ \frac{1}{2}I_1}{cos\ \frac{1}{2}I} \times AB = (cos\ \tfrac{1}{2}I_1\ sec\ \tfrac{1}{2}I)(T_1 + T_2)$$

Now since T is equal to $AC + T_2$, we may write the solution thus:

$$T = [\ (cos\ \tfrac{1}{2}I_1\ Sec\ \tfrac{1}{2}I)\ (T_1 + T_2)\ ] + T_2$$

* * *

Daily Field Reports on Construction Work

By G. H. Hailey*

The daily field reports used on our construction work are shown in the accompanying forms. These reports are made out by the timekeepers on the work. Each form is $8\frac{1}{2}$x$13\frac{1}{2}$ in.

As will be seen, the reports are made daily, on two sheets, the first being the time report and the second the equipment and material report. On the time report the names of the men in the gang, together with their hours and rates, are shown in the lower left part of the sheet. On the first day of each month both the names and the numbers of the foreigners are shown, but during the remainder of the month only the numbers are required. It will be noticed that each man must be accounted for. If one does not work a full day, he must be shown as "discharged," "laying off," etc.

The upper portion of the report contains the classifications of work done during the day, entered by hours under each occupation and extended in dollars and cents to show cost of each classification for the day. The total hours in this part of the report must check with those in the lower left portion. The total cost of each classification from the start of the work is shown in the "Amount to Date" column. In the lower right part of the report is shown the quantity of work performed during the day, covering the items for which there are unit prices in the contract.

The second sheet of the daily report, known as "Equipment and Material Report," contains the daily record of the use of equipment and materials as well as a report of the materials received and shipped during the day. The "Equipment Record" not only serves to give to the general office information as to the location of all larger equipment, but also shows the actual hours of work performed

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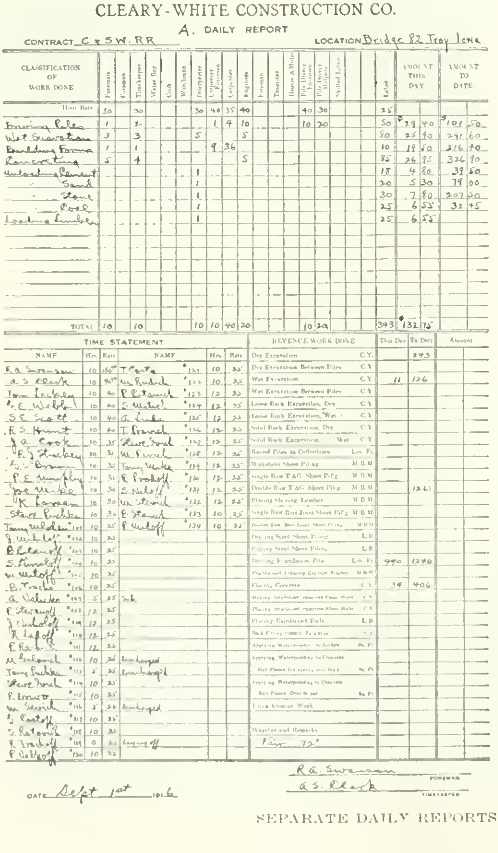
*Chief Engineer, Cleary-White Construction Co., general railway contractors, 105 West Monroe St., Chicago.



CLEARY-WHITE CONSTRUCTION CO.

A. DAILY REPORT

CONTRACT C & S W. RR LOCATION Bridge 82 Troy Iowa

CLASSIFICATION OF WORK DONE	Foreman	Foremen	Timekeeper	Water Boy	Cook	Watchman	Interpreter	Carpenter Foreman	Carpenter	Engineer	Fireman	Teamster	Horses & Mules	Pile Driver Foreman	Pile Driver Helpers	Skilled Labor			Labor	AMOUNT THIS DAY		AMOUNT TO DATE	
Hour Rate	50		30				30	40	35	40				40	30				25				
Driving Piles	1		2					1	4	10				10	20				50	$29	40	$101	50
Wet Excavation	3		3				5			5									80	25	90	291	60
Building Forms	1		1					9	36										10	19	50	216	40
Concreting	5		4							5									85	26	95	326	90
Unloading Cement							1												18	4	80	39	50
" Sand							1												20	5	30	79	00
" Stone							1												30	7	80	207	50
" Coal							1												25	6	55	32	45
Loading Lumber							1												25	6	55		
TOTAL	10		10				10	10	40	20				10	20				343	$132	75		

TIME STATEMENT

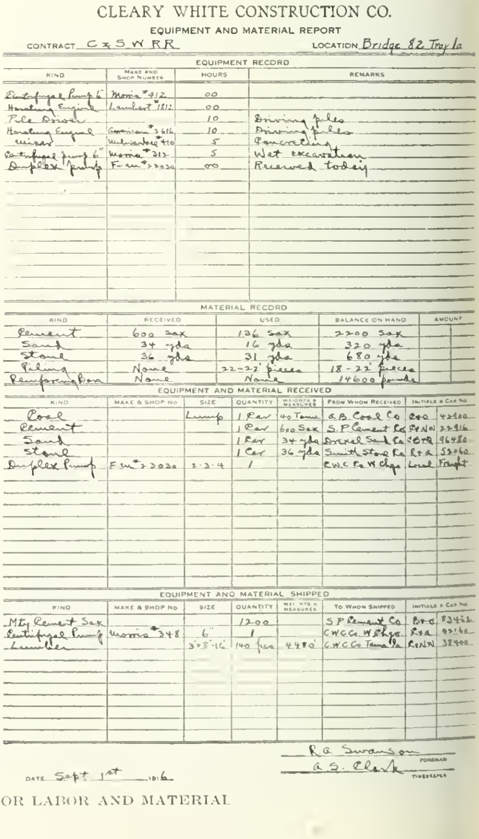
NAME	Hrs.	Rate	NAME	Hrs.	Rate
R A Swenson	10	150.00	T Costa *121	10	25
A S Clark	10	90.00	W Rudich *122	10	25
Tom Lackey	10	40	P Petanich *123	12	25
F E Webb	10	40	S Mitich *124	12	25
S E Scott	10	40	A Luka *125	12	25
R S Hunt	10	40	T Pranich *126	12	25
J A Cook	10	35	Steve Novich *127	12	25
R J Stuckey	10	35	M Pervich *128	12	25
G S Brown	10	35	Tony Mike *129	12	25
P E Murphy	10	35	P Prokoff *130	12	25
Joe Mike	10	30	S Nikoff *131	12	25
K Larsen	10	30	M Stevich *132	12	25
Steve Pushka	10	30	P Stanich *133	10	25
Tony Milden *101	10	25	P Mitoff *134	10	25
J Mikoloff *102	10	25			
B Petanoff *103	10	25			
S Novakoff *104	10	25			
M Mitoff *105	10	25			
B Trecha *106	10	25			
A Velucko *107	5	25	Sick		
P Stevanoff *108	12	25			
J Nikoloff *109	12	25			
R Lazoff *110	12	25			
P Rachich *111	12	25			
M Salovich *112	10	25	Discharged		
Tony Pushka *113	5	25	Discharged		
Steve Novich *114	10	25			
P Ernest *115	10	25			
M Savich *116	5	25	Discharged		
G Pastoff *117	10	25			
S Ratovich *118	10	25			
R Trachoff *119	0	25	Laying off		
P Velkoff *120	10	25			

REVENUE WORK DONE		This Day	To Date	Amount	
Dry Excavation	C.Y.		243		
Dry Excavation Between Piles	C.Y.				
Wet Excavation	C.Y.	11	126		
Wet Excavation Between Piles	C.Y.				
Loose Rock Excavation, Dry	C.Y.				
Loose Rock Excavation, Wet	C.Y.				
Solid Rock Excavation, Dry	C.Y.				
Solid Rock Excavation, Wet	C.Y.				
Round Piles in Cofferdams	Lin. Ft.				
Wakefield Sheet Piling	M.B.M.				
Single Row T&G Sheet Pil'g	M.B.M.				
Double Row T&G Sheet Pil'g	M.B.M.		1263		
Placing Shoring Lumber	M.B.M.				
Single Row Butt Joint Sheet Pil'g	M.B.M.				
Double Row Butt Joint Sheet Piling	M.B.M.				
Driving Steel Sheet Piling	L.B.				
Pulling Steel Sheet Piling	L.B.				
Driving Foundation Pile	Lin. Ft.	440	1240		
Placing and Framing Grillage Timber	M.B.M.				
Placing Concrete	C.Y.	34	406		
Making reinforced concrete Floor Slabs	C.Y.				
Placing reinforced concrete Floor Slabs	C.Y.				
Placing Reinforced Rods	L.B.				
Back Filling [illegible]	C.Y.				
Applying Waterproofing to Arches	Sq. Ft.				
Applying Waterproofing to Concrete Slab Floors [illegible]	Sq. Ft.				
Applying Waterproofing to Concrete Slab Floors Over [illegible]	Sq. Ft.				
Extra Account Work					
Weather and Remarks					
Fair 72°					

R A Swenson FOREMAN

A S Clark TIMEKEEPER

DATE Sept 1st 1916



CLEARY WHITE CONSTRUCTION CO.

EQUIPMENT AND MATERIAL REPORT

CONTRACT C & S W RR LOCATION Bridge 82 Troy Ia

EQUIPMENT RECORD

KIND	MAKE AND SHOP NUMBER	HOURS	REMARKS
Centrifugal Pump 6"	Morris #412	00	
Hoisting Engine	Lambert #1812	00	
Pile Driver		10	Driving piles
Hoisting Engine	American #2616	10	Driving piles
Mixer	Milwaukee #410	5	Concreting
Centrifugal Pump 6"	Morris #312	5	Wet excavation
Duplex Pump	F-M #22030	00	Received today

MATERIAL RECORD

KIND	RECEIVED	USED	BALANCE ON HAND	AMOUNT	
Cement	600 sax	136 sax	2200 sax		
Sand	34 yds	16 yds	320 yds		
Stone	36 yds	31 yds	680 yds		
Piling	None	22-22' pieces	18-22' pieces		
Reinforcing Bars	None	None	14600 pounds		

EQUIPMENT AND MATERIAL RECEIVED

KIND	MAKE & SHOP No	SIZE	QUANTITY	WEIGHTS & MEASURES	FROM WHOM RECEIVED	INITIALS & CAR No	
Coal		Lump	1 Car	40 Tons	A.B. Coal Co	C&O	42400
Cement			1 Car	600 Sax	S.P. Cement Co	C&NW	22916
Sand			1 Car	34 yds	Drexel Sand Co	CB&Q	96480
Stone			1 Car	36 yds	Smith Stone Co	C&A	52060
Duplex Pump	F.M. #22030	2·3·4	1		C.W.C. Co. W. Chgo	Local	Freight

EQUIPMENT AND MATERIAL SHIPPED

KIND	MAKE & SHOP No	SIZE	QUANTITY	WEIGHTS & MEASURES	TO WHOM SHIPPED	INITIALS & CAR No	
Mty Cement Sax			1200		S P Cement Co	B&O	83462
Centrifugal Pump	Morris #348	6"	1		C.W.C. Co. W Chgo	C&A	43160
Lumber		3"×8"-16'	140 pcs	4480'	C.W.C. Co Tama Ia	C&NW	38400

R A Swenson FOREMAN

A S Clark TIMEKEEPER

DATE Sept 1st 1916

SEPARATE DAILY REPORTS FOR LABOR AND MATERIAL y each machine; and therefore the expense and efficiency f any particular piece of equipment may be readily etermined. The "Material Record" shows the supply f material on hand and also the amount used for the lay as a check against both the cost and the quantity f unit-price work performed as shown on the time eport. The lower part of this sheet gives the daily nformation regarding material, supplies and equipment eceived and shipped.

These reports give complete information regarding the ondition of a job and also furnish the figures necessary or the preparation of cost data, not only for the labor xpense, but also for the use of equipment and the aterials used. No extra expense is incurred in the reparation of these reports, because they are easily made y the timekeepers; and on a contract of any considerable ze a timekeeper is required. We have made it a practice use young engineers for such work, and they have no ifficulty in taking the necessary measurements and btaining the other data required for the preparation of e reports. In case of any "extra work" performed, or which bills must be made, it is a very easy matter to et the expense from the reports. This includes not ly the labor, but also the equipment and materials sed.

One of the large western railways, for which we are ing some bridge work, after seeing our reports the st season has decided to adopt the form for its own ork. Other contractors may have daily report forms tter and more useful than these; if so, I should be ad to see some samples published. The samples may more interesting to engineering accountants than to gineers, but from the standpoint of cost data alone e forms will probably appeal to some engineers.

⁂

Station-Men System Succeeds on the Alaskan Ry.

As soon as it was noised about that Anchorage, Alaska, as to be the starting point of construction work on the laskan Ry., the population of the town jumped to 2,000. any of the newcomers were employed at once in handg supplies and construction equipment that arrived on h incoming steamer. These men were hired as day borers and received a wage of 37½c. per hour, eight urs constituting a day's work. Many of the men workg about the material yards were fed at the messhouse r $1 a day. The total force at work at the end of May, 14, was about 100 men, this number increasing to about 0 in the following summer.

Work Done by Station Men

It had been decided that the most satisfactory meth l to pursue in the actual construction of the railay, where the work could be classified and contracted r at unit prices, was by the use of station men. Under is method a number of men associate themselves tother as partners, taking short pieces of work at a rtain price per cubic yard for grading, or per acre for earing or grubbing.

Scarcely any capital is necessary to take a station conact, as the Commission furnishes the necessary equipent at a moderate rental. The men also have the ivilege of purchasing supplies at reasonable prices at e commissary established by the Commission. This is not obligatory, however, as they are free to buy where they desire.

The recently published reports of the Alaskan Engineering Commission (covering the period Mar. 12, 1914 to Dec. 31, 1915) state that "the large contractor was eliminated and the station men consequently received more for their work." Their profits have varied according to skill and experience. The average gross wages received by 46 station gangs on grading was 41c. per hour per man; the gross wages received by 31 gangs on clearing work was 60c. per hour per man. Gross wages are wages earned after making all deductions for cost of tools, explosives, team hire, outfit rentals and hired labor, but not subsistence. The number of men on station work fluctuated from 100 early in June, 1915, to 724 in the latter part of July of that year.

Contract Prices and Cost of Construction Materials

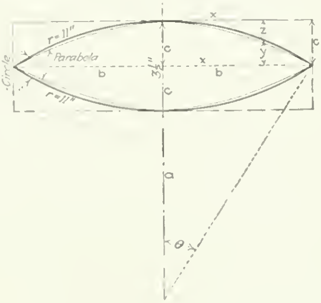
All material removed in grading was classified under one of the three following heads: Solid rock, loose rock and common excavation. The prices paid were: For solid rock, 75c.; for loose rock, 32 to 35c., and for common, 25c. per cu.yd. Where material had to be hauled in excess of 400 ft. an additional price of 1c. per cu.yd. per 100 ft. was paid.

For clearing the right-of-way the price ranged from $30 to $75 per acre, depending upon the character and density of the timber. For piling and culvert timbers 10 to 15c. per lin.ft. was paid. The native timber was cut into ties, these costing the Commission 35 to 37c. each, delivered at Anchorage or along the line. Lumber for bridges and buildings was imported from Puget Sound, the price varying from $15 to $28 per M ft. b.m. The bridge timbers were framed in the material yard at Anchorage and hauled by construction train to the site.

⁂

Finding Moment of Inertia of Lenticular Section

A special computation problem solved by William Vetter, State Highway Department, Springfield, Ill., gives a simple formula for the strength of a lenticular body (in this case a bearing rocker). The method involves some approximation, but should be dependable in all practical cases, especially for flat arcs.



LENTICULAR ROCKER SECTION

The arcs of the rocker section are circular. Drawing parabolic arcs as shown in the sketch, the moment of inertia of the parabolic segments is $^{16}/_{35}$ of the moment of inertia of the rectangle that contains them:

$$I = \int_0^b \tfrac{1}{3} y^3 dx = \tfrac{1}{3} \int_0^b \left(\frac{c}{b^2}\right)^3 \times (b^2 - x^2)^3 dx = \tfrac{16}{35} \times \tfrac{1}{3} bc^3$$

Considering both circular and parabolic segments as shown, it is evident that the difference between the radii of gyration is very minute, and the two can therefore be considered equal. (The radius of gyration of the circular segment is probably greater than that of the parabolic.) Therefore, the moments of inertia are approximately proportional to the areas involved.

$$\textit{Area of circular segment} = \pi r^2 \times \frac{\theta^\circ}{360^\circ} - \frac{ab}{2}$$

$$\textit{Area of parabolic segment} = \tfrac{2}{3}\, bc.$$

Substituting the values $r = 11$ in., $b = 5.95294$ in., $c = 1\tfrac{3}{4}$ in., $a = 9\tfrac{1}{4}$ in., and $\theta^\circ/360^\circ = 0.091$, there results:

$$\textit{Area of circular segment} = 7.05981 \textit{ sq.in.},$$
$$\textit{Area of parabolic segment} = 6.91178 \textit{ sq.in.}$$

also:

$$\textit{Ratio} \frac{7.05981}{6.91178} = 1.02142$$

The moment of inertia of the parabolic segment $= {}^{16}/_{35} \times \tfrac{1}{3}\, bc^3$.

Substituting in this formula the values given above, we have:

$$^{16}/_{35} \times \tfrac{1}{3} \times 5.95294 \times (1\tfrac{3}{4})^3 = 4.86155 \textit{ in.}^4$$

whence the moment of inertia of the four parabolic segments is

$$4 \times 4.86155 = 19.4462 \textit{ in.}^4$$

and the approximate moment of inertia of the circular rocker section is

$$19.4462 \times 1.02142 = 19.86 \textit{ in.}^4$$

In case the ends of the rocker should be cut off, it is necessary to subtract from the moment of inertia of the remaining figure the moment of inertia of the two end areas which may be considered to be triangles.

FINE AGGREGATE

An Unusual Engineering Term—The Watertown-Newton boundary line and the Brookline-Newton boundary line were perambulated on Aug. 4 by committees representing the town of Watertown and the town of Brookline and a committee representing the city of Newton of which the city engineer was a member.—Report of the City Engineer of Newton.

Field Determination of Bridge Skew—Willis Whited, Bridge Engineer, State Highway Department, Harrisburg, Penn., writes that in reconnoissance work for ordinary highway bridges no great accuracy is required in determining the skew; even a variation of 5° being seldom important. The method of determining this skew, in the field, which Mr. Whited has employed for a number of years, is to take an ordinary 6-ft. rule, hinged about its 3-ft. joint, place one arm in the line of the road and the other arm in the line of the stream; the distance between the two ends is the chord of the angle of skew of the bridge. The following is a table by which the angle can be determined:

Radius equals 36 in.

Chord	Angle	Chord	Angle
18 in.	29° 00′	36 in.	60° 00′
20 in.	32° 20′	38 in.	63 40′
22 in.	35° 40′	40 in.	67° 20′
24 in.	39° 00′	42 in.	71° 20′
26 in.	42° 20′	44 in.	75° 20′
28 in.	45° 40′	46 in.	79° 20′
30 in.	49° 20′	48 in.	83° 40′
32 in.	52° 40′	50 in.	88° 00′
34 in.	56 20′		

Intermediate angles can easily be interpolated.

Motor Trucks and Trailers with self-dumping side-hopper bodies have been found best for roadwork in Leyte Province, Philippine Islands. These dump bodies were designed by the district engineer's office (L. T. Clark, Tacloban, Leyte), and have proved more successful than the self-dumping bodies originally furnished with the trucks and trailers, because the stone can be dumped more quickly and also because the material falls in two rows on either side of the road, thus permitting the traffic to pass between the piles. The ordinary self-dumping body piles the stone in the middle of the road unless much time is taken to back the car so as to dump it on one side. This is often impracticable on account of the narrowness of the road. The new bodies are designed with the floor of sufficient pitch to permit the stone to fall as soon as the sides are unhooked. The whole 7.5-cu.m. load is dumped in about 5 min. Because of adverse climatic and road conditions, few facilities for repairs or of obtaining spare parts, the district engineer considers that these 6-cylinder 60-hp. trucks are too costly, not only from the standpoint of purchase price, but also from that of operation and repair. Also, they and the steel-tired trailers do too much damage to the road. The 4-cylinder 40-hp. truck with rubber tires, however, has proved a success. It hauls more, partly because it does not have to be laid up when it rains, and hauls at a cheaper rate both per kilometer-cubic meter and per kilometer run. A charge of 15c. per km. run in 1915 resulted in saving $897, while with a 6-cylinder truck it has been necessary to make a charge of 30c. per km. run to meet all expenses.—July "Bulletin" of the Bureau of Public Works Philippine Islands.

MOTOR TRUCK AND TRAILER EQUIPPED WITH SIDE-HOPPER SELF-DUMPING BODIES

Artificial Breeze Waves Flag—The spectacle of a flag waving from its staff in a seemingly quiet atmosphere was presented at the recent Atlantic City convention of the American Electric Railway Association. It was a part of the exhibit of the Genera Electric Co., and how i worked is seen from the accompanying sketch. The pole was a tapered tube 2 ft. high, 9 in. in diamete at the bottom and 5 in. a the top. The bottom terminated in an elbow set o the outlet of a 2-hp. motor-driven blower. For 9 ft down from the top of the tube were two rows of ½ in. holes 1½ in. apart and on either side of the flag With the blower going, the jets from these holes kep the flag waving. The blower and pole base were inclosed in a box covering The effect of the flag wa heightened by lighting i from projecting lamps o either side of the hall This would be an effectiv decoration for any larg convention hall or exhibition, and it is not unlikel that it will become a familiar scene at such affairs

FLAG WAVED BY ARTIFICIAL BREEZE

Editorials

Engineering News Prize Offer for Short Articles

The attention of readers is again called to the offer of prizes made in *Engineering News* of Oct. 26 for the best hort articles on four selected engineering subjects in four different fields of engineering work. As was there stated, he sum of $300 is offered in prizes, there being four first prizes of $50 and four second prizes of $25, while articles not receiving a prize but accepted for publication will be paid for at the rate of $10. The four subjects selected are n the fields of road construction, rock drilling, concrete work, and motor truck transportation, all of them fields in which a very large number of engineers are actively at work at the present time and in all of which new developments are constantly appearing.

Letters have been received by *Engineering News* since he announcement of the prize offer inquiring whether rticles written for the competition should describe actual perations at one specific place, or whether articles discussng the subject generally are desired. Since others may have had similar questions in mind, it may be well to say hat either class of article is acceptable for the competition. The decision as to merit will be made regardless of this particular distinction although it would appear that generalizations can hardly be kept down to the minimum of 1,000 words.

One of the motives which has influenced the editors n making this prize offer is to encourage the writing of hort technical articles, describing results of actual experince, by the men who are actually engaged in construction work and who often, through contact with practical problems, obtain information that deserves to go on record or the general benefit of the profession.

There are always available for publication in *Engineerng News* long, elaborate articles which take up a large mount of space and, if accepted, necessitate the crowding out of other matter more condensed in form. There is on he other hand almost always space for prompt publication of the article by a contributor who has something important to say and who can say it in brief, concise form.

We do not mean by this to decry the value of the long and elaborate monograph in technical literature. Such papers have their place; and the funds of the engineering societies are well utilized in printing such papers and making them available to the profession. The technical ournal, however, in order to adequately cover its field, must keep its readers posted on the new developments all he time going on in the various departments of engineerng work and must give preference to the shorter articles which tell the story in a condensed form which the busy engineer will find time to read.

As announced in the offer, the competition will close on Dec. 10. The brevity specified for the articles, none of which are to exceed 1,000 words, makes it easy for engineers who may not have seen the previous announcement of this prize offer to undertake their preparation of articles now and send them in before the competition closes.

Blundering Road Legislation in New Jersey

The voters of New Jersey gave a large majority, at the election of Nov. 7, in favor of approving the Eagan bill, which was enacted by the last legislature and provides a bond issue of $7,000,000 to raise money for state highway improvement. The large majority in favor of the bill is not surprising, for the measure was placed before the voters as practically a panacea for the road troubles from which New Jersey is now suffering, and very few of the voters were aware of the serious defects in the bill. These defects are not at present important, however, for the attorney-general of the state has rendered an opinion that the provisions of the Eagan bill cannot be carried into effect because it specifies certain work to be performed and provides an appropriation far below the estimated cost of the work. On this account the bill is rendered null and void by another statute of New Jersey.

The Eagan bill provides for a $7,000,000 bond issue to build 555 mi. of roads located in various parts of New Jersey. The bill specifies that these roads are to be paved with granite, asphalt or wood block, brick, concrete, bituminous concrete, asphalt "or other pavement having a hard surface and of a durable character"; the width of the pavement is to be at least 18 ft., and the total width of the roadway at least 30 ft.

Dividing $7,000,000 by 555 shows that the permissible expenditure on these roads would be less than $13,000 per mile. With a minimum width of 18 ft., there would be at least 10,560 sq.yd. of paving to be laid per mile; and of the materials specified as permissible for the paving, concrete is the only one that could possibly be brought within this limit of expense, even if the entire sum available were to be expended on the paving alone.

As any engineer with even an elementary knowledge of road building and road reconstruction is aware, there is a great deal of work and expense involved in road reconstruction aside from the paving. Col. Edwin A. Stevens, State Road Commissioner, in a report to Governor Fielder last August, estimated that to build these roads in accordance with the specifications laid down in the law would cost in the neighborhood of $16,000,000.

The voters of New Jersey, in approving the Eagan bill, were doubtless under the impression that they were providing a very large sum of money, sufficient to solve New Jersey's road problem. The investigations of the State Chamber of Commerce, however, show that in 1914 the state with its counties and towns spent over $7,200,000 on road construction and maintenance, and the annual expenditures have materially increased since then. Further, whereas the Eagan bill only provides for the improvement of thirteen specified through routes with an aggregate of 555 miles, there are in the state over 9,000 miles of improved roads, a very large proportion of which are in such bad condition that they need thorough repair.

The one ray of light in the situation is that a state commission was appointed some months ago, as announced in

Engineering News, to study the entire New Jersey road situation and outline the proper policy for the state to adopt. That commission is still to make its report, and it is to be hoped that it may deal with the road question with better understanding than did the framers of the Eagan bill.

⁂

More Evidence of Unreliability of the Stronger Bronzes

Just two years ago, in *Engineering News* of Nov. 26, 1914, there was published a review of the disquieting experiences that the engineers of the Catskill Aqueduct had had with some bolts, rods and other rolled materials of high-strength bronze, such as manganese bronze and tobin bronze. These high-strength bronzes had their origin in a series of researches carried out by the late Dr. R. H. Thurston while he was connected with the Stevens Institute some thirty years ago. They have approximately the strength of soft steel, and because of this high strength and their freedom from corrosion they have been very widely used for a number of years in many fields of engineering construction.

In the large control works in connection with the Catskill Aqueduct construction, extensive use was made of these high-strength bronzes. It was not until some suspicious cracks were found in some of the rolled material that any doubt was entertained as to their reliability. Extensive investigations and tests carried out under direction of A. D. Flinn, Deputy Chief Engineer, following this discovery showed that all classes of rolled material of these bronzes were more or less unreliable, while forgings and castings appeared to be unaffected. The failures of the rolled material were so numerous and extensive as to cause the gravest apprehension. Hundreds of bolts broke at one time or another when under tension, and bolt heads snapped off. New bolts that had never been used or placed under stress and were still in the packing cases in which they were shipped were found cracked and broken. Some ¼-in. flange plates inspected after manufacture and found then in good condition were examined a few months later and showed serious cracking.

Comparatively little has been heard of similar trouble elsewhere with these bronzes, although Mr. Flinn's investigations disclosed that something of the sort had been experienced in Germany and investigations had been made in the Government testing laboratories in Berlin.

The annual report (just issued) of Gen. George W. Goethals, Governor of the Panama Canal, discloses that serious trouble has also been experienced at Panama with the large manganese-bronze bolts used to support the counterweights on the spillway gates. General Goethals says:

> On Oct. 10, 1915, the counterweight of spillway gate No. 13 at Gatun gave way and dropped into its pit, demolishing all weights. This machine had not been operated for several days and was not being operated at the time of the accident. On investigation it was found that all four manganese-bronze counterweight bolts had given way.
>
> Each spillway counterweight consists of 56 cast-iron blocks weighing 750 lb. each, resting on a cast-iron base plate and supported by four 1¾-in. manganese-bronze bolts running into a cast-steel yoke at the top. The total weight of the counterweight is 45,700 lb. and assuming that the load is equally distributed, each bolt supports 11,425 lb., or a stress of 4,750 lb. per sq.in. of metal. Sections of the bolts were sent to the mechanical division for test, which gave an ultimate tensile strength of 61,400 lb. and 63,900 lb. per sq.in., respectively, for the two bolts tested. This would indicate a factor of safety of about 13.
>
> All guard-gate counterweight bolts were examined an instructions given to replace the defective ones with ste bolts. An examination of the Miraflores spillway counte weight bolts resulted in finding two bolts broken off at th head and others with surface cracks, indicating probable fai ure. All counterweight bolts of the spillway-gate machin have been replaced with steel, and bronze bolts are bein replaced with steel wherever failures occur.

Surely if these high-strength bronzes are liable to su failures, engineers need to be on their guard, not on as to the use of these materials in new construction places where their failure might cause disaster, but inspect carefully any structures under their charge whi may contain these materials that may possibly be in condition of incipient failure.

The investigations that were made by the Board Water-Supply Engineers failed to reveal any method inspection or test which would distinguish between bron that was sound and reliable, and material that was on tl point of failure. These failures were not confined eith to any one brand or make of the bronzes examined, indica ing that reliance could not be placed on the methods us by any particular manufacturer.

That the mystery in connection with the inexplicab failure of these materials will eventually be solved ca hardly be doubted. The value to engineers of a materi of such high strength, which is at the same time resista to corrosion, is so great that the facilities of the be research laboratories ought to be devoted to the task solving this problem.

The copper industry has been experiencing such period of phenomenal prosperity and unlimited deman for its product during the past two years that nobody ha cared particularly whether the market for copper in tl form of these strong bronzes was seriously impaired or no Present conditions in the copper industry, however, cann possibly be permanent. Some of the firms that have ma such large profits in the copper business during the pa two years can well afford to appropriate an insignifica percentage of these profits to find out how the stron bronzes can be so manufactured as to be reliable.

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Cost-of-Service Water-Meter Rates to the Front

After several years of committee investigation and co vention discussion, the New England Water-Works Ass ciation has recommended a particular form of metere service rate for general use by water companies an departments. Bills made up in the approved way wi show a fixed service charge depending on the magnitud of the consumers' requirements plus a variable quantit charge depending on the reading of the meter. The adop tion of this standard, studied in connection with th related discussions and reports of the association, is particular interest and import, indicating as it does th apparent acceptance by a large organized group of wate utilities of the idea of a cost-of-service basis for makin rates. A big and important step has been taken—a advance has been made from which retreat is unbelievabl For this progress great credit is due to the New Englan Association's Committee on Meter Rates, under the leade ship of Allen Hazen.

The committee has been honorably discharged, but le no progressive water-works man think that cost-of-servic rates have been actually inaugurated. The present actio is more like a nomination, with the election yet to com The empty shell of cost-of-service rates has been accepted to make the idea a living reality, the figures which are to fit the blank spaces provided must be arrived at by adequate accounting, if the manager is going to do anything more than make the most unscientific division of total expense by number of customers or pumpage. Adequate accounting means standardized accounts, fashioned after the general form adopted for other utilities by a multitude of state regulation commissions which desire o know what each service costs each class of customer. The imposition of such standard accounts would have been forced on the water industry long ago, had there been the same degree of regulation over these municipal departments and companies as is imposed on gas and electric services.

The New England Water-Works Association has done little with standardized accounts beyond appointing a ommittee, but the door to this field has now swung open through the disposition of the rate-schedule puzzle. We may expect to see standardized accounting loom up larger on the association's horizon as its next great task. A peculiar situation arises: The New England Association has accepted the two-part rate basis and has neglected the standardized accounting required to back it up. The American Water-Works Association has probed the depths of the accounting problem, but has paid little attention to the most important end of good bookkeeping—true scientific rates. Which will consummate the development first?

A Suggestion for Making Water Rates

When the New England Water-Works Association at its November meeting adopted the combination of service and meter charges as the recommended basis of metered-service water rates, it also apparently adopted, but only as a pertinent suggestion, a scheme for computing the service charge by adding to a price per 1,000 gal., first 10% of the cost of the meter and service pipes (where the company and not the consumer paid for these), then \$1 per year for meter reading, billing and collecting, and finally \$2 to \$120 for unregistered water.

That was an excellent suggestion—so far as it went. It remained a mere suggestion and did not attain the dignity of a strong recommendation, as it apparently did not meet universal approval. It probably would have been widely applauded and thoroughly promulgated as a part of the adopted two-part rate scheme if it had been only a little broader. It evidently failed to meet all conditions of water-works operation, and it obviously was a particular case of a broader and more general statement that can be made. We venture to make that generalization here and urge that something like it be mentally attached to the two-part scheme:

Compute the service charge by adding to a price per 1,000 gal. or 100 cu.ft., first $X\%$ on the cost of the meter and service pipes where owned by the company, then $Y\%$ on the cost of equipment required to meet the peak-load demand of the customer, then $\$Z$ for meter reading, billing and collecting, and finally $\$A$ to $\$B$ for unregistered water.

The reasons for such a suggested procedure need little exposition. There are two kinds of water-works: (1) The product-dispensing type, which pumps at a small steady rate, or collects as nature furnishes, and delivers out of adequate storage at varying rates; (2) the service type, which maintains pump pressure all the time and has power apparatus enough to meet its peak-load demands. For the first type of water company the $Y\%$ mentioned above becomes insignificant—even disappears, for the peak-load equipment consists only of a possible addition to diameter of mains, and even this may be absorbed in the provisions for fire protection.

Paying attention to the Y percentage in the case of the service type of water-works automatically clears away much of the worry about manufacturers' rates. If an industrial customer does not draw during peak-load hours, Y may disappear so that an attractive rate can be made to him that will still render a respectable profit to the water-works—or, where profits are not sought, at least make a more continuous use of plant and increase the spread of investment charges. This would be a development parallel to the success of electric central stations in building up off-peak commercial loads.

It would be superfluous to attempt here any more detailed application of the suggested scheme. Suffice it to say that it is not an original or a novel or an untried experiment—it is a scheme broadly applied in public-utility fields today and universally satisfactory to customer and utility alike.

Engineers and Federal Water-Power Legislation

If Congress before the close of the coming short session passes legislation, in a form sufficiently favorable, there will probably be constructed in the next three to five years water-power development amounting to between one and two million horsepower on navigable rivers and on power sites in the far West. This work is of great importance to American engineers engaged in water-power engineering, to other engineers engaged in the manufacture of water power and electric machinery, and to still other engineers engaged in work in which this vast amount of power will be utilized. The extent to which the interests of engineers are dependent on this legislation ought to be understood by all members of the profession, as well as by those whose bread and butter is at stake.

There is no dissent whatever from the proposition that it is very greatly in the public interest that this water-power development shall take place. So far as this source of power is to be utilized to replace power developed by the burning of coal, it operates to lessen the draft on our coal resources and to conserve a gift of nature which once used up can never be replaced. So far as this power is applied to new uses, it will aid in developing new industries, and particularly the chemical industry, whose importance to the national welfare has come to be understood during the past two years as never before.

Everyone knows that Congress was unable at its last session to reach an agreement upon the terms of the bills proposed for enactment to permit this water-power development to go forward. It has been announced that these bills are among the measures which will be taken up and pushed for passage at the coming short session; but the scanty time available, aside from that necessary for the regular appropriation bills, makes their passage extremely doubtful unless strong pressure is brought to bear upon Congressmen so that they may understand the extent to which this legislation is supported by public opinion.

Unless Congress does enact Federal water-power laws at this session, it will probably be years before any such legislation will be possible. The new Congress will not assemble till a year hence. When it does meet its complexion will be so evenly divided politically that there will be little probability of any bill being passed to which there is any considerable opposition. It is always vastly easier to defeat a bill than to secure its passage, even when majorities are not so thin.

There has been a widespread expression of opinion on the part of engineers during the past few years that the profession should take a greater part in public affairs and especially in those where technical matters are involved and in which the interests of the profession and the public are at stake. Many have urged in the strongest terms that the engineering societies should take action to further legislation of importance to the profession.

No better opportunity could be found for the engineering profession to transform words into deeds than the present. While the individual engineer is as a rule powerless to do anything, except where he may happen to have a personal acquaintance with some member of Congress, there is no doubt whatever that proper representation by the engineering societies at Washington, if the work is done in the right way, may have an important influence in securing properly framed legislation.

The national engineering societies are already moving in the matter. The American Institute of Electrical Engineers has for years had a standing committee on water-power legislation, which has repeatedly visited Washington and appeared before Congressional committees. The American Society of Civil Engineers has recently appointed a similar committee with authority, we are informed, to go to Washington and spend whatever time is necessary there to secure results. It may reasonably be expected that the other national engineering societies, many of whose members have interests at stake quite as great as the members of the Civil and Electrical Engineers, will likewise appoint similar committees.

There is no doubt that such committees will welcome the aid by formal resolutions or otherwise, of state and local engineering societies which may not be able to send delegates to appear before Congressional committees. The more nearly those who go to Washington on this errand impress upon Congress that they represent the united voice of the engineering profession, the more likely will be their success.

We need not take space at this time to discuss in detail the provisions of the pending bills and the arguments that have been made in opposition to them. The thing that should be clearly understood is that the ground of the opposition is not that legislation which will permit water power development is undesirable, but that the legislation now framed gives greater privileges to those who undertake water-power development than are necessary in order to secure the investment of capital. On this matter the unbiased judgment of independent experts should be helpful to a wise solution.

It ought to be more generally understood that in the Federal water-power bills now pending the Government parts with no perpetual franchise, but only grants a 50-year lease. The detailed conditions of this lease are a fair subject for argument, and opinions may reasonably differ. It is certain, however, that the legislation as finally enacted must lay down conditions sufficiently attractive to induce the investment of capital, or it will wholly fail of its purpose.

It must not be overlooked in this connection that with all the nations of the world bidding for the money of American investors, opportunities are open to them to earn a high rate of interest by the purchase of foreign bond issues. The promoter of a water-power enterprise who competes for capital in the investment market must have something substantial that will combine reasonable safety and opportunities for good profits or the so-called public water-power sites will continue unimproved.

Letters to the Editor

Queens Incinerator Tests

Sir—In your issue of Sept. 28, 1916, there appeared an article on the refuse incinerator for Queens Borough, New York City, by J. C. Woodman, of the Decarie Incinerator Co. In so far as this article is an expression of the personal views or opinions of Mr. Woodman, no criticism is offered; but when he presents certain tabulated results of the incinerator tests as the official statement of the committee that supervised the tests, he is misstating the facts. The committee in question, of which the writer was a member, did not as a whole tabulate the results of the tests in its report. Each member of the committee secured his own data, and since these complied with the requirements of the guarantee, signed a report to the architect which reads in part as follows:

> That thereafter, on May 8, 1916, one unit of the said incinerator digested 50 tons of refuse and garbage of the proper proportions within the contract period and at costs within the guarantees. On May 10, 1916, the second unit of the incinerator disposed of 50 tons of garbage and refuse within the contract time and at costs less than those specified in the agreement. On May 15, 1916, both units of said incinerator were operated and consumed 100 tons of garbage and refuse within the contract period and within costs of those provided in the agreement.
>
> We therefore certify to you that the said incinerator and appurtenances meet the requirements of the guarantees provided in the said contract and the said supplemental agreement.

Inasmuch as the tabulated results set forth in Mr. Woodman's article differ considerably from those obtained by a majority of the committee, objection is made to the statement that the results shown in said article are the official expression of the committee as a whole.

CHANDLER WITHINGTON,
Chief Engineer.
Department of Finance, New York City.
New York City, Oct. 9, 1916.

[Proof of Mr. Withington's letter was submitted to Mr. Woodman. The comments of the latter follow.—Editor.]

Sir—When I prepared my article on the Queens Borough incinerator, I knew that no tabulated results were included in the official report of the committee named by

Mr. Withington. I did not intend to convey the idea that the results as tabulated by myself from observations taken by myself were those obtained by the different members of the committee.

In saying that these were "results of the official test made under supervision of a committee of the Board of Estimate of New York City" I meant that these were results obtained while they were present and not necessarily the results that the committee embodied in its report.

I wish to add that, so far as the results go, I am prepared to operate this plant under the conditions stated in the guarantees, at any time, and can produce results as good if not better than those tabulated in my article.

J. C. Woodman,
Supt. of Construction, Decarie Incinerator Co.
New Orleans, La., Nov. 3, 1916.

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Should Engineers Take Part in Politics?

Sir—About ten days before the presidential election, the writer received by the same mail two communications that caused a considerable shock to his professional sensibilities. One of these communications was an appeal signed by 13 prominent members of the American Society of Civil Engineers in New York, urging the writer to join a politico-engineering club and contribute $10 thereto, to promote the election of Judge Hughes as President of the United States. The other was a similar appeal from a prominent member of the society in Chicago, in the interest of President Wilson's candidacy.

Up to this time the engineering profession, as such, has held itself aloof from the mad and brutal scramble for political "loaves and fishes" that has been going on all over the country, occupying a more exalted plane and looking with dignified "neutrality" upon the activities of partisan politics. The great "American Society" in especial, was regarded by the writer as a serene haven of peace and purity from the polluting influence of politics and politicians. I have often used this expression in talking to younger engineers, that there can be no such thing as a political engineer, because when an engineer becomes a politician he ceases *ipse facto* to be an engineer.

Clarksdale, Miss., Nov. 11, 1916. T. G. Dabney.

[To avoid possible misunderstanding, it may be well to emphasize that the engineering society named did not as a society take any part in political activity. Any action by members of the society of the sort mentioned, must have been taken as individuals.—Editor.]

⁂

Is Passing Examinations To Be the Chief End of Man?

Sir—I understand that the Civil Service Commission of an important city has announced an examination of candidates for appointment as Civil Service Examiner in Mechanical Engineering. A few years hence we shall doubtless hear of examinations to test the qualifications of the candidates who are to examine the examiners! No doubt the civil service laws have been of enormous benefit in replacing appointment for political pull with appointment for capacity and ability; but the best friends of the civil service system are those who clearly recognize the limitations to its useful application. C. S. Merit.

Early Asphalt Pavements

Sir—In connection with the early use of asphalt in the construction of pavements, referred to in *Engineering News*, Sept. 7, p. 434, I think that you are mistaken in inferring that any asphalt pavements of the modern type were constructed before DeSmedt's experiments in the seventies of the last century.

All the earlier pavements were of an asphaltic mastic composition; that is to say, a material in which the amount of bitumen present was greater than that which was sufficient to coat the particles and more than enough to fill the voids of the aggregate.

This is evident from the descriptions of the use of asphalt in pavements given in Halleck's publication on "Bitumen," 1841, in which it is stated:

> They mixed together the mineral tar and sand; second, mineral tar and lime, slacked by immersion; third, mineral tar, sand and lime.

From the context it is evident that the reference here is to a type of mastic and not to a sand mixture such as was devised by DeSmedt in attempting to lay a pavement that should be a substitute for the rock-asphalt pavements of continental Europe. Clifford Richardson.

New York City, Oct. 25, 1916.

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Some Heavy Rainfall

Sir—The very remarkable precipitation at Altapass, N. C., July 15-16, reported (*Engineering News*, Nov. 9, 1916) by Prof. Alfred J. Henry as 22 in. in 24 hr., if correctly stated, is believed to surpass previous records for the United States by a wide margin and perhaps lends color to a severe downpour that was reported by the Maryland Climate and Crop Service as occurring July 26-27, 1897. Although, as I recollect, no rain gage was available, the evidence indicated a precipitation in this storm of 14.75 in. in 18 hr. To confirm the report a special inquiry was made by the Climate and Crop Service, and the result was published by the United States Weather Bureau in December of that year. Heavier downpours are, however, on record:

Place	Date	Inches	Period
Nedunkem, Ceylon	Dec. 15-16, 1897	31 76	24 hr.
Genoa, Italy	Encyclopedia Britannica.	30 0	26 hr.
Gibraltar	Encyclopedia Britannica.	33 0	26 hr.
Hills above Bombay, India	Encyclopedia Britannica.	24 0	One night
Khasia Hills, India	Encyclopedia Britannica.	30 0	Each of 5 days
Lampehoehoe, Hawaii	Dec. 24, 1901	41 3	28 hr.
Mayport, Fla.	Sept. 29, 1882	13 7	24 hr.
Newtown, Penn	Aug. 5, 1843	13 0	3 hr.
Concord, Penn	Aug. 5, 1843	16 0	3 hr.
Bear Valley Dam	Feb. 26-27, 1891	17 0	24 hr.
Sherbrook, New South Wales	Jan. 13, 1911	13 57	1 day
Galveston, Tex	Oct. 22, 1913	12 19	12 hr
Galveston, Tex	July 13-14, 1900	14 35	24 hr.
Galveston, Tex	July 7-8, 1901	14 1	24 hr.

Kenneth Allen,
Engineer of Sewage Disposal.
Municipal Building, New York City, Nov. 13, 1916.

NOTES AND QUERIES

"What Solution Is Used To Make White Marks on Van Dyke Negatives?" is asked by a correspondent. "Is a lacquer or varnish applied after the solution?"

Railway Valuation Reports—In publishing the abstract of the Government valuation report on the Atlanta, Birmingham & Atlantic Railroad Co., it was stated that the company was in a receiver's hands, which was true at the time the valuation was made up as of June 30, 1914 Since that time the company has been reorganized as the Atlanta, Birmingham & Atlantic Railway Co Through an error in the report as furnished, it was stated that the railway is narrow-gage. The road has always been standard gage.

Slab-Deck Concrete Railway Bridge Over Highway

SYNOPSIS—This bridge has a deck of self-supporting slab spans, the longer spans of which have I-beam reinforcement. Special construction is involved to carry a station platform extending across the bridge.

The type of bridge consisting of concrete bents carrying precast concrete deck slabs, which has been used so extensively on track-elevation work, is being employed by the Rock Island Lines for crossings over country highways. The purpose is to avoid the maintenance work required for steel bridges and open timber decks. These concrete bridges are being built particularly where old plate-girder bridges have to be renewed. The accompanying plans represent a typical structure of this class. It provides for a roadway and two sidewalks, as the road in this case is near a town and forms an approach to the railway station. Fig. 1 shows the general design.

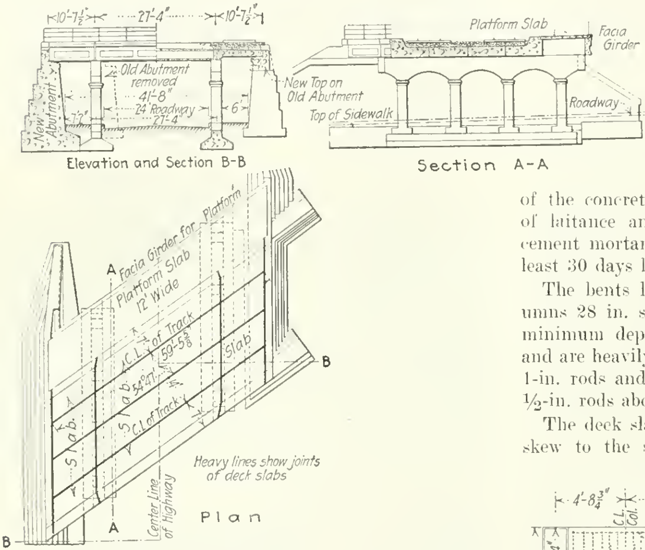


FIG. 1. CONCRETE SLAB-DECK BRIDGE CARRYING TRACKS AND STATION PLATFORM; ROCK ISLAND LINES

The old bridge was a deck plate-girder structure of about 35-ft. span. One abutment is retained (with necessary alterations to the top). The other is to be removed to make way for an additional sidewalk. Inside of each curb line is a concrete bent consisting of four rectangular columns on a continuous footing wall and supporting a cap girder whose lower surface is arched between the columns and at its cantilever ends. The construction and reinforcement of the bents are shown in Fig. 2.

Four lines of slabs form the deck, the slabs of the outer rows having curb walls to retain the ballast. A special feature in this case is that on one side of the bridge an extension of the station platform is provided by a 6-in. slab that is supported on the adjacent track slab and an outer fascia girder, as shown in the cross-section, Fig. 1.

The new abutment is of gravity section, with a stepped back. The face has a batter of 1 in 12 and has a projecting toe beneath the sidewalk. This abutment is about 100 ft. long and is divided by three vertical expansion joints. The sections are keyed together in the joints by a groove 4 in. deep, 8 in. wide on the outer face and 4 in. wide at the bottom.

The concrete is 1 : 3 : 5 for the body of the abutment and 1 : 2 : 4 for the bridge seat, coping and back wall. The specifications provide that horizontal joints are to be avoided. If it becomes necessary to stop work before completing the section to full height, vertical dowels must be set at the seam in sufficient number to prevent horizontal movement. When work is resumed, the surface of the concrete must be roughened, thoroughly cleaned of laitance and foreign matter and slushed with 1:2 cement mortar. The concrete must be allowed to set at least 30 days before the deck slabs are placed.

The bents have footing walls 7½ ft. wide, with columns 28 in. square and cap girders 28 in. wide with a minimum depth of 3 ft. They are of 1 : 2 : 4 concrete and are heavily reinforced. The columns have 16 vertical 1-in. rods and 1-in. dowels to the footings, with ties of ½-in. rods about 16 in. apart.

The deck slabs are arranged parallel to the tracks and skew to the supports, with longitudinal joints on the center lines of the tracks, as shown in the plan. They are in four rows, the two outer rows having curb wall to retain the ballast. The outer slabs on one side have paneled face, but the paneling is omitted on the other side, as this slab is concealed by the fascia girder carrying the station platform.

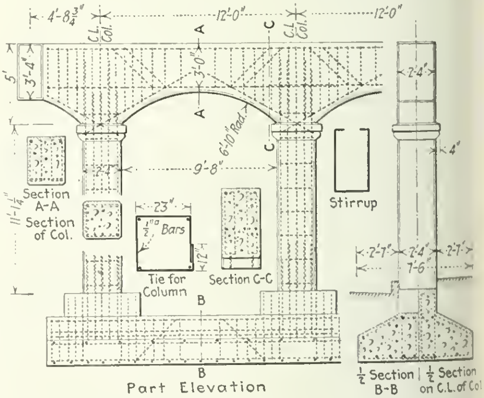
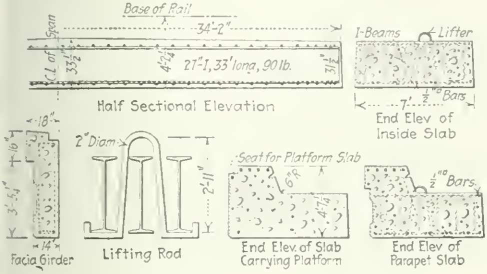


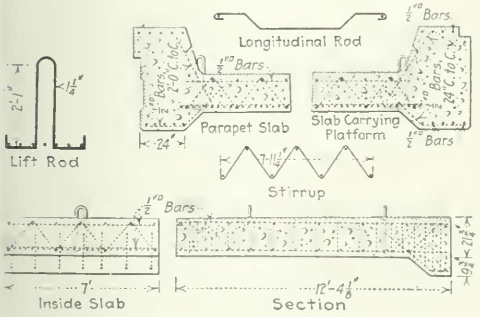
FIG. 2. DETAILS OF CONCRETE BENT

The slabs for the roadway span are 7 ft. wide, 33½ in. deep at the middle and 31½ in. at the ends, with the facing sides slightly inclined inward. The depth over the curb wall is 55¼ in. These roadway slabs (Fig. 3) are really concrete-filled I-beam spans, since the main structural feature is not the concrete, but a set of 27-in. I-beams, 33 ft. long, spaced 18 in. c. to c. They are thoroughly cleaned of paint, oil and rust before being set in the form. There are transverse bars at top and bottom, and longitudinal rods are laid between the bottom flanges of the I-beams. For handling, each slab has a 2-in. lifting rod; this straddles one I-beam and has the legs bent to fit under the adjacent beams. After the slabs have been set, the tops of the lifting rods will be cut off with hacksaws, so as not to obstruct the waterproofing.

The slabs for the sidewalk spans (Fig. 3) are similar, but without the I-beams. They are 20¼ in. thick at the abutment end, with a rib across the other end to bring the top level with the deeper roadway slabs. The reinforcement consists of longitudinal and transverse rods at top and bottom and transverse stirrups bent in V-shape to fit over and under the top and bottom bars respectively. The lifting rods have long bottom flanges extending under the lower reinforcing rods.



SLABS FOR ROADWAY SPAN



SLABS FOR SIDEWALK SPANS

FIG. 3. DETAILS OF DECK SLABS

The concrete for all slabs is 1 : 2 : 4 and must be allowed to set for at least 60 days before the slabs are moved into place. Immediately before placing them in final position the bridge seats and tops of bents must be cleaned, wetted and covered with 1 in. of cement mortar. The fascia girder that carries the outer side of the station platform is built as a continuous girder over the three spans, its total length being 59½ ft. It is 57¼ in. deep and 11 in. thick, with a coping and panels on the outer face, while the top is recessed to form a seat for the platform slab, as shown in Fig. 3. The concrete is 1 : 2 : 4. The steel reinforcement consists of horizontal bars at top and bottom, with incline shear bars near the supporting bents and with closed rectangular stirrups. All bars are wired at the intersections. The shear bars are spliced to the horizontal bottom bars, the splices being 3 ft. long and wrapped for the entire length with No. 16 wire. Upon the girder is a gas-pipe hand railing.

The platform slab (like the fascia girder) is in one piece over the entire length of the structure; its length is about 60 ft., supported by the abutments and bents, and its sides are supported on the deck slab and fascia girder. It is 8 ft. 2 in. wide and 6 in. thick, reinforced with longitudinal and transverse rods in the bottom. It contains about 10.3 cu.yd. of concrete and 860 lb. of steel. This slab will be cast in place and will be secured by dowel rods in the tops of the abutments and the fascia girder.

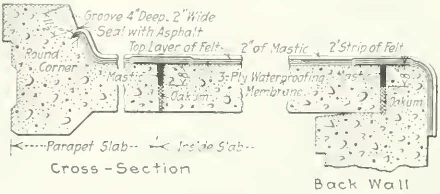


FIG. 4. WATERPROOFING FOR SLAB-DECK BRIDGE

Special attention has been given to the waterproofing of the deck, and the arrangement is shown in Fig. 4. The tapered longitudinal openings between the slabs and the openings between the ends of the deck and the back wall are filled for half their depth with oakum, well hammered down, and then with mastic to the level of the top. Over these joints are laid 24-in. strips of felt or saturated burlap. The concrete surface (clean and dry) is then mopped with an asphaltic priming coat, upon which is laid a membrane of three-ply saturated burlap or felt fabric, each layer being mopped with a waterproofing compound. A second layer of felt or burlap is placed upon this and covered with a 2-in. surface coat of mastic. This forms the finished surface upon which the ballast is laid. At the sides the waterproofing course is carried up the curb wall and is secured in a groove provided for the purpose, being sealed in place with hot asphalt.

This structure, which is a rather new development in railway bridges over country roads, was designed by I. L. Simmons, Bridge Engineer, under the direction of C. A. Morse, Chief Engineer of the Rock Island Lines.

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Canadian Water-Power Resources—According to information furnished by officials of the water-power branch of the Canadian Department of the Interior to the Dominion's Resources Commission, Canada has electric power developed to a total extent of 1,712,193 hp. The developed power of the various provinces is as follows Nova Scotia, 21,412 hp.; New Brunswick, 13,390; Prince Edward Island, 500 Quebec, 520,000; Ontario, 789,466; Manitoba, 56,730, Saskatchewan, 45; Alberta, 33,305, British Columbia, 265,345, Yukon, 12,000. It is estimated that, exclusive of the northern territories, a large part of the Yukon and the northern and eastern portions of Quebec, there is 17,746,000 hp. available for development—8,000,000 hp. of which is in range of present markets and likely to be in use in the course of 15 years

Panama Canal Annual Report

The annual report just issued by the Governor of the Panama Canal, Gen. George W. Goethals, shows that the total cost of the canal's construction to June 30, 1916, has been $364,118,000. The total appropriations by Congress for the canal, its fortifications, etc., aggregate $415,985,000, but out of this amount over $19,000,000 was for fortifications and over $17,000,000 for the operation and maintenance of the canal since it was opened in 1914. Other appropriations for colliers to bring coal to the canal, etc., make the total of deductions from the total Congressional appropriation sufficient to bring the final construction cost to the amount above stated.

From this total cost of $364,000,000 for construction, however, there should further be deducted material and equipment transferred by the canal to the Alaskan Engineering Commission and the State Department, valued at $7,155,000, and the payments made and to be made by Panama for municipal work done for the cities of Panama and Colon. There is also a considerable amount of other construction material that will eventually be sold. Taking all these into account, it would not be far out of the way probably to say that the total cost to the United States of building the Panama Canal has been $350,000,000.

It is of interest to note here that the engineers' estimate of total cost made in 1908 was $375,201,000. The work has been carried out at unit prices so much below those used in the estimate of 1908 that the sum above noted as the total cost of the canal has included the cost of a number of other important works not included in the estimate of 1908, namely, a 1,000-ft. dry dock, two coaling stations, terminal piers and wharves, hospital buildings at Colon and Ancon, while claims for injuries and deaths of employees amounting to $1,340,000 have been paid, which were not provided for in the 1908 estimate.

It is further of interest to recall in this connection that, according to the figures given in General Goethals' paper at the International Engineering Congress, the cost of construction alone for the Panama Canal was only about $210,000,000, including all expenses up to June 30, 1914. The principal items that swelled the total cost to the $350,000,000 above stated were $17,000,000 for sanitation, $7,000,000 for the government of the Canal Zone, $50,000,000 to the French canal company and the Republic of Panama, $10,000,000 for buildings in the zone, and about $16,000,000 for the Panama railroad and its steamship line.

1,000-Ft. Dry Dock

The new dry dock completed during the year contains 12,897 cu.yd. of mass concrete and 17,757 cu.yd. of reinforced concrete. The average cost of the mass concrete was $5.59 per cu.yd., and of the reinforced concrete $7.73 per cu.yd. The miter sill and quoin posts of the dock are of granite blocks. Great care was used in placing and dressing these blocks to true surfaces, special steel templets being prepared for the purpose. When completed, the maximum variation of the granite sills from a true plane was $\frac{1}{32}$ in. The granite blocks amounted to 425 cu.yd., and the total cost of the completed granite work was $847.87 per cu.yd. The miter gates of the dry dock are of the same design as those used in the canal locks and were built by the same contractors, the McClintic-Marshall Construction Co., of Pittsburgh. The miter posts and the quoin posts of the gates are of greenheart timber from British Guiana. The cost of the gate leaves, exclusive of the greenheart, was $98.92 per ton.

Four pontoons, to be used as small boat landings, were built of reinforced concrete on the floor of the dry dock. These pontoons are each 120 ft. 6 in. long, 28 ft. 2 in. wide and 7 ft. 10 in. deep. They are designed to float with a 3-ft. freeboard. The entire bottom, sides, interior bulkheads and frame up to a height of 6 ft. were cast in one continuous pour. After the forms were stripped, the sides of the pontoons were waterproofed by the Sylvester process. The four pontoons complete with all accessories cost $44,111.

Concrete Blocks for East Breakwater

A breakwater has been built in the bay opposite Colon to protect shipping from the heavy waves created by the trade winds. It is 6,741 ft. in length and is built of rock dumped from a double trestle, the rock in the core being protected from wave action by large blocks of armor rock placed on the slope. This armor rock was quarried at Sosa Hill, on the Pacific side. After excavating from this quarry for some time it was found that the amount of rock it would be necessary to excavate to secure a sufficient amount of large blocks was so large that it was determined to protect the slopes of the breakwater by cast concrete blocks. A contract was let for the manufacture of cubical blocks, 7 ft. on a side, weighing about 50,000 lb., at 38½c. per cu.yd. About 6,700 blocks were delivered under this contract, and in addition the manufacture of blocks was undertaken by hired labor, 7,700 blocks being built in this way of a mixture of run-of-bank gravel and cement 4½ : 1, at a cost of $3.68 to $4 per cu.yd.

Buildings on the Isthmus

The first concrete buildings erected on the Isthmus were of hollow cast concrete blocks. These were cheaper than hollow tile, and it was believed that solid concrete walls would be too damp for the Panama climate. It was found however, that after the hollow-block wall had received a coat of stucco on the outside and plaster on the inside, it was more expensive than poured reinforced concrete Buildings are now erected of reinforced concrete for main walls and floors, with blocks for interior partitions only To save the expense of white plaster, the interior of all concrete buildings is now finished in cement, the surface being treated mechanically and painted in suitable colors

The use of corrugated iron for roofs of buildings has been standard on the Isthmus from the beginning of canal operations. While satisfactory for temporary buildings the rapid deterioration and necessary expense for frequent painting, with its unsightly character, make it undesirable for permanent buildings. After experiments with various kinds of roofing material, red asphalt shingles were adopted as the most satisfactory roof covering for frame buildings.

Electric-Power Station and Water-Supply

The hydro-electric power station at Gatun produced current during the year at an average cost of 0.6 mill per kw.-hr., including all operation, maintenance and repair costs and division overhead charges, but not including depreciation. When a 3% charge on the capital cost of the entire power system for depreciation is added, the cost of the power generated at the hydro-electric station was 2.7 mills per kw.-hr. When distributed from substations, including all charges, the cost of the current used for power was 7.7 mills per kw.-hr. The cost for lighting ervice, including the maintenance of house-lighting systems and lamp renewals, was 1.15c. per kw.-hr.

The estimated normal yield of the Gatun Lake waterhed during the dry season from January to April nclusive is 2,160 sec.-ft. The actual yield in the months of January to April, 1916, was 2,200 sec.-ft. There was discharged during January over the Gatun pillway over two billion cubic feet of water, which would have been sufficient to provide for about 330 lockages in ddition to those actually made during the dry season. Experience in the operation of the locks shows that the maximum number of lockages that could be made in 24 hr. is 48, assuming that both chambers are used and that one essel leaves the upper flight at Gatun just as another nters the lower chamber.

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Corrosion of Submerged Metal at the Panama Locks

Although the Panama Canal was completed less than hree years ago, the annual report of General Goethals, Governor of the Canal, reveals that parts of the lock mahinery have suffered seriously from corrosion, and exensive renewals have already been necessary.

A year ago, in *Engineering News* of Sept. 9, 1915, here was described the destruction of the half-million dollar yacht "Sea Call," within a few months of its completion, as the result of galvanic action between the Monel metal plates of its hull and its steel frames and fittings. Corrosion caused by electrolytic action between dissimilar metals in the valves controlling the lock water supply ppears to have been an important factor in the difficulties at Panama.

The paints originally applied to the exterior of the gates also prove to have been short-lived and its replacement with Bitumastic Enamel has been necessary. We quote from General Goethals' report as follows:

> At the time the water was let into the locks all the ates had been painted and put in first-class condition. The nteriors of the gates were coated with Bitumastic Enamel under a five-year guarantee, and the exteriors covered with various kinds of submarine paints.
>
> When the floating caisson arrived in December, 1914, it was nstalled at the lower east lock at Miraflores and the chamber pumped out, permitting an examination of the gates, valves, and fixed irons. At that time they were found to be in good condition, although there was some rusting of the plates and rivets. In January, 1915, the west chamber at Miraflores was pumped out after being submerged about 15 months. The paint on the gates was blistering badly, and from experience gained from various paints applied at other ock gates it was decided that something must be adopted hat would give better protection than anything in the paint line that had yet been used.
>
> Difficulty had been experienced with paints applied to the spillway gates at Gatun, and because of the condition of the nterior of the gates on which Bitumastic Enamel had been used it was decided to test out the use of this material on one of the spillway gates. It appeared to give adequate protection; and as the contractor guaranteed the effectiveness of this material for five years, a contract was entered into for coating all of the lock gates with Bitumastic Enamel. The gates at Gatun were coated and the work finished.
>
> Due to the condition of the pumps in the caisson, the impeller blades of cast iron being entirely eaten away, work on the Pacific side was not completed.
>
> ### CORROSION OF CYLINDRICAL VALVE PARTS
>
> Observations during the past year disclosed that the corrosive action on the cylindrical valves has been severe. In July, 1915, the west flight of Gatun Locks was drained, and all the accessible cylindrical valves were examined. Marked corrosion was taking place on certain parts of the valves, although the entire valve was made of cast iron or steel, no bronze parts being adopted in the original design. In the lower level an average of 75% of the seal segment nuts were corroded, in some cases fully half the nut had disappeared
>
> It was also found that the bolts holding the stops in place were in such condition that they had to be replaced in every valve in the lower level. All valves were put in good condition and painted with red lead.
>
> On the Pacific locks no examination was made of the valves at Pedro Miguel or those on the west side of the Miraflores center wall, but the east valves at this site were found to be in good condition; however, as all painted surfaces of the valves had failed, it was decided to coat all exposed iron and steel surfaces with Enamel, and a contract was entered into for doing this work.
>
> ### CORROSION IN THE RISING-STEM VALVES
>
> Considerable corrosion has taken place in the rising-stem valves. The half-inch plates have been attacked in a manner similar to those on the lock gates, and portions in the vicinity of the rivets in the lower valves at Gatun and the upper and lower valves at Miraflores have been violently attacked. The bottom seal casting of the valve which comes in contact with the babbitt-metal seal on the bottom of the valve is being rapidly eaten away. A number of the valves at the Pacific locks were in such condition that the bottom seal had to be machined off to make the valve tight.
>
> In order to protect the valve from any further electrolytic action between the cast-steel seal and the lower babbitt-metal seal, all babbitt-metal was removed and replaced with a seal of greenheart lumber. Some of the bronze side-seals and springs were found to be broken both at Miraflores and Gatun. Otherwise the seals were in good condition and required only a small amount of draw-filing to make the contact surfaces perfect. The top gate-valve seal is of cast steel and is held in place by bronze bolts. In practically every instance the corrosion has been excessive around the heads of the bronze bolts, cutting away the metal and in some cases allowing the bolts to loosen and fall out. Several castings had to be replaced. The worst case of corrosion of the seal occurred on the upper valves at Miraflores.
>
> At Gatun practically all valves were installed with fixed side-seal castings, which all gave evidence of considerable corrosion, but not sufficient to cause any leaks. At Miraflores removable side-seal strips were of machinery steel, and in every case corrosion had reached such a point that all side-seals had to be replaced. Inasmuch as the corrosion had apparently been aided by the proximity of the bronze side-seals which bear upon them, it was decided to replace all machinery steel with lignum-vitæ wood, in this way tending to place an insulating substance in contact with the bronze. All porous concrete around the fixed irons was removed and replaced with cement, and wherever babbitt-metal had been used to fill the recessed holes for bolt-heads at the Pacific locks the metal was removed and replaced with cement.
>
> ### CORROSION OF ROLLER TRAINS
>
> At both the Atlantic and Pacific locks considerable corrosion of roller trains has occurred, the rollers of which are made of tool steel. At the Atlantic locks a number of rollers, bolts, and filler castings were missing. All were replaced, and the heads of all bolts were riveted over to prevent further losses. Similar conditions were found at the Pacific locks, and as it is impossible to protect the rollers by any paint, arrangements were made to install one-half inch pipes from the tunnel floors down to the base of the roller-train tracks. Crude oil is forced through the pipes, and it is believed from the results of experiments made with a model that the crude oil will rise along the surface of the roller-train track and in this way protect the rollers by coating them with oil.
>
> As a result of the examination of the valves at Gatun it was decided to have them coated with Bitumastic Enamel. At the Pacific locks more complete protective measures were taken, as follows: (1) All bronze side-seals were lined up and strips of zinc bolted to the valve each side of the seals at the bottom of the valve; (2) where necessary, the bottom-valve seal was machined off to give solid metal contact with the bottom seal; (3) all removable side-seal strips were taken out and replaced with lignum-vitæ wood strips. Where removable strips were not installed, the fixed irons were milled down to take the wooden side-seals, (4) all babbitt metal used in the assembly of the valve for embedding and protecting bolt heads from corrosion and for calking purposes was removed and replaced with cement; (5) all babbitt-metal used in the bottom seal was removed and replaced with greenheart lumber; (6) all steel work of the valve was coated with Bitumastic Enamel This left only the bronze side-seals exposed; (7) all fixed irons were coated with Bitumastic Enamel; (8) the channel-iron supports for the rollers were coated with Bitumastic Enamel and arrangements made to lubricate the roller trains and tracks with crude oil during operation and while the valves are submerged; (9) all submerged portions of the valve stems were coated with Bitumastic Enamel, (10) all bronze bolts are being replaced with steel as fast as breakage occurs.

Horse or Motor for Collecting City Garbage

By B. F. Miller, Jr.*

In this age of the motor, when almost every day develops some new use for its power, one might quite naturally imagine that in the collection of municipal garbage and refuse the sooner the horse-drawn vehicles were discarded the better. An investigation of this subject in 125 American cities discloses the fact that there is still much to be said in favor of the horse, especially for garbage collection.

The writer here submits the arguments pro and con, received in response to a circular letter sent to 225 American cities, from which about 125 replies were received. It will be noticed that comparatively few cost data are given, due primarily to the fact that so few cities have used motor apparatus (105 are still using horse-drawn apparatus), or that some of them have not used it long enough to have compiled any data of value. The replies showed:

1. A growing tendency toward placing garbage collection under the active supervision of departments of public works, as opposed to supervision by health boards.

2. A decided sentiment in favor of municipal collection instead of the prevailing contract system.

3. An awakened interest in the serious study of garbage collection and disposal, as for example, the excellent report of I. S. Osborn on the collection and disposal of garbage for the District of Columbia.

Briefly summarized from the replies, the principal arguments for the use of motor-driven vehicles for garbage collection are as follows:

1. Where the garbage can be delivered to a central unloading station and then taken from this point to the disposal plant with motor vehicles, there is no doubt much economy in the use of the motor. However, the practicability of a central station is somewhat doubtful. It would, to be of advantage, have to be located in a somewhat populous district, and several cities, notably Seattle, that have tried this plan have discarded it because of the serious objections of people living in the neighborhood of the central station. If some means of eliminating the objectionable odors at the central station were devised, possibly it might become practicable. Of course, with such a station the hauls of the horse-drawn wagons would be shortened, and much time would be saved in not having the collectors make the trip to the disposal plant.

2. Los Angeles reports that motors in residence districts are advantageous over teams because collections can be made more regularly and that motor collection is at least as cheap as horse collection under similar conditions.

Los Angeles is using two 2½-ton trucks for garbage collection in its residence district. The first collection is 8 mi. from the reduction plant. The cost of collection and delivery to the plant by motor is $2.75 to $3 per ton; by team it is $2.37. The trucks are operated by one driver and two collectors and make two loads per day. Each truck travels from 20 to 40 mi. per load collected and works 8 hr. per day. In the same district a team of three horses and driver made one load per day, wagons hauling 2½ to 3 tons per load and trucks 2½ to 3½ tons. The cost given above includes maintenance, depreciation and interest. The cost data for horses included depreciation for stock, but no account was taken o extraordinary wear on stock due to long hauls.

3. Pasadena reports using a 7-yd. truck, costing $2,450, for refuse collection. The life of the truck is 5 yr., and the cost of operation is $7.11 per day, exclusive of depreciation, but including oil and distillate. This truck averages 42 mi. per day, hauling 16 cu.yd. average, and replaces two two-horse and two one-horse wagons. The two two-horse wagons covered 20 mi. per day and the tw one-horse wagons covered the same distance. The truck requires two men to operate, while the wagons requir four men and six horses.

4. Spokane reports that, for residence districts, lon hauls and heavy loads, one truck takes the place of fou teams.

5. Tampa reports a 50% saving in the use of the moto truck, in replacing horse-drawn apparatus, for partia collection only. In street-cleaning apparatus a 50% sav ing was effected. No figures were given to prove thi statement.

6. Detroit uses motor collection from hotels an restaurants and also from central collection station.

7. Joliet, Ill., uses motor trucks from central statio

8. Brockton (Mass.), Montgomery (Ala.), Paterso (N. J.), and Augusta (Ga.), have discarded horse-draw apparatus and installed motors for house-to-house col lection, but are not yet ready to report cost data.

9. The Norfolk Navy Yard expects one motor truc to replace one two-horse and three one-horse teams.

10. Buffalo is considering central collection depots an motor delivery from this point to the disposal plant.

11. Nashua, N. H., collects rubbish with a truck an finds that one truck does the work of from two to thre teams and shows much economy.

The objections to motor apparatus, as given, wer briefly as follows:

1. The speed gained on the long hauls is more tha offset by the time consumed in getting on and off t truck while loading.

2. With a truck, a driver would be necessary all t time in addition to the other operators, thus adding ext cost, while with horses, a team or single horse can trained to move from house to house at a call from t driver, who also collects the cans.

3. Either the life of the motor will be shortened, ow to many stops and starts, or if the engine is allowed run, excessive use of gasoline results.

4. Many cities place refuse in sanitary fills, and moto are not practical in low marshy ground.

5. The cost of motor equipment is considered by ma to be prohibitive.

6. The Denver Hog Ranch Co., which collects garba for the City of Denver, says:

> We are using teams to collect garbage from the City Denver, in preference to trucks, our haul being about 5 The rainfall in this country is only about 13 to 15 in. p annum; consequently, the roads are usually in good conditi except perhaps for a short time in the spring. We have go over the truck proposition several times with different sal men who had an idea that they could save us money on colleetion and removal of the garbage, but it is our conclusi after careful investigation that the only way a saving mig be made would be to have all the garbage collected and moved to a central point and then hauled from this centr point to a place of disposal.

7. Motor vehicles are not adapted to pick-up work.

8. In northern climates, where heavy snows are pre lent, motor trucks are not suitable even for long hau

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*City Engineer, Meadville, Penn.

9. Syracuse, N. Y., is discarding trucks for house-to-house collection and using them for hauling from a central station.

10. Toledo has discarded trucks, on account of heavy grades and rough roads.

11. Dayton experimented with one truck in house-to-house collection and found that it did not pay. The cost to collect with truck was $1.37 per ton, as against $1.09 for horse collection.

From the foregoing replies the following conclusions may be drawn:

1. Motor vehicles are not practicable for house-to-house collection of garbage, except perhaps in a few instances where residences are far apart, as in Los Angeles and Pasadena.

2. Where it is possible to establish central stations (and there does not seem to be an immediate possibility that they will become very popular), the motor will prove an economy for the long haul.

3. In refuse collection the motor seems to show considerable economy.

4. In downtown districts it would appear that better service, even though not as cheap, might be obtained from trucks in collections from hotels and restaurants.

5. Horse-drawn apparatus seems most suitable for house-to-house collection and for delivery to central loading stations, for the reasons given above.

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Motor-Truck-Highway Problem

The legislature of the State of New York recently passed an act to amend the highway law in relation to registration fees for motor trucks and omnibuses. The act requires that a commission comprising the state commissioner of highways, the superintendent of public works and the state engineer shall adopt and file in the office of the secretary of state on or before Jan. 1, 1917, a new schedule of registration fees to be paid by the owners of motor omnibuses and motor trucks. These fees are to be based "upon the time and extent of the vehicles' use of the public highways, and the relative wear and tear of the highways resulting from their use."

On Nov. 21, the first public hearing of this special commission was held in the capitol at Albany, Edwin A. Duffey, state highway commissioner, acting as chairman. Between 40 and 50 persons attended the hearing, the great majority of them being representatives of motor-vehicle manufacturers and owners. In fact but a single representative was present to state the case of the highway official and the general public, and that man was Eugene W. Stern, chief engineer of the Bureau of Highways, Borough of Manhattan, New York City, whose experience in maintaining pavements under extraordinarily heavy motor-truck traffic has been described in *Engineering News,* Oct. 12 and Nov. 16, 1916.

The substance of the contentions made by the motor-truck interests were: (1) That the commission's jurisdiction could not be interpreted to include any but state highways; (2) that a large number of motor vehicles in cities never use the state highways; (3) that there were too many variables entering into the problem to ever reach a fair determination of the wear of highways caused by motor trucks; (4) that the task before the commission was an impossible one, because anything in the nature of special fees was discriminatory and unconstitutional; (5) that it was the business of the government to build the roads adequate to traffic; (6) to maintain the roads by general taxation and (7) that they had an inalienable right to use the public highways for any purpose they saw fit.

Mr. Stern contended, that stripped of the clouds which were thrown around it, the problem was only one of common sense—the police power to protect public property. He would absolutely prohibit the use of vehicles which were proved destructive to the public highways. His illustrations were drawn from the destruction of the pavements on West 42nd St., and on other streets in New York City by the 18-ton subway contractor's motor trucks.

The motor truck representatives readily admitted the damage in this case but claimed that this was an exceptional and unique instance; also it was hinted that the pavements were not the best. Mr. Stern stated that damage done by these few trucks in less than a year amounted to $9,000 per mi. of pavement—and the best types of city pavement at that. He said New York City officials were at work on an ordinance to prevent recurrence of this destruction.

Some constructive suggestions were made by representatives of the motor truck manufacturers, one being that the fees should be based on Gross Weight × Speed × A Factor. The difficulty of controlling the speed of motor vehicles was, however, emphasized, one automobile engineer stating that there was no gasoline-engine governor which was not easily tampered with.

The various elements which it was suggested must enter into any formula that would meet the specification for the fees required by the law were: Kind of tires, springs, type of pavement, season of year, gross load, load per inch of tire and diameter of wheel.

The Motor Truck Club of America was represented at the hearing by its president Roderick Stephens, George H. Pride, W. O. Shadbolt, G. A. Green, A. F. Masury and Arthur J. Slade, as well as its counsel, Charles G. Bond.

It was tentatively agreed to hold another hearing in New York City.

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Railway Clearances in Switzerland were modified by a new federal order of Mar. 18, 1916, to conform to new maximum car and lading outlines adopted by an international conference early in 1914. The new clearance diagram is coupled with a maximum car and lading outline, and a limiting line for existing structures and for repair or maintenance operations. This last is intermediate between the car and clearance lines. The main widths are: Car, 3.15 m.; existing structures, 3.55 m. on main track and sidings, 3.35 m. on loading tracks; clearance, 4 m. (13.12 ft.). The heights above top of rail and the top widths are: Car, 4.50 m.; height, 1 m. top width; existing structures, 4.55 m height, 1 m. top width; clearance, 4.80 m. height, 1.52 m. top width. The upper corners are formed not by a single slant, but by two lines forming a very flat obtuse angle. The principal offset of the side clearance line is 0.76 m. above top of rail, to a width of 3.30 m.; for existing structures the height of offset is 0.90 m., to a width of 3.25 m. The bottom widths are: Car, 2.40 m. at 0.13 m. above top of rail; clearance, 2.43 m. at 0.05 m. above top of rail. Variations of ¾ to 3 in. in lateral position of railway vehicles in most unfavorable position on curve are allowable at certain specified heights; this presumably relates to spring action, as a table of increase of clearance width on curve is also specified. The full text of the new regulation is given in "Schweizerische Bauzeitung" of June 3, 1916. It is noted that the clearance diagram differs from that of 1894 chiefly in greater width at the lower corner, where the new diagram slants from bottom width 2.13 m. at 0.05 m. above rail to width 3.09 m. at 0.38 m. above rail.

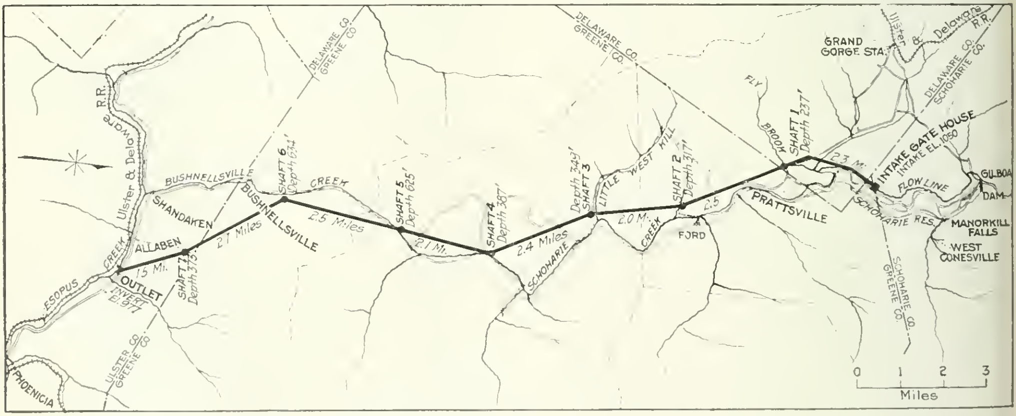
News of the Engineering World

Rock Tunnel 18 Miles Long for New York Water-Supply

The Board of Water Supply of the City of New York has given notice that a contract will be let next spring for an 18-mi. tunnel through one of the main ranges of the Catskill mountains, to divert the waters of Schoharie creek into the Ashokan reservoir. This tunnel is one of the principal features in the development of the other half of the 500,000,000-gal. daily supply from the Catskill watersheds, for which appropriation was made in April (see *Engineering News*, Mar. 2, 1916, p. 435).

The water from the Schoharie drainage area (314 sq.mi.) will be impounded by a large dam (probably between 200 and 300 ft. high) with an outlet through this 18-mi. concrete-lined tunnel, which is to be about 11 ft. in diameter, into the Ashokan reservoir. The now practically completed aqueduct from the Ashokan reservoir to New York City has a capacity of 500,000,000 gal. daily. The estimated cost of utilizing the Schoharie watershed is $22,000,000 and the construction of the dam and tunnel will probably require 8 yr.

The projected tunnel, as shown by the accompanying plan, extends from a point on Schoharie creek between the towns of Prattsville, Greene County, and Gilboa, Schoharie County, to a point on Esopus creek in the town of Shandaken, Ulster County. The tunnel will be driven from 8 shafts, ranging in depth from 240 to 640 ft., except the shaft at the northerly end, which will be only 100 ft. deep. The distances between shafts vary from 10,400 to 11,200 ft. The rock is blue and red sandstone (commonly called bluestone) and embedded shales characteristic of large portions of the Catskill mountain regions. Diamond-drill borings are now in progress to furnish data for final location.



MAP OF CATSKILL DISTRICT SHOWING LINE OF NEW 18-MI. WATER TUNNEL

The tunnel will be at hydraulic gradient and not a pressure tunnel, except the section between the inlet gatehouse and shaft No. 1, which will be depressed to pass beneath the gorge of Bear Kill and other possible depressions in the rock. The slope of the tunnel proper will be about 4 ft. per mi. The minimum thickness of the concrete lining will be 12 in.

J. Waldo Smith is Chief Engineer, and Alfred D. Flinn is Deputy Chief Engineer of the Board of Water-Supply.

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Wilmington Water-Works Changes

The four-states section of the American Water-Works Association met in Wilmington, Del., Nov. 15, for a most interesting and instructive session. The forenoon was devoted to an inspection of the pumping plant, the site of the new mechanical filtration plant, a large covered concrete reservoir now under construction, and a slow sand filtration plant that has been in continuous operation since 1909.

Within the last two years the sudden increase in water consumption, due chiefly to new manufacturing demands, has set at naught all previous calculations, and has required radical developments and improvements to be undertaken. These developments, and the part the Wilmington water-works has played in water-purification history, furnished the theme for the afternoon discussion, which was led by George W. Fuller, New York City, consulting engineer for the city.

The development of an additional water-supply involves the construction of a 12,000,000-gal. rapid sand filter plant adjoining the present pumping station. The present preliminary filters are being changed into a coagulating basin and storehouse. Beneath the new filters will be a filtered-water reservoir of 360,000,000 gal. capacity. The pumping plant, with the present two Holly high-duty pumping engines (each 12,000,000 gal. daily capacity) will be increased by three new steam-turbine-driven centrifugal pumps of a total capacity of 30,000,000 gal. daily.

The water from the new rapid sand filter plant will be pumped to two distributing reservoirs, one a new 7,500,000-gal. covered concrete reservoir of a beam and girder type roof. This roof will be used as a park, playground and skating rink.

The present slow sand filtration plant at Weldin Farm, about 2 mi. from the pumping station, will continue in use, the intention being to operate the mechanical filters when the water is particularly turbid, and the slow sand filters at other times, although both may be used simultaneously.

At present the water is taken from Brandywine Creek, conducted in an open channel to the pumping station, where it is passed through preliminary filters and pumped to the Porter reservoir at Weldin Farm. From here the water passes through the slow sand filters to a reservoir beneath, and thence into the city mains.

The chief engineer of the Wilmington water-works is Edgar M. Hoopes, Jr., and S. N. Van Trump is superintendent.

California Votes $15,000,000 for More Road Work

The vote on issuing bonds to the amount of $15,000,000 to complete the California State Highway Department program was overwhelmingly in favor of the issue, according to press dispatches. This money will not be available until July 1, 1917, and in the meantime the State Highway Department is threatened with a serious shortage of funds.

The proposed state highway system comprises 3,300 mi., of which 1,400 has already been completed, or is near completion, under the original $18,000,000 bond issue. The new bonds will bear interest at 4½%.

It has also been announced that California is the first state to receive Federal aid under the new road law.

Cleveland To Mend Pavements

A bond issue of $3,000,000 for repairing and repaving the streets of Cleveland, Ohio, was carried at the recent election. The agitation for this work was begun several years ago, and the condition of the pavements became the subject of investigation by civic associations. Recently much promotion and publicity work was done by a Committee of One Hundred Organizations. A tentative program has already been adopted for the 1917 work, which will take care of at least 10 mi. of the most urgent repairs and repaving, according to press reports.

The Mining Congress and the Holmes Memorial

The 19th annual session of the American Mining Congress, held at the La Salle Hotel, Chicago, Nov. 13 to 16, dealt mainly with legislation and with the general administration and commercial aspects of mining, rather than with technical matters. Some of the subjects were related more or less directly to engineering and practical mining, the latter including safety work and rescue methods. Among the papers listed were "Uniform Mining Legislation as Affecting Mining Engineering," by J. A. Garcia, of Chicago, and "The Engineer's Relation to Western Water-Power Development," by Dr. Henry S. Drinker (Lehigh University), of South Bethlehem, Penn.

In addition to five general sessions there were 14 sectional meetings of the five divisions on legislation, coal, metalliferous, public lands, and oil and gas. At one of the general sessions a strong appeal was made for subscriptions to the Joseph A. Holmes Safety Association, which has been organized as a permanent memorial to the late Dr. Holmes (head of the U. S. Bureau of Mines), and with the purpose of developing safety in mining operations. This is a unique method of commemorating in a permanent and useful way Dr. Holmes' valuable and energetic work in the interests of the mining industry.

A Million Dollar Fund for the United Engineering Library

The consolidation of the library owned by the American Society of Civil Engineers with the United Engineering Library, owned by the three other great national societies—the Mining, Mechanical, and Electrical Engineers—makes this the greatest collection of engineering books in the world. The trustees of the United Engineering Society, which controls the administration of this library, are seeking to raise a million-dollar endowment, the income of which will be available for the perpetual administration and enlargement of the library. On Nov. 15, the president of the United Engineering Society, Charles F. Rand, announced the gift by Dr. James Douglas, of New York City, of $100,000 toward this endowment fund. Dr. Douglas is a past-president of the American Institute of Mining Engineers and is president of the Phelps-Dodge Co., of New York City.

Taxation Changes Proposed for Pittsburgh

Among 20 recommendations made by a taxation committee in a report submitted Nov. 13 to J. G. Armstrong, mayor of Pittsburgh, Penn., six are here reprinted as of interest to many engineers:

> Immediate adoption of a comprehensive city plan, including the "zoning" principle, in order that existing realty values may be conserved.
>
> Adoption of principle of excess condemnation in making public improvements, especially in laying out of new streets and in widening or extending old ones.
>
> The water department, as a social or community enterprise, should make no profit, but should be self-sustaining.
>
> Larger revenues should be obtained from the rental and use of city property—wharves, markets, etc.
>
> Increase of the automobile license tax by 50 per cent., and distribution of the total proceeds, 30 per cent. to the city, 30 per cent. to the county, 40 per cent. to the state.
>
> Abolition of the exemption of machinery in the city.

The committee was composed of 11 members, including William Price, chairman, and Julian Kennedy.

Will Jacket Clearwater Basin with Reinforced Concrete

Bids are being asked on a $200,000 reinforced-concrete job of unusual character. The clearwater basin of Cleveland's new filtration plant, a covered groined-arch structure 195x938 ft. in plan by 30 ft. high, is to be repaired or reconstructed, in consequence of the partial failure that occurred July 10, 1916, as described in *Engineering News* of July 27, 1916, p. 186. After that failure, which consisted of the fall of four panels of roof and their supporting columns, further evidences of damage appeared. Engineers engaged to report on the case recommended finally a complete jacketing of the old structure, the process being virtually a replacement of the present basin structure, leaving the old work in place and using it as form for the new work.

There will be a new floor slab, laid on top of the present floor; a new roof slab, laid on top of the present roof; new side walls, carried up inside the existing walls and communicating with the new roof by way of openings at the top of the existing walls; and hooped jacketing for the columns. All of the new concrete is to be fully reinforced.

G. B. Dusinberre, Commissioner of Water, City Hall, Cleveland, is in charge of the reconstruction.

* * *

Montreal's Municipal Water-Power Project Condemned

A commission of prominent engineers made a report on Nov. 20 to the city authorities of Montreal on the water-power project which has been under construction for several years in connection with the city's water-supply. The commission finds that the final cost of the project will be at least $10,600,000, and that not over 7,000 hp. will be developed. The minimum fixed charges and operating expenses of the power plant will be $108 per hp. per annum while the city could purchase power in the open market from some of the hydroelectric plants in the vicinity of Montreal for not more than $20 to $25 per hp. per annum.

The commission urges that the city should abandon the present project, on which it has already expended over five million dollars, and estimates that by so doing it can save $262,000 per annum by purchasing power compared with the cost of completing the present project.

* * *

Navy Department Wants Four Designing Engineers

The Bureau of Yards and Docks, Navy Department, at Washington, is in immediate need of four high-grade designing engineers at salaries of from $10 to $15 per day, and the Civil Service Commission is announcing an early non-assembled competitive examination from which to provide eligibles. The announcement of the examination (issued Nov. 20, 1916) is in part as follows:

> The United States Civil Service Commission announces an open competitive examination for designing engineers, for men only, to fill four vacancies at salaries ranging from $10 to $15 per diem in the Bureau of Yards and Docks, Navy Department, Washington, D. C. The duties of the position embrace the design and supervision of design of large and various engineering works in steel, concrete, reinforced concrete, etc., for the navy yards and naval stations.
>
> Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated:

Subjects	Weights
1. Technical education	30
2. Experience and fitness	70
Total	100

> Graduation with a degree in engineering from a college or university of recognized standing, with subsequent experience of not less than 15 years on general design work, of which not less than five years must have been in responsible charge in the successful designing of works of importance and magnitude, such as structural steel shops and storehouses, reinforced-concrete structures, retaining walls and deep foundations, tunnels or subways, waterfront work, such as quay walls, piers, wharves or dry docks, etc., are prerequisites for consideration for this position.
>
> In view of the early date of examination demanded by the urgency of making appointments as soon as possible, it is necessary that persons desiring to be considered should secure the necessary form at once and mail it, properly executed, to the Commission without delay.
>
> Applicants must not have reached their fifty-fifth birthday on the date of the examination.
>
> Persons who meet the requirements and desire this examination should at once apply for Form 1312, stating the title of the examination desired, to the United States Civil Service Commission, Washington, D. C.; the Secretary of the United States Civil Service Board, Post Office, Boston, Mass., Philadelphia, Penn., Atlanta, Ga., Cincinnati, Ohio, Chicago, Ill., St. Paul, Minn., Seattle, Wash., San Francisco, Calif.; Customhouse, New York, N. Y., New Orleans, La.; Old Customhouse, St. Louis. Mo. Applications should be properly executed, excluding the medical certificate, and must be filed with the Commission at Washington prior to the hour of closing business on Dec. 11, 1916.

ENGINEERING SCHOOLS

University of Pennsylvania

The Board of Deans of the University recently adopted a resolution requesting all members of the faculty to give information before undertaking any work outside of the University which would be in conflict with a University statute, which says:

> No officer of instruction shall engage in any other occupation which, in the opinion of the trustees, will interfere with or impair the satisfactory discharge of his duties in the University.

Western Reserve University

The Division of Municipal Administration and Public Service of the new School of Applied Social Sciences is offering a general course in municipal organization for municipal and county employees. The course will be under the direction of A. R. Hatton, and much of the work will be given by H. G. Hodges, formerly in the Philadelphia Department of Public Works. It is aimed to break away from the more familiar courses in municipal government.

NOTES

A Preliminary Outline of a City Plan for Cincinnati, Ohio, is to be submitted by George E. Kessler, St. Louis, Mo., to the City Planning Commission of Cincinnati in December. The outline will be based largely on a survey of past, present and prospective improvements made by the engineering and park departments.

Direct Rapid Transit from the South Station, Boston, to Harvard Square, Cambridge, Mass., will be afforded in a few weeks by the equipment and operation of the portion of the Dorchester Tunnel in Summer St., between the South Station and Washington St. This will be done by the Boston Elevated Railway Co

The Consumption of Cotton Fiber in the manufacture of explosives has reached enormous proportions. During the year 1915 there were used in making explosives in the United States 214,000 bales of bleached cotton fiber (of 500 lb. each), and during the first nine months of 1916 there were 421,695 bales so used. Besides this consumption in the United States the heavy consumption of export cotton for the same purpose is well known. It is apparent that a large percentage of the cotton crop is now being converted to explosives, which furnishes one explanation why cotton is selling at 20 to 21c per lb., the highest price reached since the Civil War.

Steel Rail Prices Raised to $38 Per Ton—The steel rail manufacturing companies announced last week a further increase in the price of standard steel rails to $38 per ton at the mill. The regular capacity of most of the steel rail mills, however, is reported to be covered by contracts for material already sold, of course at previous market prices, so that the new selling price of steel rails will chiefly affect rails to be delivered nearly a year hence. Even at this advance in price, however, it is noteworthy that steel rails, which, up to a short time ago were the aristocrat of the steel market, selling at a higher price per pound than other rolled material such as structural shapes, are now selling at a lower rate than any other rolled material. Under these conditions there will be little dispute that the manufacturers were justified in making the advance in price.

The New Coaling Plant of the Panama Canal at Cristobal is announced by the "Canal Record" to be now in regular operation for commercial use, although not yet entirely completed. Two of the four reloader towers have been taken over for operation and are found to be able to deliver coal to vessels usually faster than it can be handled. A ship recently coaled had a large open hatch amidship over self-trimming bunkers, and 1,250 tons were delivered to this vessel in 3 hr. These reloaders were designed for rapid delivery of coal to barges and colliers, with large and conveniently placed hatches. As merchant vessels, however, have a great variety of hatches and coaling ports, it is probable that portable pipe chutes will be added to the reloaders. These chutes will be so arranged that they can be swung to various positions, so as to deliver the coal to ports inaccessible to the ordinary reloader chute.

Preparedness in Military Troop Transportation is dealt with in the report of a special committee of the American Railway Association, appointed to coöperate with the United States military authorities in moving troops to the border. From June 29 to Nov. 11 there were sent to the Mexican border approximately 136,000 soldiers; 33,000 have been returned, 9,000 are in mobilization camps and still to be sent to the border, and 103,000 who are down there must be returned The committee says: "The routing of troops from mobilization camps to border points was specified by the Quartermaster General's department. The routes were apparently arranged to give as many railways as possible an opportunity to participate in the traffic. While in most cases the routing was excellent, there were still cases where troops were handled over circuitous routes with resulting dissatisfaction." The committee recommends that a statement be obtained from the War Department of possible concentration points to which troops might be sent on the several coasts and on the Mexican border, and that a series of possible and preferred routings be prepared from the several mobilization camps to such concentration points. It also proposes that arrangements for pooling the expenses and earnings in the movement of troops be made so that direct routes may be in all cases selected. One feature that enabled the movement of troops to be made promptly was the exchange of passenger equipment on a large scale, something entirely new in the history of American railroading in any such proportions.

Protection of Drawbridge Openings on street-railway lines is being investigated by a special committee appointed by Mayor Curley, of Boston, as a result of the recent fatal accident at the Fort Point bridge. Prof. Charles M. Spofford, of the Massachusetts Institute of Technology, is chairman of the committee, and among other members are John D. Carty, of the Department of Public Works; George W. Bishop, of the Public Service Commission; James C. Andrew, of the Boston Edison Co., and Col. W. E. Craighill, Corps of Engineers, U. S. A. At a public meeting on Nov. 16, President Matthew C. Brush, of the Boston Elevated Railway Co., stated that his company is installing a third track on the Cambridge viaduct, so arranged that in case a car runs past the danger signal set against it, it will be diverted to a sand track and brought to a gradual stop. President Brush is quoted by the Boston "Herald" as saying further: "The company believes that there should eventually be constructed at all drawbridges an absolutely positive barrier that will prevent street cars and all vehicles from reaching the edge of the draw. We believe that recent developments permit the practical construction of such a barrier, our engineers having designed within the last week a device of this character Pending the installation of such positive barrier, gates at all bridges now in use will be painted white with black stripes. One or possibly two red lights with a large lens should be installed on all gates directly between the rail. There should also be installed signs 100 and 200 ft. respectively from the gate, indicating 'Slow' and 'Stop,' when the draw is open There should also be immediately installed at all drawbridges a large gong, electrically operated, interlocked with the bridge mechanism so that it will be impossible for the draw tender to open the bridge until he has closed the switch that rings the gong"

PERSONALS

A. L. Crissinger has been appointed State Highway Superintendent of Beaver County, Pennsylvania.

Roy E. Spear, for five years Assistant City Engineer of Bartlesville, Okla., is now Assistant City Engineer of Flint, Mich.

A. J. Egloff, has been appointed Deputy Commissioner of Parks and Public Buildings of Buffalo, N. Y., at a salary of $2,500 per annum.

A. C. Schutz, formerly Assistant Chief Engineer of the Locomobile Co., of America, is now Chief Engineer of the Mercer Automobile Co., Trenton, N. J.

William F. Coleman, County Surveyor, of Warren County, Kentucky, has been appointed County Road Engineer, with headquarters at Bowling Green, Ky.

George W. Corrigan, Assoc. M. Am. Soc. C. E., Roadmaster of the Southern Pacific Ry. at Hornbrook, Calif., has been promoted to be Division Engineer of the Stockton division, with headquarters at Stockton, Calif. He was graduated from the University of Missouri in 1900 and began his railway experience as a rodman with the Union Pacific R.R. From 1901 to 1907 he was with the Missouri Pacific Ry., as Assistant Engineer and Division Engineer. He went to the Southern Pacific in 1908 as an Assistant Engineer, maintenance-of-way department.

Gen. Geo. W. Goethals was retired from the Army on Nov. 15 under the law which gives an officer the privilege of retirement after 40 years of continuous service. Early in 1915 General Goethals requested relief from his duties as Governor of the Panama Canal, and his resignation was accepted to take effect on Nov. 1. When the great slides of September, 1915, blocked the Canal, General Goethals withdrew his resignation and returned to active duty on the Isthmus. He still retains his Commission as Governor, but is now acting as Chairman of the Commission appointed by the President to investigate the effect of the eight-hour law and will probably soon be retired from the former position and be succeeded by Col. Chester Harding, Corps of Engineers, U. S. A., who has been Acting Governor of the canal for the past two years when General Goethals has been absent.

OBITUARY

Benjamin Rush Whitney, a pioneer railroad contractor, of Kansas City, Mo., died Nov. 9. He was City Engineer of Kansas City in 1885 and 1886.

Mrs. Charles F. Rand, wife of Charles F. Rand, a Past-President of the American Institute of Mining Engineers and President of the United Engineering Society, died at South Orange, N. J., on Nov. 17, after a brief illness from pneumonia.

John Robert Moore, for the past 25 years an Assistant Engineer in the Bureau of Highways, Borough of Manhattan, New York City, died recently at his home in Merrick, Long Island. Before his connection with the Bureau of Highways he was with the engineering staff of the Central R.R. of New Jersey.

John Arnold Barrett, Assoc Am. Inst. E. E., Electrical Engineer of the American Telephone and Telegraph Co., New York City, died Nov. 12 at his home in Brooklyn. He was 58 years old. He was a graduate of Dartmouth College and had been for 25 years in the employ of the American Telephone and Telegraph Co.

Daniel C. Kingman, Brigadier-General U. S. A., retired, former Chief of Engineers, died at Atlantic City, N. J., Nov. 14, in his 65th year. He was born in New Hampshire and was graduated from the Military Academy at West Point in 1875. A portrait and biographical sketch of General Kingman were published in "Engineering News," Oct 23, 1913, p. 834, at the time of his promotion to the head of the Corps of Engineers. He was retired Mar. 6 of this year.

Frank O. Sinclair, M. Am. Soc C. E., City Engineer of Burlington, Vt., died Nov. 15 He was born Sept. 7, 1860, at Burlington. He was graduated from the University of Vermont in 1882. For ten years he was engaged in railroad location and construction work in the West and South. In 1892 he opened an office in Burlington for private practice and had charge of the building of the lines of the Burlington Traction Co., and of many other local projects. He took an active interest in municipal affairs, as a member of the Board of Aldermen from 1899 to 1903, as Superintendent of the Water Department from 1905 to 1907, and as member of the Board of Street Commissioners from 1913 to 1916. He was appointed City Engineer in 1914. Mr. Sinclair was also Consulting Engineer of the Public Service Commission of Vermont. He was chairman of the Vermont section of associate members of the United States Navy consulting board; he was a past-president of the Vermont Society of Civil Engineers. He is survived by a widow and three children.

ENGINEERING SOCIETIES

PAVING BRICK INSTITUTE.
Dec. 5-6. Meeting in Cleveland at Statler. Asst. Secy., H. M. Macdonald, 830 Brotherhood of Loc. Engrs. Bldg., Cleveland, Ohio.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

NORTHWESTERN ROAD CONGRESS.
Dec. 8-9. In Chicago. Secy., J. L. Long, Moline, Ill.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

The Engineers' Society of Western Pennsylvania, through the board of elections, has nominated the following for office during 1917: President, A. L. Hoerr; vice-president, George H. Neilson; treasurer, A. E. Frost; directors, E. W. Pittman, George H. Barbour.

The American Society of Safety Engineers has elected the following officers for 1917: President, Harry H. Dehn; vice-president, Cornelius Van Horn; treasurer, Leonard W. Davies; secretary, W. John Pedroncelli. The next regular meeting will be on Nov. 22 in the Engineering Societies Building, New York City.

The Oklahoma Society of Engineers will hold its annual meeting in Tulsa, Dec. 27 and 28, at the Chamber of Commerce, the first session opening 9 a.m., Wednesday. At the last meeting the membership was boosted from 41 to 75, and an equally encouraging increase is hoped for this year. The secretary is H. G. Hinckley, Oklahoma City.

The Paving Brick Institute will be conducted on Dec. 5 and 6 in Cleveland, at the Hotel Statler. The meeting will close with a dinner, for which a large program is promised. The subjects for discussion include the use of powdered coal, producer gas in burning brick, equipment efficiency, labor and the development and application of a bonus system.

The Galveston (Tex.) Engineers' Club, recently formed by members of the engineering department of the Gulf, Colorado & Santa Fe Ry., met to elect officers on Nov. 1. Membership is not limited to employees of the Santa Fe, but is purposed to be as broad as that of the usual local engineering society. Three meetings have been held thus far, and the membership list numbers 25.

The New York Railroad Club at its annual meeting on Nov. 17, in New York City, elected the following officers: President, James Milliken, Superintendent of Motive Power, Philadelphia, Baltimore & Washington R.R.; vice-presidents, Sidney Chambers, C. L. Bardo and Miles Bronson; treasurer, R. M. Dixon, and secretary, Harry D. Vought, 95 Liberty St., New York City.

Society of Automobile Engineers—In order to have one authoritative body dealing with the matter of standards for internal-combustion engines used on vehicles of all classes, the Societies of Aëronautic Engineers and of Motor Boat Engineers have decided to consolidate with the Society of Automobile Engineers, and the name of the society is likely to be changed to the Society of Automotive Engineers. It is probable that the association of engineers engaged in building farm tractors will also join this consolidation. Coöperation will be arranged, it is expected, with the American Society of Agricultural Engineers and the National Gas Engine Association. It is planned to have one vice-president to represent each special field of engineering covered.

Appliances and Materials

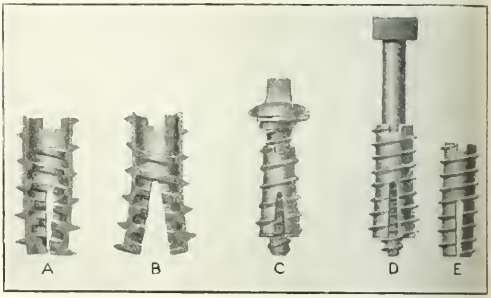
Colloidal Bitumens

Patents have been granted to Clifford Richardson, consulting engineer, New York City, on "the introduction of clay in the form of a colloidal aqueous paste and the combining of this paste with bitumen in such a way that when the water is subsequently driven off the bitumen forms the continuous phase of the colloidal material." The effect of the added colloidal matter is to give stability to the bituminous substances. It is possible to obtain with the proper amounts of asphalt and clay a material much resembling vulcanized rubber.

* * *

Expansion Sockets for Bolts and Screws

The "Tenax" expansion socket for anchoring screws and bolts into walls, railway ties, etc., is a French invention that is being tried with screw-spike track fastenings for rails on the Delaware, Lackawanna & Western R.R. It is on the same principle as the Lakhovsky (French) fastening used with screw spikes on the Pennsylvania Lines. The "Tenax" device is a malleable iron sleeve, threaded on the inside to fit the bolt or screw, and having on the outer side a sharp spiral thread to form an anchor. The lower part of the sleeve is split, and the sides here are pressed together so as to slightly reduce the normal diameter. The hole bored in the tie is threaded with a tap corresponding to the exterior thread on the sleeve, and the sleeve is then screwed into place. As the screw spike is screwed home it spreads or expands the split end of the sleeve, forcing the exterior thread into the surrounding wood. For use in concrete, the sleeve is set in its expanded position with the screw or spike in place, the interior threads being greased. After the concrete has set, the bolt is removed, until the piece which it is to hold is put in place. At A and B in the accompanying sketches are sections of the socket in open, closed and expanded position; C and D show the socket applied to a screw spike and bolt respectively; E is a view of the socket in normal position. The device is manufactured (under the Wagner patents) by Le Tenax Co., 6 Rue de Mont-Thabor, Paris (France), and the Tenax Metal Expansion Socket Co., 58 Lombard St., London (England).



EXPANSION SOCKET OR ANCHOR FOR BOLTS AND SPIKES

* * *

Boiler-Water Purifier

A boiler feed-water purifier, to be submerged inside the boiler itself, has been designed by the Boiler Water Purifier Co., Bellevue Court Building, Philadelphia, and given the trade name "Economo." The water is led through preheating pipes run alongside a long horizontal treating tube, and is admitted to an end compartment of the latter. There is a horizontal central diaphragm extending nearly the length of the tube to give a long flow path. The scale is precipitated in the lower chamber, by heat action, and settles as sludge. The bottom of this lower chamber is bled by a blowoff. Partly submerged skimmer cones are piped, through check valves, to the purified-water discharge line and the feed-water inlet, so that when the purifier blowoff is opened, boiler pressure forces steam and boiler water through the whole apparatus to wash it out.

Engineering News

VOLUME 76 NOVEMBER 30, 1916 NUMBER 22

Tunnel for Marseilles Canal Largest in World

In several recent issues of *Engineering News*, articles have appeared descriptive of the very large section tunnel now being driven just north of Marseilles, France, for the Marseilles-Rhône canal. Two of these articles (Aug. 26, 1915, p. 386, and Oct. 21, 1915, p. 803), gave the details of the section and the methods of driving the canal. At that time, however, photographs showing the work were not available. We have now, through the courtesy of the Department of Commerce, been able to obtain some views of the tunnel and its environs, which will be received with interest by American engineers.

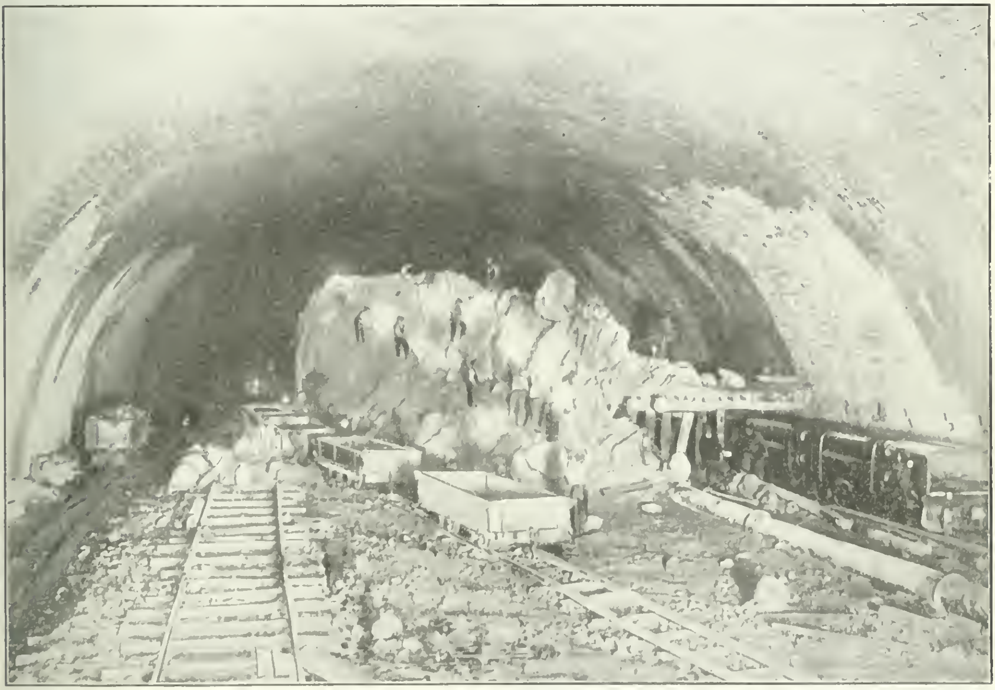


FIG. 1 REMOVING CORE OF LARGE TUNNEL SECTION, MARSEILLES-RHONE CANAL

The Marseilles-Rhône canal extends from the Rhône River at Arles to the Bay of Marseilles. For a distance of 20 mi. it practically parallels the river, but as the river approaches the Mediterranean the canal turns to the east and goes along the shores of a bay there and then cuts directly through the high ridge of mountains extending just back of the City of Marseilles. Emerging from this ridge, it passes around Marseilles Bay within a breakwater to the harbor of the city.

The total length of the canal is 51 mi. Its typical section is 82 ft. wide and 10 ft. deep. It is being built not only to take care of the traffic in the lower Rhône, which is somewhat difficult of navigation, but also to insure the passage of the Rhône barges directly into the harbor of Marseilles without having to pass around the turbulent waters of the cape just west of the city. For many years the project had been held up because of the difficulty of getting through the mountain ridge north of the city; but the present project, initiated in 1903, penetrated this ridge with the so-called Rove tunnel, which is now being constructed. The tunnel heading was carried through last winter, and it is understood that work on the construction is continuing in spite of war conditions.

The view on the next page is taken from one of the breakwaters in Marseilles harbor, looking toward the ridge

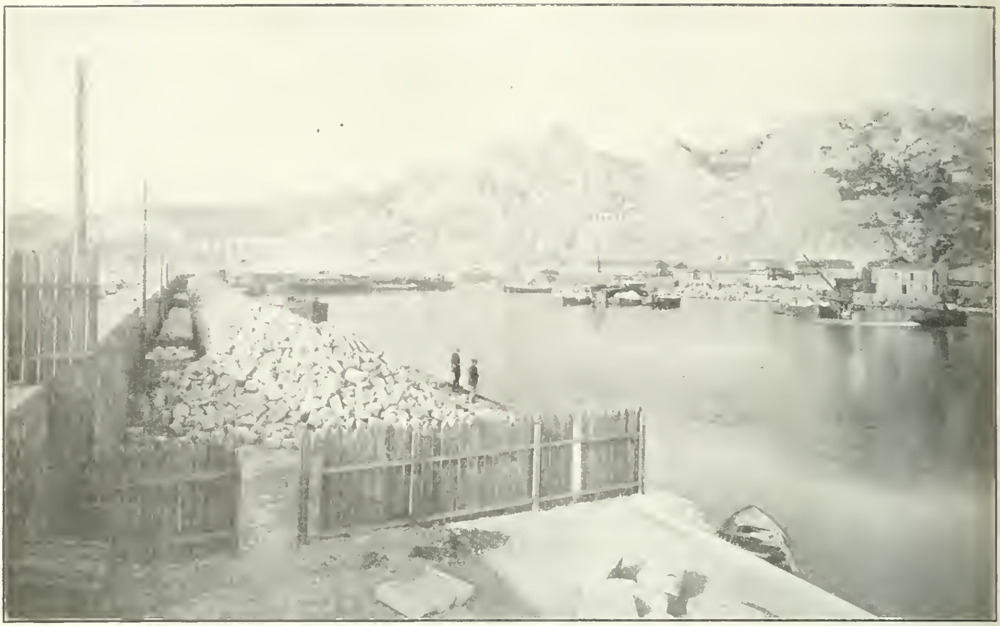


FIG. 2. MARSEILLES HARBOR, LOOKING TOWARD PORTAL OF ROVE TUNNEL

of hills that the tunnel penetrates. The tunnel portal may be made out just below the side-hill viaduct about halfway up the hill in the center of the picture.

The Rove tunnel is 4½ mi. long, and the typical section has a square invert 59 ft. wide and 15 ft. deep with approximately a semicircular arch of 41-ft. radius, giving an excavated section 79 ft. wide and 50 ft. high, with a clear area of 3,250 sq.ft. This section, it will be noticed, is about six times as great as an ordinary double-track railway tunnel. The comparison of the amount of yardage in the tunnel with the yardage of several other large European tunnels is given in the accompanying table. It will not only have the greatest section, but will have the greatest length of any tunnel built completely in French territory.

RELATIVE LENGTH AND CUBAGE OF FOUR EUROPEAN TUNNELS

Name	Length in Mi.	Excavation in Cu.Yd.
Rove	4.5	2,800,000
Simplon	12.3	2,100,000
St. Gothard	9.3	1,300,000
Loetschberg	9.1	1,000,000

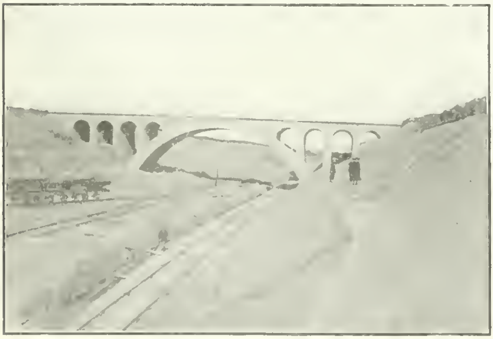


FIG. 3. MARSEILLES-RHONE CANAL IN DEEP CUT NORTH OF ROVE TUNNEL

As described in previous articles, tunnel construction is carried on from three arch headings, which are opened one into the other, leaving a central rock section to be removed. The view on the first page, taken inside the tunnel in the present year, shows work going on in the removal of this central section and illustrates very well the enormous size of the arch. As shown there, the lining is of masonry, which is backed on concrete made of a special lime and not of portland cement. The driving was started at both portals, and the work is being carried on from each end. It is being driven in rather hard rock that requires little timbering, with hand-handled air drills that work very well, an advance of 15 to 18 ft. a day being made in the headings, which are about 100 sq.ft. in section. The spoil is taken away on small trains running in the side heading and drawn by compressed-air locomotives in the headings and by steam locomotives in the main section. Little water has been met, and what has filtered into the tunnel is taken away by side drains. Artificial ventilation has been resorted to.

The south portal of the tunnel, shown in the view in Fig. 2, is in the face of the cliff. The north portal, however, emerges toward a bay in earth, so that the approach for a distance of a mile is in a deep cut that is being excavated with steam shovels. Fig. 3 shows the general type of section here and one of the handsome masonry bridges crossing the canal.

The construction of the tunnel is being done by Leon Chagnaud, a well-known French contractor who is noted in Europe for his work on the Paris subways and on the Loetschberg tunnel.

A very complete article describing the canal appears in *Le Génie Civil* for May 20, 1916.

Outlet Control of Elephant Butte Dam

By F. Teichman*

The Elephant Butte Dam, recently completed by the United States Reclamation Service, is located on the Rio Grande in New Mexico, about 120 mi. north of El Paso, Tex. It has a height of 200 ft. above the river bed and will store, for level of permanent spillway crest (7 ft. below the top of the dam), 2,638,000 acre-feet for the irrigation of about 180,000 acres in New Mexico, Texas and Mexico.

The different outlets of the dam are arranged near its east abutment. There is a total of twelve passages piercing the dam, all of the same area: Six passages 3 ft. 11 in. by 5 ft. for power purposes (penstocks), three of which have their center 20 ft. above the river bed, the other three being 30 ft. 8 in. vertically above the first; two sluice passages of the same dimensions and on the same level as the lower penstocks; four service passages 5 ft. in diameter controlled by balanced needle valves, two of these having the center of their seat at the level of the center of the sluice passages and the lower penstocks (20 ft. above the river bed) and the other two having their seat 56 ft. higher. Each of the twelve passages is a complete unit by itself except the service passages. One lower and one upper service passage take the water from the same well, entrance to which is had through two gates 3 ft. 11 in. by 7 ft. 6 in. There are then two service units each with two balanced valves and circular outlet passages of 5 ft. diameter.

Each of the several outlet units of the dam has a double means of closure. In the case of the two service units this has been indicated above; the outer slide gates, 3 ft. by 11 in. by 7 ft. 6 in., are always wide open or fully closed and are called the emergency gates; the inner balanced valves control by their degree of opening the amount of discharge of service water. The two sluice passages have each two slide gates 3 ft. 11 in. by 5 ft. placed in tandem, 25 ft. between the faces of the gates. The conduit is formed in cast iron to a point of 12 ft. 2 in. below the face of the downstream gate and then presents concrete surfaces. In the case of the sluice passage the downstream gates are the emergency gates (always wide open or fully closed), and control is had by means of the upstream gates. Thus the jet from under the controlling gate has to pass 37 ft. 2 in. of cast-iron lining before entering the concrete passage, and less harm is expected to the passage by having the upper gate control the jet. Each penstock has one slide gate 3 ft. 11 in. by 5 ft.; and at the downstream end of the cast-iron conduit, which here has assumed a circular section and is 24 ft. from the face of the gate, it is closed at present by a bumped head. When, in the future, these penstocks are connected with a power plant, this head will be replaced by a spigot end of 5-ft. pipe with lead joint designed for internal calking. The lead-jointed pipe will be continued to the power plant (inside calking inside the dam body), and the penstock will there receive its second gate.

Besides the two means of closing any of the twelve passages through the dam, there is a third means provided in the form of a steel shutter, built up of a ⅝-in. plate, I-beams, etc., which may be let down from the top of the dam over any one of the twelve entrance castings of the 3 ft. 11 in. by 5 ft. or 3 ft. 11 in. by 7 ft. 6 in. slide gates. The entrance opening of all these twelve castings is the same, 5 ft. 5 in. by 8 ft. 8 in., so that the same shutter of 6 ft. 5 in. by 10. ft. 6 in. can be used to cover any opening. There are seven shutter chutes provided, reaching from the top of the dam to the face of the entrance casting, one chute for each of the sluice passages and one chute for each pair of penstocks or service passages that lie in one vertical plane. The shutter is let down through these chutes by means of a shutter winch, motor-operated and on wheels, so as to be easily movable from one chute to another. The chutes are inclosed passages near the dam face and therefore cannot be obstructed by drift. Of course, the use of the shutter for the closure of a passage is possible only if one of the gates of such passage can be closed (likewise one gate of that passage over which the shutter may have to pass in order to reach a lower passage to be closed). The shutter is a means to make inspection and repair of any of the upstream gates possible at any time. The hydrographic conditions that control the operation of the reservoir are such that it cannot be expected that any of the upstream gates will be

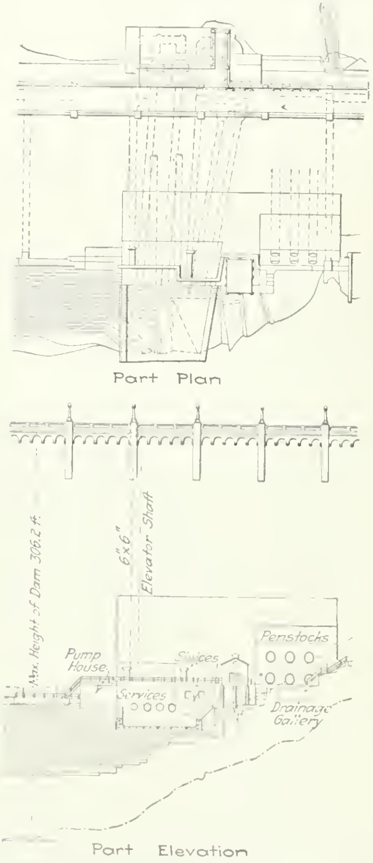


FIG 1 PLAN AND ELEVATION OF PART OF ELEPHANT BUTTE DAM, SHOWING OUTLET CONDUITS

come accessible by virtue of lower water level in the reservoir.

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*Engineer, United States Reclamation Service, Washington, D. C.

Besides the twelve passages through the dam above spoken of, there is a thirteenth, a 15-in. diameter penstock starting inside the entrance casting of penstock No. 6 and supplying the energy for a small power plant, placed on the toe of the dam, which plant serves the local requirements of the dam and of its attendants as to light and power.

The reservoir carries a considerable amount of drift that would be a menace in the penstocks and also in the balance valves. For this reason a straining structure of reinforced concrete is arranged, the lower part of which expands horizontally to cover all entrances and extends to 58 ft. above the river bed. It holds back the débris by permitting entrance to the tower only through a large number of slots of 3-in. width. Above this lower part the structure continues as a tower of 12 ft. 6 in. by 26 ft. 4 in. to a point 153 ft. above the river bed, being built parallel with and against the water face of the dam, which at this place has an incline of 1 to 12. The slots of this tower are 1½ in. wide. The great height of the straining tower was conditioned by the absence of any relation between the irrigation period and the location of water levels in the reservoir and the duration of such locations.

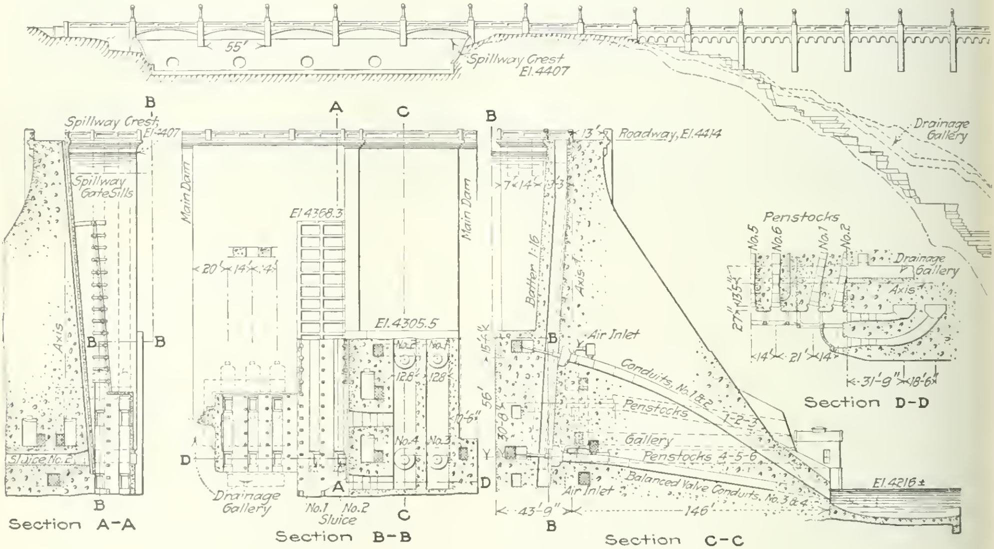

FIG. 2. DETAILS OF OUTLETS OF ELEPHANT BUTTE DAM

The service of irrigation water through the dam was assumed as 2,100 sec.-ft. to be furnished in part through the penstocks after the installation of the power plant. Until then the service and sluice gates must furnish this amount. The two levels of the four service gates are so arranged that the maximum functional head of the upper balanced valves (the static head of the spillway level plus the suction head at the point of issue of the jet) is about equal to the maximum functional head of the lower balanced valves obtaining when these latter must be put to use because the upper valves, wide open, cannot furnish the required 2,100 sec.-ft. on account of the lowering of the reservoir level (to about 45 ft. below the spillway). As a matter of fact, the maximum functional head of the upper valve is made somewhat smaller than that of the lower valves, because the upper gates will have to pass more water under their maximum head than the lower valves. After the reservoir level has dropped to about 100 ft. below the spillway, the two lower balanced valves, wide open, will not be able to discharge 2,400 sec.-ft., and then one sluice gate may be opened wide (72 ft. static head) and the deficiency supplied by control of the balanced valve. Finally, both sluice gates are opened wide, and a balanced valve controls the deficiency. Such disposition is of course much preferable to the one where the needle valve is wide open and the partial opening is made with the sluice gate, the advantage of the former being due to the solid jet from the needle valve for any opening and the absence of metallic vibrations such as may occur at the lower end of the partly open sluice-gate leaf.

A 5-in. diameter bypass connection is provided for the upstream and for the downstream sluice gates and a 6-in. bypass for the slide gates of the service wells. A bypass for the penstock gates will be arranged later, at the toe of the dam, making a connection from the 15-in. penstock to all of the 5-ft. diameter penstocks. Thus all the slide gates can be relieved from pressure, which is of importance when it comes to open a gate under a heavy head after it has been closed for a long time and become "frozen" to its seat. Of course, any of the slide gates may in an emergency have to be closed under full head, but to close a slide gate under high head requires less force than to open it under the same head, especially if it had been closed for a long period.

As stated above, the passages of the needle valves as well as the sluice passages will serve for irrigation water. These six passages converge toward a pool at the toe of the dam which is provided with heavy curved concrete floor and sides so as to prevent attack on the river bed on the part of the issuing jets. The convergence of these six passages required curvatures of the passages in their vertical planes, and these curvatures were made so that the jet under maximum possible head will hug the bottom of the passage.

A generous supply of air under atmospheric pressure to the point of issue of the jet from a slide gate or needle valve under high head is of importance, especially for partial openings of these gates or valves. Such air supply will reduce or destroy the partial vacuum created by the jet and thereby will reduce vibrations, will make the jet more steady and prevent the detonations that may be occasioned by the entrapping of air by the jet and its subsequent release from under pressure into a partial vacuum. For this purpose the gates that will work with partial opening—the upstream sluice gates and the needle valves—were provided with air inlets just below the seat of these gates or valves. Each upstream sluice gate has four 3½-in. diameter pipes terminating in the roof of the passage just beyond the face of the gate, and these pipes run into a manifold with 7-in. diameter pipe connection. The needle valves have each a 12-in. diameter air connection.

The air is brought to annular conduit surrounding the liner of the 5-ft. diameter passage near the plane of maximum contraction of the jet, and from this annular conduit the air runs to the jet through a large number of holes in the liner. A larger air inlet, serving likewise as a manhole, is provided on top of the 5-ft. diameter passage about 16 ft. downstream from the seat of the needle valve.

All gates and valves are operated from chambers inside the dam body. The chambers of the same battery of gates are interconnected, but the chambers of different batteries, as a rule, are not. This is done to prevent flooding of the chambers of one gate system by a possible accident in a chamber of another gate system. Thus the chambers of the penstocks are interconnected, and they have their individual gallery of access (*A*), shown in Fig. 2.

The chambers of the two upstream sluice gates are interconnected (also shown in Fig. 2), as are those of the downstream sluice gates, but each system has its own gallery—gallery *B* for the former, the drainage gallery of the dam for the latter—and one gallery cannot be flooded from the other. The lower needle-valve chambers are nearly on a level with the floor of gallery *C*. This gallery has a riser to the chambers of the upper needle valves. The four chambers of the needle valves—being the valves that need most frequent attention—and gallery *C* can also be reached from the top of the dam through a vertical elevator shaft. This elevator will be used by the attendants of the power house on their way to and from their dwellings on the hill above the dam. The slide gates of the service well are accessible from the same gallery *B* that connects with the chambers of the upstream sluice gates.

The numerous passages, chambers and galleries in the body of the dam required an addition to the upstream and downstream faces of the dam throughout the block in which they occur. These additions are made large enough so that the critical stresses in the dam body are not larger here than elsewhere.

The Elephant Butte Dam has been referred to in several articles in *Engineering News* as the storage dam of the Rio Grande Project, United States Reclamation Service, A. P. Davis, Chief Engineer, L. C. Hill was supervising engineer and later consulting engineer. E. H. Baldwin, succeeded by L. J. Charles, was the construction engineer. The writer designed the outlet control system and gates.

Booster Pumping Station for Water-Supply to a Suburb

The municipal water-works system at Sioux City, Iowa, includes a booster pumping plant for serving the suburban district of Morningside, and this plant is to be enlarged after five years' successful operation. The district has a 10-in. main with 6-in. branches. The elevation of the district is 161 to 170 ft. above datum, while that of the city reservoirs is 261 ft., and recording gages on the hydrants showed pressures of only 22 to 31 lb. To give an adequate fire pressure it was proposed to build a pumping station between the city proper and the suburb, delivering water to a standpipe 120 ft. above the highest point of the latter, or about 270 ft. above datum. However, the cost of this was prohibitive.

The plan adopted was to build a substation at a point 115 ft. above datum, where the static pressure is 50 lb., and to install three two-stage centrifugal pumps. Each of these has a capacity of 370 gal. per min. when pumping against a head of 215 ft., and when they are drawing at the rate of 1,000,000 gal. per day the pressure in the suction main will not fall below 15 lb. Each is driven by a 40-hp. 500-volt electric motor, running at 1,200 r.p.m. One pump is used as a relay and is operated only in case of a large fire.

The pumps deliver the water into a header connected to a steel compression tank 6x23 ft. This is provided with a small motor-driven air compressor, which keeps the tank more than half full of compressed air, forming an expansive cushion which maintains the water pressure between the time of stopping and starting the pumps. An electric regulator starts them automatically when the pressure falls below 50 lb., and stops them when the pressure reaches 100 lb. A new 12-in. supply main has been laid recently to this booster station.

Water is pumped through the 10-in. discharge main for a distance of 3½ mi. Pressure tests at hydrants about 1 mi. distant (using four streams from 2½-in. hydrant connection and 1-in. nozzles) showed 65 to 75 lb. pressure at the nozzle, with vertical streams thrown to a height of 84 to 90 ft.

The mechanical efficiency of the pumps was 75% at the time of installation. Current is taken from the lines of the Sioux City Gas and Electric Co. and the Sioux City Service Co., connections being so arranged as to prevent loss of power in case of accident to either line. It is furnished at the flat rate of 2c. per kw.-hr. The average monthly consumption is 3,000 to 3,150 kw.-hr., with bills ranging from $12 to $61 per month. The booster station now furnishes water to 1,980 service taps in the suburban district.

This plant was designed by F. W. Cappelen, consulting engineer, of Minneapolis, Minn. Plans for its enlargement, along the lines of the original installation, have been ordered by J. M. Lewis, Commissioner of Parks and Public Property, who described the system in a paper presented at the recent meeting of the Iowa and Illinois Sections of the American Water-Works Association, at Davenport, Iowa.

Maintenance of Macadam Roads with Bituminous Binders

By Theron M. Ripley*

SYNOPSIS—A summary of experience on Division No. 3, New York State highways, with recommendations for practice based on this experience: a detailed description of procedure.

Aside from the interest that highway engineers have in the use of bituminous oils[1] on roads, every automobilist has a more or less personal interest too. Probably no other portion of highway construction or maintenance has so many disrespectful things said about it. It dirties the car, and father and son lose their temper. It spots mother's new veil and sister's white hat, and they, also, become peevish.

Cold oiling to a macadam road is what the bath is to the small boy. He may not like it, but it is good for him; and no substitute has been found. The period of bad traveling, over any particular piece of oiled road, should not exceed one week during the months of July and August, and frequently it is less.

Two General Classes of Macadam To Be Maintained

The macadam roads of New York State are of two general classes—waterbound and bituminous-bound (penetration method). Both need constant maintenance, and a light application of bituminous oil, so far as shown, is the best "life-saver."

Waterbound roads, subject to horse-drawn traffic of medium weight, have remained in fair condition for a number of years with little or no maintenance—so it is said. Under a traffic consisting of horse-drawn and motor-driven vehicles it is known that many waterbound roads rapidly go to pieces.

This can be readily accounted for as the horse-drawn traffic loosens the top stone, the motor traffic raises the loosened binder, and the wind floats it into the adjacent fields. Further, a heavy, fast-moving motor vehicle not only displaces the loosened stones, but frequently throws them from the roadway.

Dust spells deterioration. The principal function o the first application of cold tar to a waterbound road i as a dust layer. The dust or binder remaining in plac assures the stability of the top stone, and the road the wears out only by the actual grinding away of the roa metal.

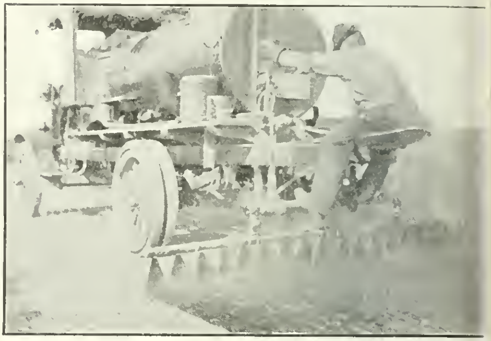

FIG. 1. MOTOR TRUCK DISTRIBUTOR FOR COLD OI USED BY JEFFERSON COUNTY

Some Specific Examples

For example, take three roads, one built in 1911, tw in 1914-15—call them roads Nos. 1, 2 and 3. No. was built by a firm from eastern New York; No. 2 wa built by a firm from New England; No. 3 was built b

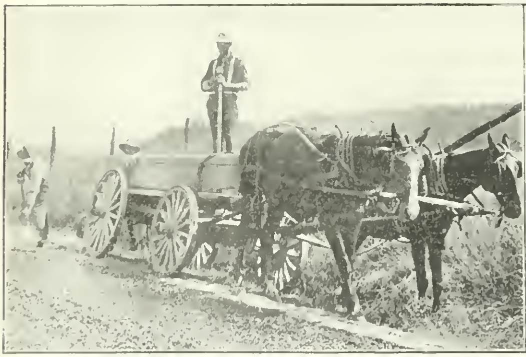

FIG. 2. SPREADING 1-IN. STONE AFTER THE FIRST POUR

Note the rut made by the wheels of the distributor in the center of the road. This rut requires careful manipulation of the roller to obtain a smooth road. Owing to this condition, contractors are advised against using this type of distributor for the application of binder for penetration

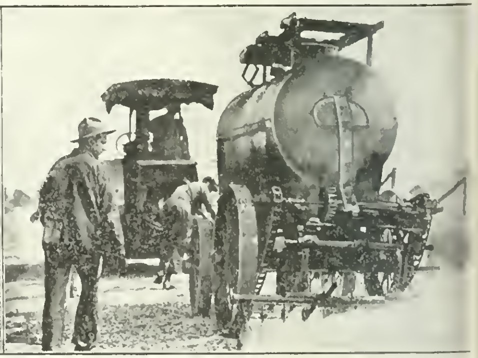

FIG. 3. "MONARCH" DISTRIBUTOR HAULED BY ROLLER, MAKING FIRST POUR

It is necessary to go over the road twice in order to secure the necessary amount of material for the first application. The machine is delivering about 0.4 gal. per sq.yd. per pour. After the first pour just enough 1-in. stone are spread to prevent the wheels sticking during the next pour

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*Division Engineer, New York State Highway Department, Watertown, N. Y.

[1] The word oil is used throughout the text to denote bituminous materials in liquid form, although they are not oils in any true sense.

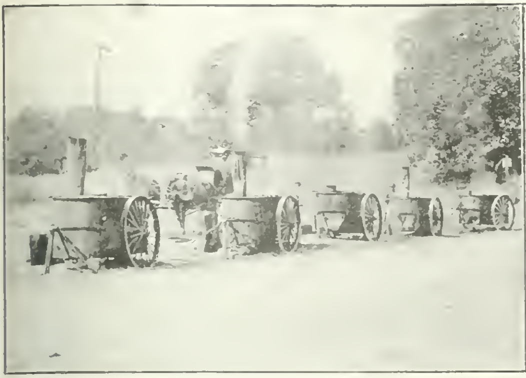

FIG. 4. BATTERY OF 100-GAL. HEATING TANKS

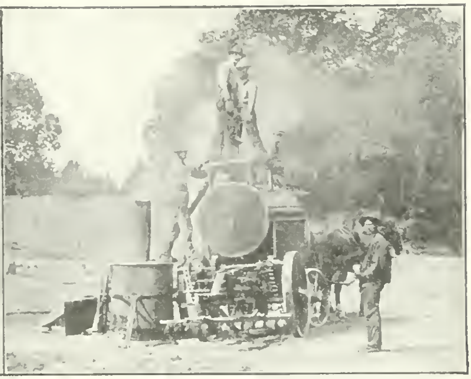

FIG. 5. TRANSFERRING HEATED ASPHALT FROM THE HEATER TO DISTRIBUTOR

In these pictures of heater and distributor it must be borne in mind that we have used the equipment at hand and not that it is necessarily the most economical. An economical equipment for this class of work would be larger heating tanks and a different type of distributor which would require but one pouring for an application of any amount required

a firm from the western part of New York. All were firms that had built earlier roads.

The results were: Road No. 1 was in fine condition in the fall of 1914 and early spring of 1915; it began to ravel in May, 1915. Of road No. 2, the part built in 1914 was in fine shape until early June, 1915, when it began to ravel in small spots. Of road No. 3, the part built in 1914 was in fine shape until the early summer of 1915, when it began to ravel.

Road No. 1 was granite with limestone screenings for binder. Roads Nos. 2 and 3 were all limestone. From the foregoing it will be recognized that the roads all began to ravel about as soon as they dried out after the spring rains. They all became dusty, particularly Nos. 2 and 3.

The traveling public did not hesitate to write the state highway commissioner or personally tell the division engineer how miserable these roads were, how incompetent the State Highway Department employees were, or what a crime it was to waste the state's money in building such roads. So discriminating has become the road user that dusty roads, however smooth, are no longer fit to ride over (provided they have been built by the state).

Since the first application of cold tar to these roads—and Nos. 2 and 3 received an oiling as soon as they were turned over to the maintenance department—no word of complaint has been registered. What is now being offered is advice as how best to apply the oil and cover.

How, When and Why To Apply Oil

A cold-tar application on waterbound roads should be made annually until a thin bituminous mat has been formed upon that portion of the road taking the most of the wheel impact. Upon roads having an exceptionally dense and large proportion of pneumatic-tired traffic this mat may extend over practically the entire width of the road after the first or second application, but on the large majority of roads it will be impossible to obtain this mat over the crown and along the edges until after at least two and probably three applications. This usual condition is due to the cutting of the mat by horseshoes and the lack of sufficient "ironing" by the softer tires to keep it bound together.

The bituminous roads do not, usually, need a cold-oil treatment until after at least one year's use. But the mistake, frequently made in the past, was to wait too long before making the first application. This application should be made as soon as the stones are so much exposed that the road can be called toothy or chattery; and it must not be too chattery, for you will either wonder later where your cold-oil application went to, or be forced into using a heavier asphalt or tar binder with correspondingly heavier cover, the limit of which is hot oiling.

Some years ago it was a statement of derision and contumely to say, "You are building these roads for the automobile owner," and arguments were strenuously advanced to combat that statement. Today it is admitted that the roads *are* being built for the motor-car owner; for the automobile, truck and motor cycle.

During the period of time when the road is undesirable because of the cold-oil application, the interests of the Highway Department, as the road maintenance force, and the interests of the automobilist clash. This clash is unavoidable unless more money is spent to achieve the same results; namely, more cover must be used in order to practically smother or entirely blot the bituminous application and thus prevent it from sticking to the car or being spattered on the occupants.

The Process of Oiling Described in Detail

The process of cold oiling is very simple and consists of four main operations: (1) The patching of the road; (2) the sweeping of the road; (3) the furnishing and applying of the oil; (4) the furnishing and applying of the cover.

Patching should always be done by the departmental forces unless some unusual conditions permit a cost-plus-percentage contract. No lump-sum or unit-price bid can be intelligently made or will be faithfully executed on this class of work.

The last three operations can be done under contract, although departmental forces, with the necessary equipment and one season's practice, can save the bulk of the contract profit, cover only what is needed and so conduct the work as best to fit the road and traffic conditions.

Sweeping bituminous roads is frequently a joke and sometimes a calamity. This type of road is often as clean as wind and rain can make it, with the exception of a few inches on the edges. When sweeping is necessary, it is done usually with a horse-drawn machine, and it never should delay the work; moreover, the road must not be swept too far ahead of the oiling, as dirt from connecting roads, fields, etc., is constantly being brought upon the macadam. A few hand brooms should always be kept with the oiling gang in order that horse droppings, material missed by the sweeper, etc., can be removed.

The cold oil is usually shipped to the nearest railroad siding in tank-cars, thence pumped into the oiler or supply tanks and hauled to the site of the work. In some cases of long haul, small amount of oil and inadequate equipment, it is cheaper to purchase and deliver the material at the work, in barrels.

The value of the use of supply tanks for transporting the oil from the railroad to the work can only be determined for each individual case, as it depends upon the haul and the class of equipment. The use of supply tanks adds the cost of another pumping and the tying-up of more equipment, if anything goes wrong with the organization; nevertheless, with horse-drawn oilers or distributors the supply tanks are necessary for economy on hauls of more than 3 mi.

With this class of equipment the pumping of the oil is done by hand, using a heavy barreled boat pump and trough. With motor-distributor equipment upon which is mounted a power pump for transferring the material, much longer hauls can be made, and in the majority of cases the supply-tank equipment can be dispensed with.

Practically all the applications made on this division are within the range of $\frac{1}{6}$ to $\frac{1}{3}$ gal. per sq.yd. of macadam; and the majority are between the limits of 0.2 and 0.25 gal. per sq.yd. The oil is delivered from the distributor to the road under pressure through nozzles set into a horizontal pipe at the rear of the distributor. The pressure is provided by a pump built into or set upon the frame of the distributor for that purpose. The amount of material spread is varied by regulating the pump, changing the nozzles, changing the speed of the machine (horses or motor) or by any combination of the three.

The lighter applications are used upon bituminous roads in good condition and the heavier applications upon new waterbound macadam or macadam in poor condition—poor condition comparatively.

Covering a Cold-Oil Application

Immediately after the application of the bituminous material it should have a covering, as thin as it is possible to spread and cover the oil. Depending upon the weather, the character of the road, the oil and the length of the work, one or more men must be continually "touching up" with more cover the places that "bleed through." Each new application of covering material should be made as thin as possible in order that the amount used be a minimum, and that the road proper may absorb a maximum amount of the oil.

If clean, small stone are used for the first cover, sand, iron-ore tailings or even sandy loam in small quantities should be used as a second light-cover material. Small stone used without finer material is a perfect nuisance to automobile travel, being readily picked up by the tires, particularly if they are of the non-skid type. To bury the oil with clean stone so deep that traffic will not be unduly inconvenienced requires an excess of cover, and a large amount is eventually of no account as a wearing coat. The binder is too light (thin) to hold it in place.

The instructions should be: Put the cover on uniformly, as thin as possible, and often enough so that the road does not look greasy. Because an automobile traveling 25 or more miles per hour picks up some of the mat is no reason why more cover should be used, but it is a reason why the motor speeds should be reduced.

How and When To Do Hot Oiling

As carried on in this division, hot oiling is a process between cold oiling and resurfacing. The surfacing materials are greater in volume or size, or both, and the labor and machinery equipment more extensive than for cold oiling. Hot oiling is resorted to when the top course of the road is pitted or rutted, beyond repair by cold oiling, but when it is of sufficient thickness so that resurfacing is not required.

In general, the sequence of operations is as follows: Patching and shaping; cleaning (sweeping?); furnishing and making the first application of oil; furnishing, applying and rolling the No. 2 stone (1-in. stone); furnishing, heating and applying the second application of oil; furnishing, applying and rolling the No. 1 stone ($\frac{1}{2}$-in. stone).

After the material is delivered along the road the equipment ordinarily required is: One horse-drawn sweeper; one-half dozen rattan or wire push brooms; two or more heating kettles (250-gal.); one distributor with pump (same machine as used for cold oiling); one roller (8- to 10-ton); two or three hand pouring pots; shovels, picks and other small tools.

From 0.4 to 0.6 gal. per sq.yd. is applied at a temperature of about 250° F. to the old road, after it has been cleaned and patched. Patching also must include any small amount of reshaping necessary, for it is a doubtful proceeding to attempt to shape the road or remove any irregularities, except of minor degree, with the hot oil and its cover. The more regular or better shaped the road surface prior to the application, the better the finished job.

Immediately after the first application of oil the 1-in. stone is spread so as to have, as nearly as possible, but one thickness of stone on the oil. The oil should be covered, but the stone should not be piled upon each other. The roller is passed over the newly spread stone until the latter is crowded together, pushed down into the oil and the surface has a generally smooth appearance. If the stone is brittle, or softer than desirable, care must be taken not to over-roll and thus preclude the penetration of the second pour.

The second, or squeegee, pour is then made (0.3 to 0.4 gal. per sq.yd.) and the $\frac{1}{2}$-in. stone spread upon it. The spreading of this cover or wearing course should be made as was the former—namely, thoroughly to cover the oil, but not pile up the material.

The rolling of the wearing course can proceed immediately if the weather is cool. On exceedingly warm summer days it may be necessary to keep the roller off this course for several hours. After the oil has hardened sufficiently, and the rolling can be done, it should be continued as long as other demands upon the roller will permit.

Hot Oiling vs. Cold Oiling

The value of hot oiling and the advisability of doing it are debatable questions on this division. Some roads treated in this manner two and three years ago are in fine shape; some are in miserable condition and the despair of the man in charge.

The kind and condition of the original surface, the amount of oil per application, the character of the stone used and the ability of the men on the job all are factors of what may be called the first term. The factors of the second term are the kind of oil, the kind and amount of traffic, and the air temperature. Asphalts are more susceptible to temperature changes than tars and have been practically abandoned for this class of work in this division.

If the application forms merely a blanket upon the old road with practically no bond, it will move under the traffic when such traffic is heavy enough or when the temperature is sufficient to soften the oil, or both.

In considering the two types of maintenance work as outlined in the foregoing it must be borne in mind that in general they are distinctive not only as to method of application, but also as to function. In considering the costs of this work it must be further realized that one method can and is frequently shaded into the other. Such shading can be intelligently done only on a basis of experience.

In the costs, following, only the types as distinctive will be considered—namely, cold oiling with light cover and hot oiling with heavier cover. The shadings or gradations will be neglected.

Cost Data on Hot- and Cold-Oil Applications

Labor is in general the same over the entire State of New York. The prices of asphalts and tars vary only as to freight rate; the price of stone and fine cover as to availability of supply—namely, from digging it out of a bank along the road to purchasing from commercial organizations and payment of freight and haulage.

Light covering material can be obtained upon only about 5% of the total mileage. Therefore, local material can be disregarded in a general cost statement. There are two commercial stone quarries in the divisional area of 7,700 sq.mi. Only one of these furnishes material that can be used by this department, and that one is on a branch railroad.

During the season of 1915, in Division 3 there was cold oiled, 240.15 mi. of macadam road, equal to 1,961,102 sq.yd. of metaled surface. This amount was divided as follows:

	By Contract			By Departmental Forces		
	Amount		Cost per	Amount		Cost per
Type	Miles	Sq.Yd.	Sq Yd	Miles	Sq.Yd.	Sq Yd
TREATED WITH TAR						
Waterbound	29 75	258,498	$0.01907	68.57	528,510	$0 01268
Bituminous.	18.18	157,613	01821	32 16	270,995	.03751
TREATED WITH ASPHALT						
Waterbound	8.62	60,660	03756	5 82	29,936	.03716
Bituminous.	75.55	647,390	.03857	0.80	7,470	.05055

The cost of tar (cold application) f.o.b. destination was 7c. per gal. in tank-cars. The cost of asphalt f.o.b. destination was 3.8c. per gal. in tank-cars. No local material was used for cover. The costs for contract work are the actual final estimates and do not include the departmental inspection. The costs for work by departmental forces are the actual payroll vouchers (including inspection) and do not include machinery depreciation.

The following costs by departmental forces are taken from Jefferson County work under Arthur G. Bruce, county assistant, for the reason that 85.53 mi., equal to 704,504 sq.yd., was done in that county. The remaining work was in widely scattered parts of the division, where most of the work was done under contract and where the equipment was more nearly incomplete. In Jefferson County two Packard motor trucks, one three- and one five-ton, were used for hauling materials and transporting men and equipment, thereby facilitating the work. The lighter truck was the more efficient. Neither cost, as shown, includes the division-engineer or Albany office charges.

A typical cost analysis of a contract job (cold application of high-carbon tar) is as follows:

Length of road—miles treated	14.77
Width of road—feet treated	16.0
Area of surface—sq.yd. treated	136,360.0
Average haul of material—miles	6.0
Bituminous material gal. per sq.yd.	0.25
Cover—lb. per sq.yd.	14.0
Cost of sweeping and furnishing and applying oil and cover per sq yd.	$0 04816

A typical cost analysis of a departmental-labor job (cold application of high-carbon tar) is as follows:

Length of road—miles treated	3.5
Width of road feet treated	14.0
Area of surface sq yd treated	26,940.0
Average haul of material—miles	6.0
Bituminous material gal. per sq.yd.	0.25
Cover—lb. per sq.yd.	14.0
Cost of sweeping and furnishing and applying oil and cover per sq.yd.	$0 04005

The cost of hot oiling in 1915, based on the only job done (by departmental forces), was as follows:

Type	Miles	Sq.Yd.	Cost per Sq.Yd.
Bituminous macadam	1.6	11,260	$0.2387

In 1914, 11.57 mi. was hot oiled by two different gangs (departmental labor) as follows:

Type	Miles	Sq.Yd.	Cost per Sq.Yd.
Waterbound	14.57	102,572.8	$0.2002

A detailed statement of the 1915 hot-oil job is:

Cost of 1-in. stone delivered on shoulders of road @ $2 50 per cu.yd. Cost of ½-in. stone delivered on shoulders of road @ $2.50 per cu.yd.	$863.00
Cost of high-carbon tar binder f.o.b. destination @ $0.1075 per gal.	971 88
Cost of unloading and hauling high-carbon tar binder—4½ mi.—@ $0.0087 per gal.	78.50
Cost of patching road, heating and applying tar and applying cover @ $355 89 per mi.	569.56
Cost of rolling (rollerman and fuel)	112 00
Depreciation on machinery (20% of purchase price)	93.00
Total cost	$2,687 94
Number of sq.yd. covered	11,260
Cost per sq.yd.	$0.2387

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Highway Engineers Unpopular in Missouri—Apropos of Missouri methods of handling roadwork commented on in "Engineering News," Oct. 19, one finds the following in the "Ewing (Mo.) News" of Nov. 2; it is a letter to the editor from one of his interested readers: "I notice in the last issue of your valuable paper, 'To abolish the office of Highway Engineer means poor roads.' Now, kind friend, a great many people think the salary of Highway Engineer taken from the road funds materially diminishes the progress of the roadwork. The salary alone would work many miles of road. Just think! Four big special road districts in the county and they do their own work, and fully half of the remainder are worked by donation. Nearly all the neighborhood roads are worked by donation, and lots of the county-seat roads get large donations by the farmers and also by the town people. Now why pay a big salary to anyone to ride over the roads in automobiles and dictate to people how to do this and that, when the average road overseer knows as much or more than the highway man?" The taxpaying people are beginning to realize that officers' salaries are the burden of taxation. We think it is time to cut some of them out."

New Type of Mattress Used for River-Bank Protection

By A. C. Everham*

SYNOPSIS—In this brush and stone mattress construction the stone is held in place between two layers of wire mesh connected by tie wires. It has been used successfully in emergency work.

To protect its right-of-way against erosion by the Missouri River, the Wabash R.R. during the past year has developed a type of mattress and bank paving that is slightly more expensive than methods formerly used, but is expected to be permanent and positive in preventing bank erosion. This method can be and has been used in extreme emergency.

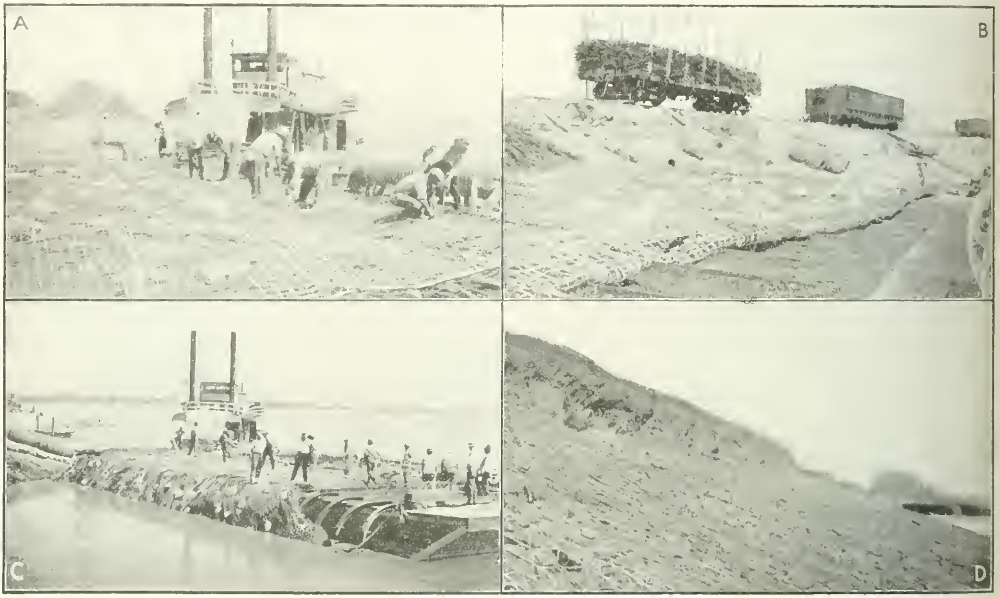

FIG. 1. MAKING THE CUNNINGHAM MATTRESS FOR BANK PROTECTION ON THE WABASH R.R. ALONG THE MISSOURI RIVER

A—Sewing the wire fabric. B—Mattress ready for launching. C—Launching the mattress from barge. D—Shore end of mattress in place

The bank protection used successfully on the Missouri River by the United States Government engineers consists of a willow mat sunk in the river with riprap, and a bank paving of riprap or one-man stone above the water level. The bank is first graded to a slope of 1 on 3 by a floating hydraulic grader. The mat is 86 ft. wide and about 12 in. thick; it is woven on a barge and then floated and sunk by throwing the stone upon it. It is anchored to deadmen 16 ft. 8 in. apart (placed 8 ft. from the top of the graded bank) by pairs of $^3/_4$-in. cables extending (one under and one over the mat) to the outer edge. The bank paving is from 12 in. thick at the water's edge to 8 in. at the top of the slope and is covered with 2 in. of quarry spalls.

This type of construction is employed only during low-water periods, when the mat can be got well out into the river and the bank paved to the low-water line. The railways, however, have to work under very different conditions and often have no sufficient warning of trouble to enable them to take advantage of the most favorable and economical conditions. The river may begin to cut the bank 100 ft. from the tracks, and in a few weeks the railway is forced to move its tracks and perhaps move them several times before material and equipment can be assembled to fight the river.

These attacks come generally during periods of high water, when the velocity of the river is very hard to combat. The railway companies therefore are forced to spend large sums of money for work that is of no value after the river falls. It is almost impossible to use the methods of the Government engineers under these conditions, it being impracticable to hold the outer edge of the mat.

The new method of protection that has been developed consists in the construction of a special type of mattress designed and patented by A. O. Cunningham, Chief Engineer of the Wabash R.R. This mattress has been used successfully on the left bank of the Missouri River near

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*Terminal Engineer, Union Pacific System, Kansas City, Mo. Mr. Everham was Engineer of Construction for the Kansas City Bridge Co., which had the contract for the work described.

Orrick, Missouri City and White Rock, all of which are between Kansas City and Booneville, Mo. The Cunningham mat, as constructed, consists of two layers of galzanized-wire fabric filled with brush and rock and tied through at 2-ft. intervals with galvanized wire. That part of the mat placed below the water level is filled with brush and riprap, while that part above the water's edge is filled with riprap only. Fig. 1 shows the work in progress, and Fig. 2 shows the details of construction.

To build the mat in the river, a barge was necessary, upon which a sufficient number of reel stands were provided to hold the galvanized fabric, which came in rolls 58 in. wide and 300 ft. long. As the fabric was unwound, the different widths were wired or sewed together with No. 12 galvanized wire, so that it made a continuous web the full width of the mat. At the beginning of the operation the wire was unwound so that the entire width of the mat (72 ft.) was laid on the deck of the barge. The edges were then sewed together. Willow brush was laid on the wire in two layers, the first one parallel to the flow of the water and the second at right angles thereto. Sufficient riprap to sink the mat was then placed, this being estimated at 1½ cu.yd. per 100 sq.ft. of mat.

The next step was to cut and place the wire fabric the right length to extend from the outer edge of the mat to the top of the bank. This was then sewed through the rock and brush to the lower layer of fabric with two No. 12 wires spaced 2 ft. in each direction and tightened by twisting with a hook. The sewing of the strips of fabric and the placing of the tie wires are shown in Fig. 3.

On the bank, upstream from the mat boat, were placed several deadmen, to which the upper end of the mat was tied with a number of galvanized-wire strands. The mat boat was then pulled from under the mat by a line fastened to a deadman on the shore and a capstan on the mat boat. The mat made on the barge projects up on the bank, so that the mat above the water level can be sewed to it, making in this way a continuous mat from the top of the bank out into the water about 70 ft. The mat on the bank was made by laying the wire on the bank, sewing the edges together, laying thereon about 9 in. of rock and then laying the wire on top and sewing this through the rock to the fabric below.

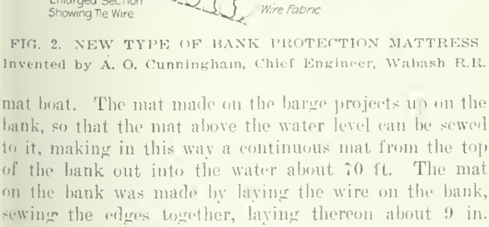
Rip Rap
Galvanized Wire Fabric
⅝" Cable
Deadman
Surface of Water
Brush laid lengthwise with Stream
Stone
9" Mat
Brush laid at right Angles to Stream
2-Nº12 Vertical Wires Twisted
Spalls
Riprap Stone
Enlarged Section Showing Tie Wire
Wire Fabric

FIG. 2. NEW TYPE OF BANK PROTECTION MATTRESS
Invented by A. O. Cunningham, Chief Engineer, Wabash R.R.

One of the advantages of this type of mat is the fact that the rock is in the mat and not on it. On this account it will hang over a very steep bank without damage to the mat. In the case of the willow or pole mattress used extensively on the river the rock sometimes rolls off and the mat floats enough to turn up the edge and permit the water to get behind or under it. In this way the protection to the bank is destroyed, and in many instances considerable damage is done by the water cutting the bank. The mat constructed as in Fig. 2, with the rock inside if it, acts like a curtain. Recent inspection of the work done in the spring of 1916 shows that the mat is in good condition. With some modification it is a very desirable type of construction, particularly in swiftly moving water and where there is a steep bank below the surface of the water.

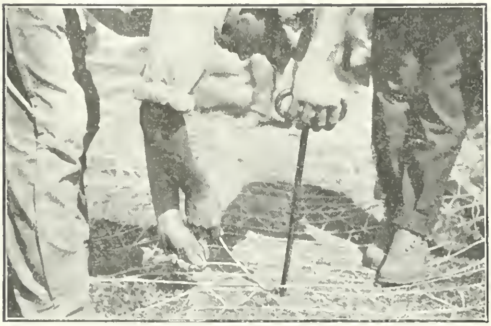

FIG. 3. SECURING THE WIRE NETTING FOR THE MATTRESS

The man at the left is sewing together the edges of adjacent strips of netting. The man at the right has a device for twisting the vertical tie wires

WIRE MAT FOR EMERGENCIES

East of Missouri City, Mo., in March, 1916, the Wabash R.R. found it necessary to stop the cutting of the river bank during a high stage of water in which the velocity of the water was too great to permit the building of a mat. The river was cutting rapidly toward the track, and the ordinary method of stopping the erosion failed. A wire mat was made on the threatened bank, and as this fell into the river the mat settled down with it. When the bank was badly eroded and the mat was hanging in the water some 10 ft. or more, the cutting stopped.

This plan worked so quickly and effectively that when the Missouri Pacific System had a very serious cutting of the bank near Wellington, Mo., its officials used the same type of construction when the usual methods failed. Here it was found necessary in about three weeks to protect some 3,400 lin.ft. of bank at a cost of over $35,000. The wire mat hung over the bank into the river before it stopped the erosion. This protection work, while only of a temporary nature, was successful. Since it was completed, the river has changed its channel, and permanent work may not be necessary at that point for some years.

The construction work for the Wabash R.R. was handled by the Kansas City Bridge Co., which takes contracts for bank-protection work on the Missouri River.

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Macadam Is a City Pavement, according to a decision of the Superior Court at Pottsville, Penn., Nov. 7, in a case where the city attempted to collect $50,000 in assessments against abutting property for a new wood-block pavement. According to the state law, only the cost of the original pavement can be charged against abutters in third-class cities. The cost of repairs and repaving must come out of the city as a whole. The judge held that the macadam surfacing was the original paving. The case is of much interest in Pennsylvania, for many cities had planned paving macadamized streets at the expense of the abutting property.

First Tile Sewers in St. Louis Compared to Brick

By Ben Moreell*

SYNOPSIS—Bids asked for either brick or tile, the latter being accepted because of lower cost. Excellent comparison of brick and tile construction.

Bids were taken on Oct. 15, 1915, for the construction of 9,500 ft. of vitrified-clay pipe sewers from 12 to 33 in. in diameter and 2,800 ft. of sewers from 39 to 57 in. in diameter. These latter were to be constructed "either of brick laid in portland-cement mortar or of two-ring segment block made of vitrified tile." The 357 ft. of 57-in. was to be 13 in., or three rings, in thickness if built of brick; the other sizes (39 to 54 in.) were to be 9 in., or two rings, thick. The specifications allowed a minimum thickness of tile sewer varying from 7¼ in. for the 57-in. to 5½ in. for the 39-in. diameter.

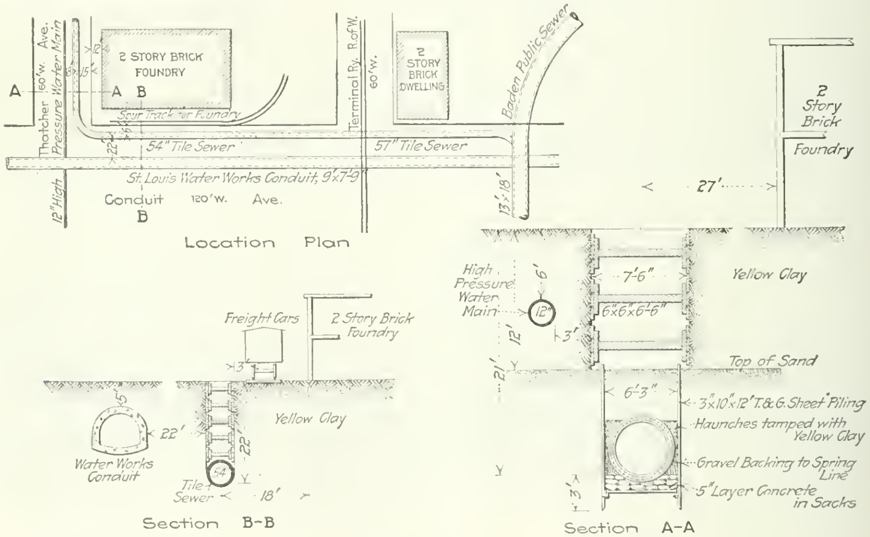

FIG. 1. UPPER—LOCATION PLAN OF TILE SEWER. LOWER—SHOWING TRENCH BRACING IN CLAY AND QUICKSAND

The proposals called for unit-price bids, allowing the contractor his choice of bidding either on the tile sewer and pipe or on brick sewer and pipe. Estimated quantities under both plans were the same except that for the tile sewer a price per lineal foot (for furnishing and laying the tile) was demanded. For the brick sewer the volume of brickwork was estimated and a price per cubic foot of brick masonry called for. A smaller quantity of excavation was estimated for the tile construction because of the thinner shell.

TABLE 1 COMPARATIVE BRICK AND TILE BIDS

Item	Estimated Quantity Brick	Estimated Quantity Tile	Low Bid Brick	Low Bid Tile	Total Amounts Brick	Total Amounts Tile
	Cu.Yd.		Per Cu.Yd.			
Class C excavation	23,700	22,150	$0 65	$0 71	$15,405 00	$15,939 50
	Lin.Ft		Per Lin.Ft			
39-in. sewer	415	415	3 11	2 31	1,290 65	958 65
45-in. sewer	405	405	3 50	2 64	1,417 50	1,069 20
48-in. sewer	465	465	3 69	2 97	1,715 85	1,381 05
54-in. sewer	1,160	1,160	4 08	3 30	4,732 80	3,828 00
57-in. sewer	357	357	6 56	4 27	2,341 92	1,524 39
Total					$26,903.72	$24,700 79

The contract was awarded to the lowest bidder, the George G. Prendergast Construction Co., of St. Louis, which bid on the tile construction. In Table 1 are tabulated the bids of the low bidder on brick and of the successful bidder, only those items which differed in the advertised list of quantities being shown.

It is evident from the table that the cheaper tile construction was the deciding factor in securing the contract. The tile prices listed, however, cannot be taken as representative, as they were undoubtedly influenced by the desire to introduce this new material to St. Louis, this being the first sewer job on which tile bids were allowed. Bids taken on subsequent work were from 10 to 20% higher.

The route is indicated in Fig. 1. The outlet is a 13x18-ft. reinforced-concrete sewer. For the first 900 ft. the sewer is located in the water-works conduit right-of-way and is skirted on one side by the 9x7-ft. 9-in water-works conduit carrying the major portion of the water-supply to the city, and on the other by a large iron foundry, railroad tracks and brick dwellings. The next 1,250 ft. on Thatcher Ave. is made hazardous by the proximity of a 12-in. high-pressure water main 3 ft. from the edge of the ditch.

The contractor made arrangements to use the Ferguson segment block, which consists of an outer heavy ring interlocked by an inner ring of light blocks. The blocks come in 6-, 12- and 18-in. lengths.

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*Assistant Engineer, Board of Public Service, St. Louis.

All excavation was removed by means of a clamshell bucket hung from the end of a 45-ft. boom mounted on a bullwheel derrick. The ground encountered on Conduit Ave. was a yellow jointed clay that slacked and peeled after exposure to the air. The trench was braced tightly with 3-in. horizontal sheeting in 20-ft. lengths, using 6x6-in. crossbraces, spaced 10 ft. on centers, as indicated in Fig. 1 (lower left-hand sketch.) All bracing was left in for the permanent protection of the existing structures. On Thatcher Ave. the ground changed gradually from yellow clay to a fine shore sand and quicksand with large quantities of water.

The right-hand drawing in Fig. 1 shows the method of construction in quicksand. The overlying stratum of yellow clay was braced by horizontal sheeting as before, while 3-in. tongued-and-grooved wood sheetpiling was driven through the fine sand and quicksand to a depth 3 ft. below the flow line of the sewer. The piling was of 3x10-in. yellow-pine boards with a ¾-in. tongue-and-groove. A 3,000-lb. Arnott steam hammer operated in a set of double, fixed leads that moved on rollers located on each side of the ditch.

The bottom was excavated in 20-ft. sections, bulkheads being driven across the ditch at the end of each section. The inch flooring was placed as follows: The section ahead of the finished sewer was excavated to a depth 6 in. above the flow line. Two men then began at the low end and excavated a 3-ft. length of narrow ditch along the sheeting for the 2x4 stringers, which were spiked in place. A space was then excavated for a 1x12 transverse board, which was nailed to the 2x4s. After the first 1x12 was placed, the men had a firm footing as they worked forward, flooring the entire bottom.

This construction furnishes a substantial foundation that effectually resists the upward pressure of the quicksand or any tendency to settle when the succeeding bottom is excavated. An attempt to obtain a foundation by packing sacked concrete into the bottom failed, as it was found that when the succeeding section was excavated, the sand would run from beneath the concrete, allowing the entire bottom to settle. Other methods were tried, but none proved so successful as the transverse boards spiked to the sheeting.

A layer of concrete in burlap sacks was placed on top of the flooring, thus furnishing a permanent foundation. The sacks prevented any loss of cement due to bailing water from the bottom and prevented sand from being washed into the sewer.

No attempt was made to pull any of the sheetpiling, and all horizontal sheeting below the level of the 12-in. water main was left in place.

Laying the Tile

The invert was laid in 20-ft. sections except in unusually difficult places, where 10-ft. lengths were used. For the arch, an 8-ft. wooden center with loose lagging for the central 18 in. was used. This allowed the bricklayer to stand in the center and lay tile on both sides up to the quarter-points, and was found to be the most convenient method of operation.

In good ground the invert can be taken out almost exactly to the proper shape. It was found, however, that even under the best conditions it was advisable to use a small amount of gravel to furnish a firm bearing for the outside blocks, which must be laid true to the correct line and grade. Ordinarily the cost of this extra gravel is negligible, as it averaged not more than ¾ cu.ft. per lin.ft. of 54-in. sewer.

Every 50 ft., 6-in. junctions were burnt on the outer block. The inner blocks were cut to fit around the junctions. All reducers were 10 ft. in length and built of two rings of brick. Manholes were built of brick from springline to the surface.

Pipe connections were made by means of 45° slants. No attempt was made to chip the blocks to fit the slant, the spaces between pipe and blocks being filled with brickwork.

Each course in the invert of curves was laid with a wooden templet cut to the radius. The arch was laid with a 5-ft. center, built to the curve.

Brick versus Tile

A comparison of brick and tile construction might be summarized as follows:

Cost—Judging from St. Louis experience, the tile is undoubtedly the cheaper. On all work where alternate bids were taken the tile has been low. The brick manufacturers claim that this has been due to the specification for three rings, or 13-in. of brickwork for all sewers of 60-in. diameter or greater, while the minimum allowable thickness for a 60-in. tile sewer is 7¼ in. The tile manufacturers, however, claim that they can underbid two-ring work with a comfortable margin for profit.

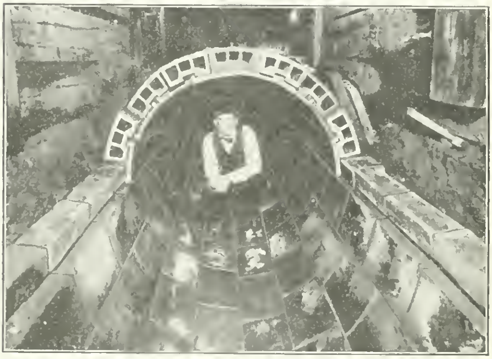

FIG. 2. INTERIOR OF 54-IN. TILE SEWER IN A 22-FT. TRENCH

Strength—A comparative test was recently conducted by the St. Louis Sewer Department. Sections of 60-in. sewer 7½ ft. long—one of tile 7¼ in. thick, the other of two-ring brick 9 in. thick—were buried in the ground and the haunches well rammed up to the quarter-points. Load was then applied through a sand cushion, the loaded area being 4 ft. along the axis of the sewer by 3½ ft. wide.

Both sections showed an initial crack at almost exactly the same load, 57,000 lb. total. The load was then increased to 116,000 lb. Under this loading, both sections were badly cracked, although the tile was in the worse condition and showed indications of collapse. Three days after the last load had been placed, the tile collapsed. The brick was allowed to stand for a week longer; then as it showed no sign of failing, the load was removed.

Readings of the deflection at the center and both ends were taken throughout the test. Judging from these readings and the nature of the cracks which appeared, it seems probable that the entire length of the section acted as a unit in resisting the loading, although only the central 4 lin.ft. was actually loaded. Under this assumption, the first crack appeared at a load of 7,600 lb. per lin.ft., which corresponds approximately to a fill of 17.3 ft. over the top of the sewer in damp yellow clay. ("Theory of Loads on Pipes in Ditches," Marston & Anderson.) The load on the test sections, however, was applied over a width of 3⅓ ft. Marston, however, concluded from his experiments that the load due to ditch filling should be considered as evenly distributed over the top quarter of the arch, in this case a width of 4.4 ft., so that the test no doubt gave more severe conditions than would be given by a 17.3-ft. fill. The 57-in. sewer was built under a fill of 18 ft. and has shown no signs of cracking.

The crushing load of 116,000 lb. is greater than would be provided by a fill of infinite height, according to Marston, indicating that there is small chance of collapse due to the weight of the backfill alone.

Durability—The durability of any material can best be judged by observation under an extended period of service, which precludes a definite opinion of the tile. Judging from the smoothness of the interior, the small number of joints and the imperviousness to chemical action, one would conclude that the tile is at least equal to the brick in this respect.

Leakage—Tile construction depends for its watertightness on the mortar joints between the outer and inner blocks. Unless particular care is taken with this joint, small openings will be left, allowing groundwater to enter. The writer has had some difficulty from this source and recommends that this matter be given special attention. Brick construction is open to the same criticism, but the bricks are more easily handled and can be thoroughly bedded in the mortar. Bricks, being rough and porous, form a better bond with the mortar.

The decrease in the joint area and the smoothness of the glazed blocks themselves undoubtedly increase the hydraulic efficiency of the sewer. Whether the increase in capacity is sufficient to be taken advantage of in the design could be decided definitely only by hydraulic tests. The smooth interior will undoubtedly make the sewer more "self-cleaning," affording small opportunity for filth to adhere to the walls.

These observations are drawn from the experience of the writer as resident engineer on the work. Some of the conclusions may be modified after observing the sewer under service conditions.

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Repair of the Tres Cruces Dam, Cavite Province, P. I.*

By C. R. Bennett†

The Tres Cruces dam is located 7 km. up the Timalan River from Manila Bay. The present structure was completed in 1886, replacing another of the same type which was washed out in the seventies. It is constructed of large cut adobe blocks quarried on the site, laid in porous lime mortar. This mortar, where protected from atmospheric action, has a high cementing value, but it will absorb water to the extent of about 20% of its weight.

The foundations of the dam rest on solid adobe. This was excavated about 1 m. deep, and a number of trenches parallel with the main axis of the dam were excavated still farther into it. The footing courses were started in these trenches, which not only gave the dam more resistance to seepage of water under it, but also gave it greater resistance to sliding.

The structure was built with a gravity section, but this is so thin in places that additional buttresses on the downstream side and a clay bank on the upstream side had to be added later to make it more stable. One section 13 m. in length is 15 m. high and only 6 m. wide at the bottom. This is immediately against the west spillway and nearly at the center of the dam. A small buttress has now been added.

During the last few years the spillways have been badly damaged, the west one having been completely washed away and the east one about 40% destroyed. Approximately 6 gal. of water per second, or 864,000 gal. per day, determined by weir measurements, have been passing

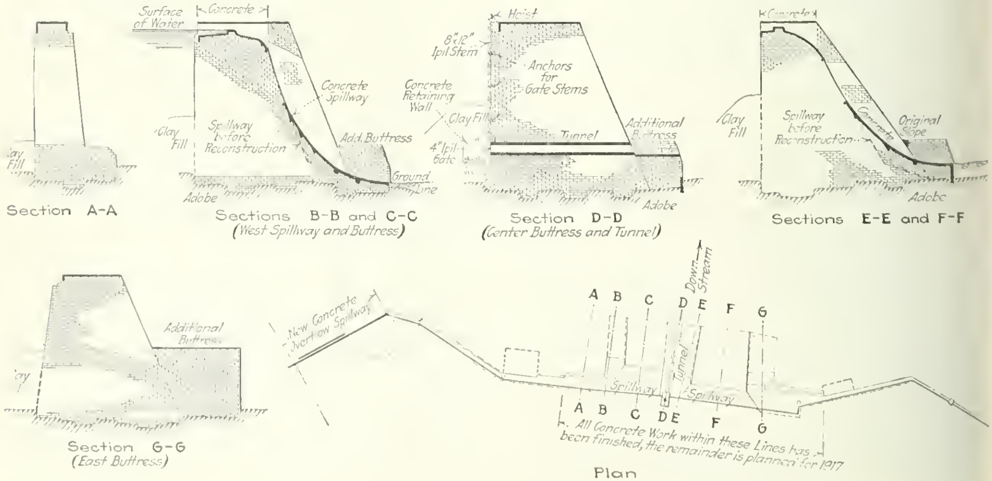

FIG. 1. PLAN AND CROSS-SECTIONS OF TRES CRUCES DAM, CAVITE PROVINCE, P. I.

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*From the "Quarterly Bulletin," Bureau of Public Works, Philippine Islands.

†District Engineer, Bureau of Public Works, Cavite, P. I.

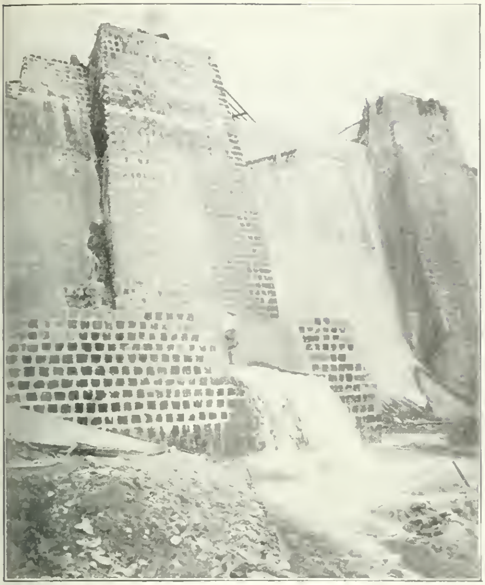

FIG. 2. TRES CRUCES DAM, SHOWING NEW OUTLET TUNNEL COMPLETED

through and under the dam, taking so much away from the irrigation ditch that something had to be done quickly, not only to preserve the irrigation system, but also to put the dam in a safe condition.

An appropriation of $15,000 was made by the friar lands division of the Bureau of Lands, and the Bureau of Public Works was requested to make the necessary repairs. Work was commenced in December, 1915.

A Tunnel To Let the Water Out

To stop the leaks showing in the face of the dam, it was necessary to let the water out; and as no gate had been provided, a tunnel had to be excavated through the structure. This was located at the original stream-bed center.

Clay had been placed by the builders, on a 1 : 1 slope, 5 m. high, on the upstream side of the dam to prevent excessive seepage through and under it, and the elevation of the tunnel was made such that the top of it when holed through came just 3 m. from the nearest surface of this clay bank. It was believed that the clay would withstand the pressure of a 46-ft. head of water (20 lb. per sq.in.) long enough to allow the workmen to escape after they had excavated through the dam masonry into the clay.

The tunnel excavation was made 1.6 m. in diameter and was lined with concrete to leave an opening 1 m. in diameter. Three 8-hr. shifts were employed, consisting of four men each. The adobe and lime mortar were so tough that never more than 1 lin.m. was completed in 24 hr. The heading was kept 2 m. in advance of the cement lining, which was placed in 3-m. sections; and the tunnel was completed at the rate of 60 cm. per day. It is just 18 m. long and required one month to complete.

When the excavation reached the end of the adobe on the upstream side and the laborers had put their picks into the soft clay, they required no instructions as to their course of action if water started seeping through the heading—they simply flew, leaving picks and bars. This was at 9 : 40 p.m. on Sunday night, and at 2 : 30 p.m. on the Monday afternoon following, the water broke through and shot out 40 ft. below the dam before striking the ground.

It took just 48 hr. to drain the basin down to the natural inlet flow, which amounted, during the whole dry season, to a stream 1 ft. deep on the bottom of the 1-m. diameter tunnel. This, however, is only one-third of the amount of water flowing into the reservoir, for another stream 2 km. farther up is dammed and its water delivered through a 300-m. tunnel to the Tres Cruces reservoir. During the repairs to the Tres Cruces dam, this supply was bypassed over the other dam by closing the tunnel.

Hundreds of natives gathered around with nets and baskets to catch the fish as the water drained out. It is estimated that at least 4,000 lb. of fish and several hundred eels, some 6 ft. long, were caught.

Repairing Face of Dam

After the dam was unwatered, a trench 1.5 m. deep was excavated in the clay bank on the upstream side and the whole of that face repointed. Every seam and joint was cleaned out to a depth of 5 cm., and a 1 : 2 cement-and-sand mortar was used for repointing them. Numerous holes were encountered below the water line, some requiring several bucketfuls of grout—28 in one case—to fill them.

A large worm-gear hoist of 6 tons' capacity was installed. A gate was built at the upper end of the tunnel, made of 4-in. ipil timbers and brass bound. A heavy brass-bound frame matching the gate was fitted into the face of the dam by excavating in the adobe, after which a rich concrete mixture, 1 : 1½ : 3, was poured in to fill the space around the frame and to connect it with the concrete lining in the tunnel. The gate opening is 75 cm. square.

Considerable trouble was encountered in making a tight closure, but this was remedied by wedging the gate up tightly against the frame and then calking around the edges from the tunnel side. After the water had risen to an elevation of 30 ft. above the gate, it was hoisted to release the wedges and burlap calking and then immediately lowered into place. It sealed the opening absolutely—not one drop flowing through. With this head the total pressure on the gate (which is 1 m. square over all) was about 10 tons.

One large additional buttress was built between the two spillways and one at the west side of the west spillway, using 30x30x80-cm. adobe blocks and a 1 : 4 mixture of cement and sand for mortar. About 6,000 blocks were used in these buttresses. About 3,000 more blocks were used in building up the ogee surfaces of the two concrete spillways. Round reinforcing bars of $\frac{3}{8}$-in. diameter were used in the concrete surfacing on each spillway, spaced 60 cm. c. to c. both ways, and $\frac{1}{2}$-in. square twisted dowel pins were driven 20 cm. into the adobe at each bar intersection, the reinforcing being wired to these dowels.

Waterproofing Old Dam

Ample provision has been made to carry away any seepage through the dam, liable to be caught behind the concrete, by the use of tile and steel pipe. At the location of the large leak, a trench 1 ft. square was dug the full width of the spillway, filled with 2-in. gravel, and from this a 5-in. vitrified-tile drain was led under the concrete to the downstream side of the curtain wall at the end of the spillway. In addition, every 2 m. along the vertical length of each spillway a 6-in. square trench was excavated and filled with large-size gravel, and every 2 m. a 2-in. galvanized-iron pipe was led out flush with the concrete surface of the spillway floor.

A strong curtain wall was built across from the two buttresses at the outside edge of each spillway, and the concrete was butted up against it. It is 1½ m. deep into solid adobe in the stream bed and is 50 cm. thick. All downstream joints in the masonry were repointed.

An additional spillway was provided at the extreme west end of the dam by constructing a concrete curtain wall from the end of the dam across a natural depression and anchoring it into a high bank on the opposite side. This spillway section is 18 m. wide and is built so that when the water exceeds 1 ft. in depth on the crest of the main dam spillways it will flow over the new one, which will take care of a great deal of flood water. This depression leads away from the dam, and being in solid adobe, can never cause any dangerous scouring around the end.

The total cost for repairs has been approximately as follows:

Materials, Bureau of Supply and local	$6,945
Payrolls and salaries, including 3.75 km. of road construction	3,947
Miscellaneous expenses, transportation, traveling expenses, etc	2,205
Provincial surcharge, 5%	530
Bureau of Public Works surcharge, 10%	1,363
Total	$14,990

* *

Imhoff Tanks and Sprinkling Filters, Cleburne, Tex.

By R. E. McDonnell*

SYNOPSIS—The design of the Imhoff tanks is shown with unusual fullness, both as to arrangement of parts, and the concrete reinforcement.

From a haphazard sewerage system and an old-type septic tank privately owned, Cleburne, Tex., with a present estimated population of 14,000, has recently changed to much more extensive and well-designed municipally owned sewers and disposal works, the latter consisting of Imhoff tanks, a dosing tank, sprinkling filters, secondary tanks and sludge-drying beds. This change was preceded by the acquisition, improvement and extension by the city of the privately owned water-works. A private water company accepted the valuation placed on the plant by the engineering firm employed by the city, but the sewerage company refused to do this.

The effluent from the old septic tank caused a nuisance in Buffalo Creek, a stream with a dry-weather flow so small as not to provide dilution of the tank effluent collected by about 10½ mi. of sewers.

In designing the new disposal works, which at the outset will treat sewage from 33 mi. of sanitary sewers, the writer's firm was confronted with the drastic Texas law of 1913 and 1915, published substantially in full in *Engineering News* of May 25, 1916, page 980. It was assumed, however, that the State Board of Health would interpret the law to meet local conditions. Since the waters of Buffalo Creek are used only for livestock purposes for a long distance below Cleburne, it was decided to install Imhoff tanks, sprinkling filters and final settling basins. From gagings and observations made on the flow in the present sewer system and from the records of the daily water consumption the plant was designed on a basis of 800,000 gal. per day, with provision for a 50% increase when necessary.

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*Of Burns & McDonnell, Consulting Engineers, Scarritt Building, Kansas City, Mo.

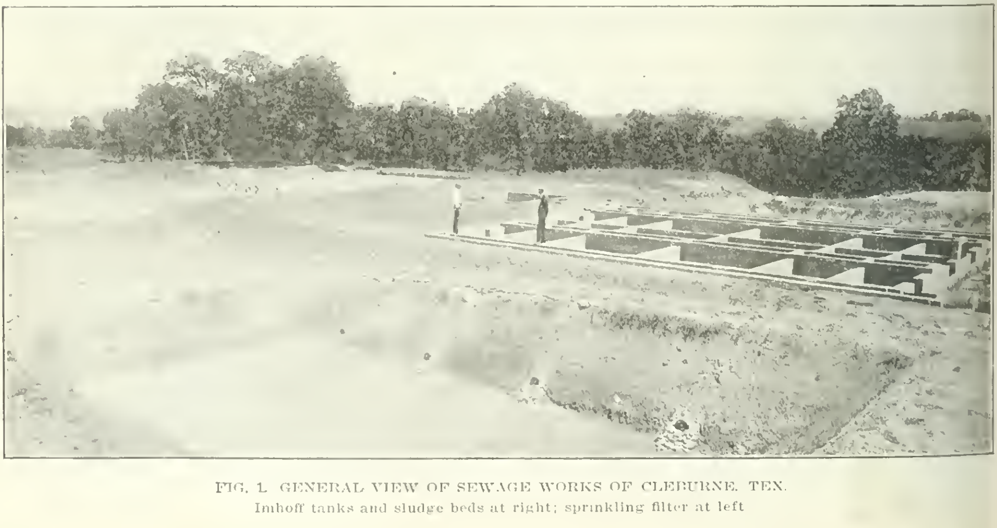


FIG. 1. GENERAL VIEW OF SEWAGE WORKS OF CLEBURNE, TEX.
Imhoff tanks and sludge beds at right; sprinkling filter at left

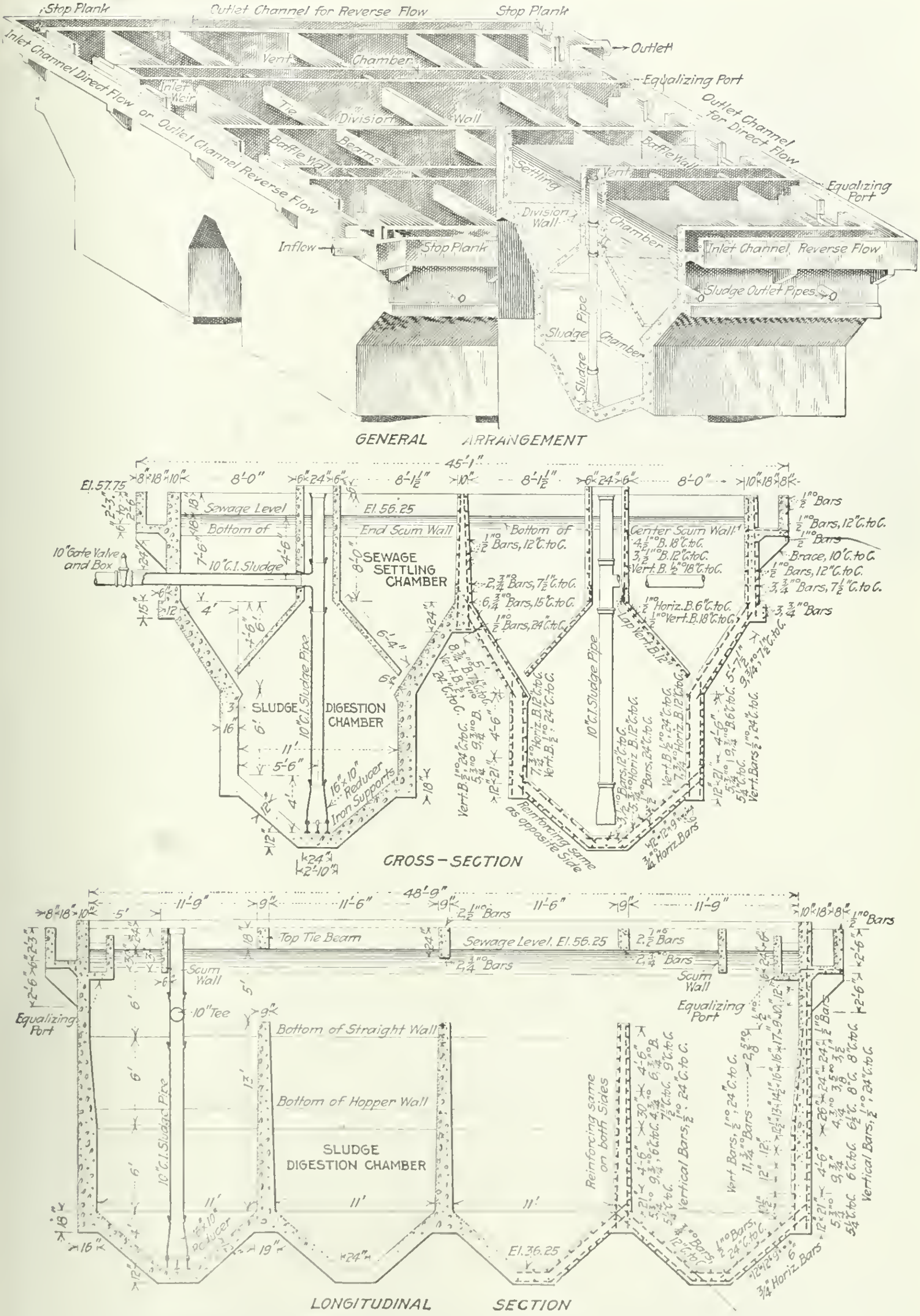


FIG. 2. GENERAL ARRANGEMENT AND DETAILS OF IMHOFF TANKS, CLEBURNE, TEX.

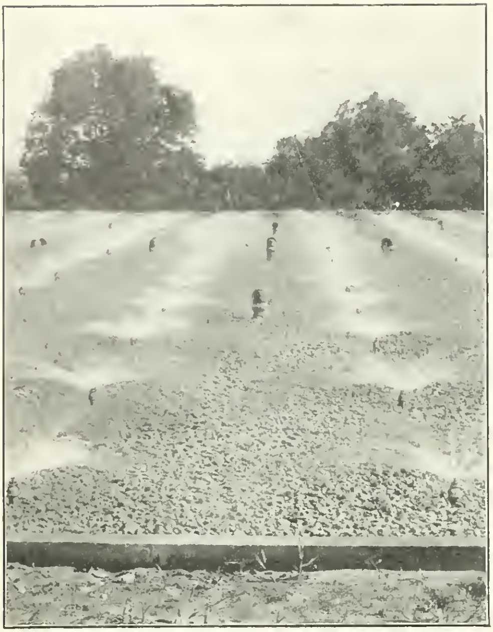


FIG. 3. SPRINKLING FILTER, CLEBURNE, TEX.

The Imhoff tanks (Figs. 1 and 2) are in two units, so that one-half may be cut out of use at any time. Each tank is 19 ft. 1 in. wide by 48 ft. 9 in. long and 22 ft. deep from sewage surface to bottom of sludge chamber. The flow chambers are designed for a 2-hr. retention period, based on an hourly rate of one-eighteenth of the average daily flow. The sludge chambers have a combined holding capacity of about 8,000 cu.ft., sufficient for 3½ months at maximum capacity.

The gas vent is 24 in. wide and extends the full length of each tank. It is formed by continuing the hopper walls 30 in. above the normal sewage level. Equalizing ports are provided to prevent any flow of fresh sewage through the digestion chamber due to any difference in outlet weir elevation or unequal flow into the chambers.

The sewage enters the controlling channels at one corner, flows into the tanks through ports 30 in. wide, two for each tank, and out through similar ports provided with sharp-crested weirs formed by removable iron plates. The ports used as inlets will have a depth of about 6 in. below the sewage level, allowing free passage of floating particles. In reversing the flow a 5-in. iron plate forming the outlet weir will be transferred to the opposite end, thus transforming the outlet to inlet ports. A concrete channel is carried around the outside of the tanks and provided with stop planks so arranged as to reverse the flow by adjustment of the planks and port openings. The tanks are provided with concrete scum walls, located 5 ft. from each end and extending 18 in. below the sewage level.

Each sludge chamber is provided with a 10-in. cast-iron sludge pipe, terminating in a 10- to 16-in. increaser. The outlet pipe is located 1½ ft. below sewage level.

The two 25x50-ft. sludge beds consist of 6 in. of sand on 6 in. of graded gravel over 6-in. tile underdrains, 8 ft. c. to c. The beds were designed to receive approximately 2,500 cu.ft. of sludge at one draw. As the climate is moderate, the sludge digestion will be fairly active the whole year, as the sludge storage and sludge-bed capacity is not as large as would be required in a colder climate.

The tank effluent flows into a tapered dosing tank and is discharged by an 18-in. siphon to the filters. When operating under the rated capacity of the plant, the siphon will discharge about every 6 min.

The sprinkling filter (Fig. 3) covers an area of 0.326 acres and is designed to treat sewage at the rate of 2,225,000 gal. per acre per day. The depth of the stone forming the filter medium averages 5½ ft. The floor of the beds consists of a 4-in. concrete slab on top of which are set 6-in. half-tile drains, 9½ in. c. to c. The floor has a slope of 1 to 40 to the main outlet drains. The upper ends of the 6-in. half tile are connected into a concrete box channel. The main outlet channel is provided with 8-in. vitrified-pipe vents spaced at regular intervals, topped with vitrified elbows that turn with the wind.

The main distributor line consists of a 24-in. vitrified pipe incased in concrete extending through the center of the filter bed. The lateral distributors are 8-in. vitrified pipe, 11½ ft. c. to c., cased in concrete. The risers, also 11½ ft. c. to c., consist of 3-in. galvanized-iron pipe, connected into vitrified tees. The nozzles are of the square-spray type.

The outside walls of the filter beds are of concrete, 6 in. thick, and are not designed to be self-sustaining, but to act as a division between the earth and the stone filter medium. The specifications provide that the earth-fill and filter rock shall be deposited at the same time, keeping the overturning forces counterbalanced.

The effluent from the filters passes into a secondary settling tank, having a 1 hr. retention period, before finally discharging into Buffalo Creek. This tank is about 24 ft. wide and 40 ft. long, with a sewage depth of 5¼ ft. at either end and 7 ft. in the middle, and a drain channel extending from either side to a central gate at the end of a sludge pipe.

The relative elevations of the various components of the plant are as follows: Sewage level in Imhoff tanks, 56.25 ft.; high water in dosing tank, 56; low water, 54; top of filter stone, 48; outlet drain from filters, 41.1; sewage level in final settling tank, 40.75; ordinary water level in Buffalo Creek, 30.5; top of sludge bed *A*, 50; top of sludge bed *B*, 48.5 ft.

The waste excavation will be graded around the plant to El. 49 to protect all parts from high water, which lasts but a very short time. High-water mark is at El. 47, but the water rarely reaches this elevation. Provisions are made for bypassing the tank effluent and the filter-bed effluent directly to the creek.

The improvements were started and made possible through the untiring efforts of Mayor C. W. Breech, who was well supported by a live, progressive council. Bids were received June 4, 1915, on 33½ mi. of sewers and the disposal plant. Hamilton Brothers Construction Co., of Houston, Tex., was awarded the contract for all the work at $114,527, of which the disposal plant amounted to $28,194. Plans were prepared and the construction work was supervised by Burns & McDonnell, Consulting Engineers, Kansas City, Mo., who also made the appraisal of the water and old sewer systems and plans on the waterworks improvements. The plant is now in operation.

Unusual Slide of Canal Lining and Its Repair

[Contributed]

SYNOPSIS—In September, 1915, the lining of a third of a mile of canal extension in the hydro-electric development of the Turners Falls Power and Electric Co., on the Connecticut River, slid into the bottom of the canal. These notes on the original construction, the slide, the probable causes and the methods of reconstruction have been contributed on request by the various engineers connected with the work.

It is commonly known that a slide of power-canal banks occurred at Turners Falls, Mass., on Sept. 10, 1915. Behind that accident, and in the repairs to the canal lining (for the protecting lining was all that failed), lie matters of interest and importance to the engineering profession which it is now useful to disclose. The following paragraphs describe the original construction and the slide, and discuss the probable causes of the failure and the methods used in reconstructing the canal linings.

Original Construction

The main features of the hydro-electric development of the Turners Falls Power and Electric Co., on the Connecticut River at Turners Falls, Mass., consisted of the enlargement of an existing power canal and its extension for a little over 1½ mi. downstream to a new power house utilizing the full local fall of 58 ft. and having a rated capacity of 36,000 kw. A general description of this whole development appeared in *Engineering News*, July 29, 1915.

For a length of approximately 1,800 ft. at the upper end of the canal extension, where the width on top was limited by houses and streets on one side and the railroad right-of-way on the other, the excavation was for a slope of 1 on 1½ with an average total depth of cut of about 40 ft., and a depth below water line of 26 ft. This slope was lined with riprap extending from an elevation 3 ft. above water line to 18 ft. below water line, the upper 11 ft. being of a uniform thickness of 18 in. for the 1 on 1½ slope; below this the surface of the riprap was sloped at 1 on 2 for a vertical height of 7 ft., thus making it 3.3 ft. thick at its base. At this point it rested on a toe of gravel fill sloped 1 on 3 for a height of 1½ ft., 1 on 6 for a height of 2½ ft. and then 1 on 1½ for the remaining foot to the bottom of the canal. At all places where there was very fine sand or clayey material there was an underlining of 18 in. of gravel underneath the riprap to prevent the water carrying the fine sand out through the riprap while emptying the canal. Fig. 7 shows a section of the original construction.

Downstream from this restricted section the canal was continued with a wider cut for a distance of 1,100 ft., the sides sloped at 1 on 2 with no 1 on 1½ slope. With this exception, the lining was made the same way. At the end of this cut the canal broadens out to a forebay pond with embankments on each side sloped 1 on 3 and lined with 18 in. of riprap.

The riprap consisted of stone taken from rock cuts in other parts of the canal and varied in size from fairly small chips to stones ½ yd. or more in volume. It consisted chiefly of sandstone and some shale and was in general rather more in flat slabs about 3 to 9 in. thick than of cubical or spherical shape. It was dumped in loose, except that a line of header courses of stones laid on edge was put in at the bottom and every 8 ft. from there up measured along the slope. The method of putting it in, dumping from the top of the bank 5 to 15 ft. above the top of the lining, eliminated the smaller fragments and the dirt which was left on the slope above the top of the lining. Some rehandling of the stone was necessary to make it conform to the lines of the slope, and this probably resulted in many of the thinner stones in places being laid flat on each other, somewhat like shingles on a roof.

The gravel used for the toe and the lining behind the riprap was also taken direct from the excavation. Although it was somewhat finer than the best quality of gravel and carried some dirt, it was for the most part of the same quality as that which was used with good results, without screening or washing, for concrete in the heavy mass work of the retaining walls.

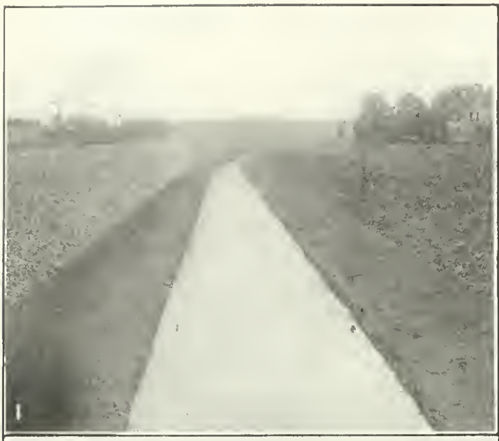
Failure of Riprap Lining

On Sept. 10, 1915, nine days after the water had been started into the canal and about 24 hr. after it was up to water line, the lining of riprap and gravel, over a length of about a third of a mile and for practically the whole of that portion of the canal where there was any 1 on 1½ slope, slid down into the bottom of the canal. A short length of about 150 ft. on the west side, where there was natural gravel behind the riprap, stayed in place. The slide started on the west side at the upstream end and within a very few minutes it extended the whole length on that side. The other side followed almost immediately after the west side had started, as if the wave of the first slide initiated it.

For the most part, the riprap with its gravel underlining piled up across the middle of the bottom of the canal, though in some cases it stopped at the foot of the slope without going beyond across the bottom. In a few local places the riprap slid to the bottom of the slope, retaining in general its character of a sheet 18 in. thick. There was very little slipping of the natural earth of the cut behind the lining, the only places where this occurred being where the top of the cut was in fine sand and the natural earth had been excavated to permit placing the 18 in. of gravel behind the riprap. Thus the accident was not in the nature of a "slide," but more a failure of the lining.

Cause of Failure

The sliding appears to have been due to three main causes, each of which probably contributed its share: (1) The inability of the riprap, with its somewhat shingly character, to stand at 1 on 1½ slope when lubricated by the water (rough tests of slabs of standstone laid flat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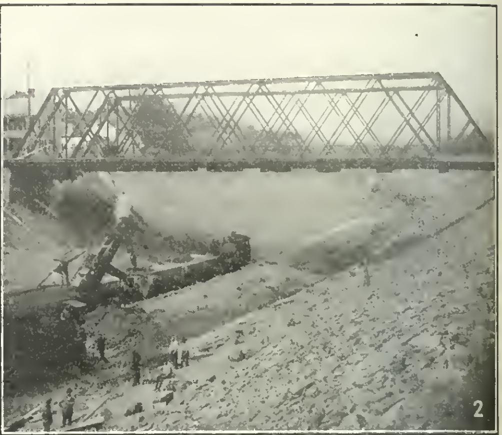
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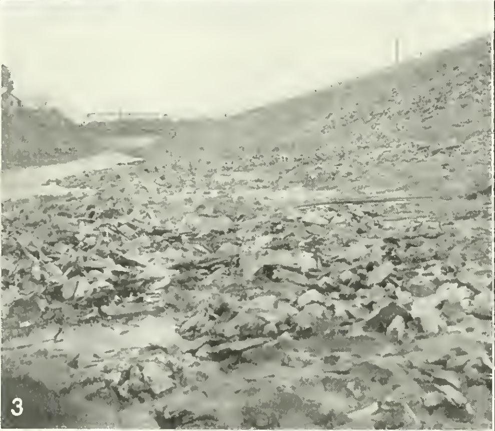
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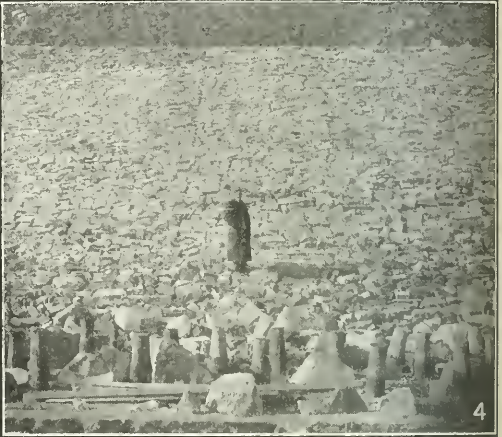
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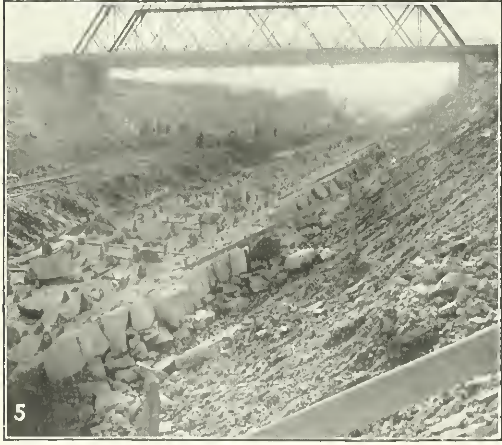
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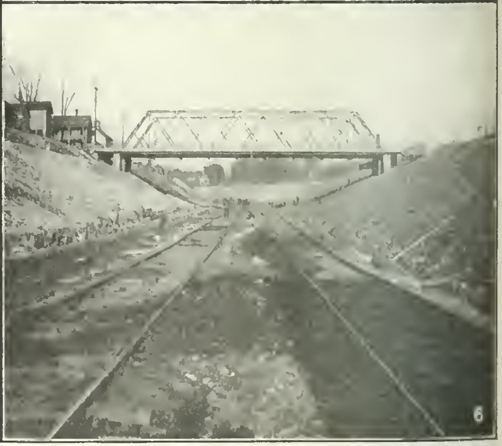
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FIGS. 1 TO 6. VIEWS OF TURNERS FALLS CANAL, SLIDE AND RECONSTRUCTION

Fig. 1—The canal on Sept. 1, 1915, looking upstream; showing original construction. The slide extended a little beyond the bend. Fig. 2—Canal on Aug. 2, 1915, looking downstream; showing original riprap on right, and on the left gravel underlining and toe being placed. Fig. 3—Canal on Sept. 11, 1915, after failure of lining; riprap on bottom. Fig. 4—Completed riprap on west canal bank, viewed from middle of bottom; also shows piling in for concrete toe. Fig. 5—Showing west-side concrete toe and paving, and berm on east side; tracks are on unexcavated material of slide. Fig. 6—Reconstructed canal, looking upstream; east side completed, and west side completed except for berm on toe

on each other at random showed a tendency to slide even at a flatter slope than 1 on 1½); (2) the softening and lubrication of the gravel fill behind the riprap, due to the water making its angle of repose less than 1 on 1½ and putting pressure on the riprap which it could not stand—being very near or beyond its own safe slope—or if not putting actual pressure on the riprap at least providing something similar to lubricated ball bearings for the riprap to slide on; and (3) the failure of the gravel toe to hold the bottom of the riprap once it started to move. Different conditions at various points showed that none of these causes was the sole one. There were places where the riprap slid, first where it had a footing on rock, and there was consequently no gravel toe, and secondly where there was no gravel behind it. There were places where it did not slide, or slid only partially, where there was gravel fill behind it. The gravel toe was evidently stable in itself, as it did not slide in the lower part of the canal, though of the same form.

Reconstruction of Lining

The coffer-dam at the upper end of the canal extension had not been removed, and the water was quickly drawn off from the new canal and work was immediately started on rebuilding this portion of the lining. The following plan was decided on for the new construction: On the east side a strip of land 15 ft. wide was obtained from the railroad, which made it possible to slope this side at 1 on 2 all the way to the top. This was not possible on the west side, where it was necessary to maintain the former top of the slope.

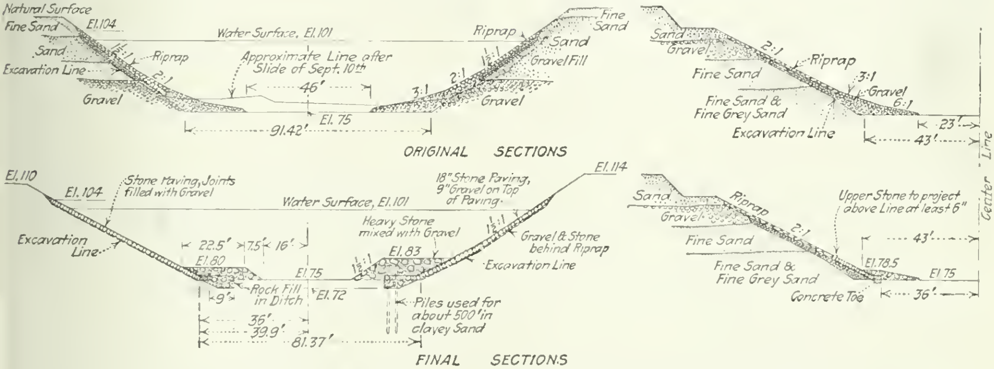

FIG. 7. OLD AND NEW SECTIONS OF TURNERS FALLS CANAL BANKS

On the east side a trench was dug 3 ft. below the bottom of the canal and 6 ft. wide at the bottom. Into this were put very large selected stone with the spaces filled with smaller stone and gravel well compacted to about 1 ft. above grade, making a kind of toe 4 ft. thick. With this toe as a footing, the lining was started, consisting of paving about 15 in. in thickness with the stones laid by hand on edge up to the top. Gravel was spread over this and washed into the spaces with a hose. On top of the toe and extending on the riprap slope a berm of rock and gravel fill 5 ft. high above the bottom of the canal and 22 ft. wide was made to give added weight to the toe. In places where the original material had slid the holes were filled to the back of the riprap with gravel and stone and well compacted with water.

On the west side the same general form of construction was adopted except that in the toe trench after the large stone had been placed, a mat of concrete was put in to a height of 18 in. above the bottom grade, thus making a footing of concrete and large stone 12 ft. wide at the top and 4½ ft. thick. On this footing the paving was laid of stones on edge, in no case less than 18 in. thick. Places where the original materials had slid beyond the original excavation lines were also filled with stone (except those near the top of the slope), so that in general the lining on this side was thicker than 18 in. The berm on the toe at the bottom was built of the same width as on the east side, but 3 ft. higher. Over the paving was spread 9 in. of gravel, which was left to be carried into the spaces between the stones by the water when the canal was filled.

For a length of about 500 ft. where the bank consisted of very fine and clayey sand, two lines of 20-ft. and 25-ft. piles were driven in the toe trench, the tops extending about 3 ft. through the concrete toe, the large stones being placed in among the piles before concreting.

The general method of doing the work was as follows: A steam shovel cut was run through the bottom of the canal at the bottom of each slope, taking out to grade the material which had slipped in, leaving a berm in the middle. This material was used either for paving where possible, or for filling in behind the paving or in the berm and toe. The trenches were dug with orange-peel buckets by locomotive cranes following the shovel. Other cranes put in the large stones which were excavated by derricks and a steam shovel from the main rock dump. The paving on the east side was secured also from the rock dump, but as the season advanced and frost interrupted, quarry waste was purchased for the paving from nearby granite quarries at a cost less than that of excavating it from the dump. The west side thus came to be lined with granite blocks, making an excellent paving. After the sides were well up, the material from the middle of the canal was excavated by steam shovel and deposited directly in either berm, together with other material taken from the dump.

It was decided that it would be advisable to make certain that there would be no future possibility of trouble from the gravel toe at the foot of the 1 on 2 slope of the downstream portion of the cut, where there was no sliding. Accordingly, these gravel toes were removed and replaced with paving resting on a small concrete toe in a shallow trench along the bottom of the slope. A small berm 3½ ft. high and 13½ ft. wide was made over this concrete.

This work was completed and the water started in again on Jan. 1, 1916, the canal being filled to the water line on Jan. 28. Since then soundings and observations show no perceptible movement of the lining, with the exception of a very slight settlement of the berms on each side.

Probably the lesson to be learned from this failure is that the earth slopes of large and deep canals, which must be designed to withstand varying currents and changes in the elevation of the water from a full to a completely empty canal, as well as the ordinary wear and tear due to frost, ice, etc., present problems in which not only the changing qualities of the natural earth at the sides of the canal but of the materials used for lining have a very important bearing upon design and construction.

When there is ample space, economy generally dictates the use for large canals of slopes so flat as to afford security against slipping, and in this case proper designing of linings to resist wear and tear is not difficult. When the space is limited so that steeper slopes must be adopted, economy may still dictate the use of slopes instead of walls, but the engineering problem becomes more difficult. The lining must be designed not only to be stable in itself, but so that it will add to the stability of the earth slope on which it rests.

The available information upon which to base designs of linings for securing stability of steep slopes at a low cost is rather limited. It is hoped that the discussion of this failure may add knowledge on this subject. In this case the final construction was entirely different in character and in consequent expense from what was originally attempted; the failure might have been avoided if similar experiences had been on record.

*

Complex Grade Changes in a Highway Bridge

A heavy street bridge with complex grade conditions has been built by the City of Pittsburgh on Herron Ave. over the Baltimore & Ohio R.R. tracks, on account of the elevation of the tracks at this point to eliminate a grade crossing at 33rd and Liberty St. Formerly, there was a pin-connected deck truss bridge at this point. The new bridge is an 118-ft. riveted pony truss span with concrete-incased floor.

The span is skewed at both ends. This fact, in connection with the flattening of grade on the span from the steep approach grade on either side, results in the break of the grade on the bridge. One of these shows in the truss outline. Further, the approach roadway being flat transversely and the roadway on the span crowned, there is a transition section just beyond either end floor-beam of the bridge. The crown transition and the changes in grade do not coincide.

Part of this situation was caused by the fact that after the ordinance grade line had been fixed, it was

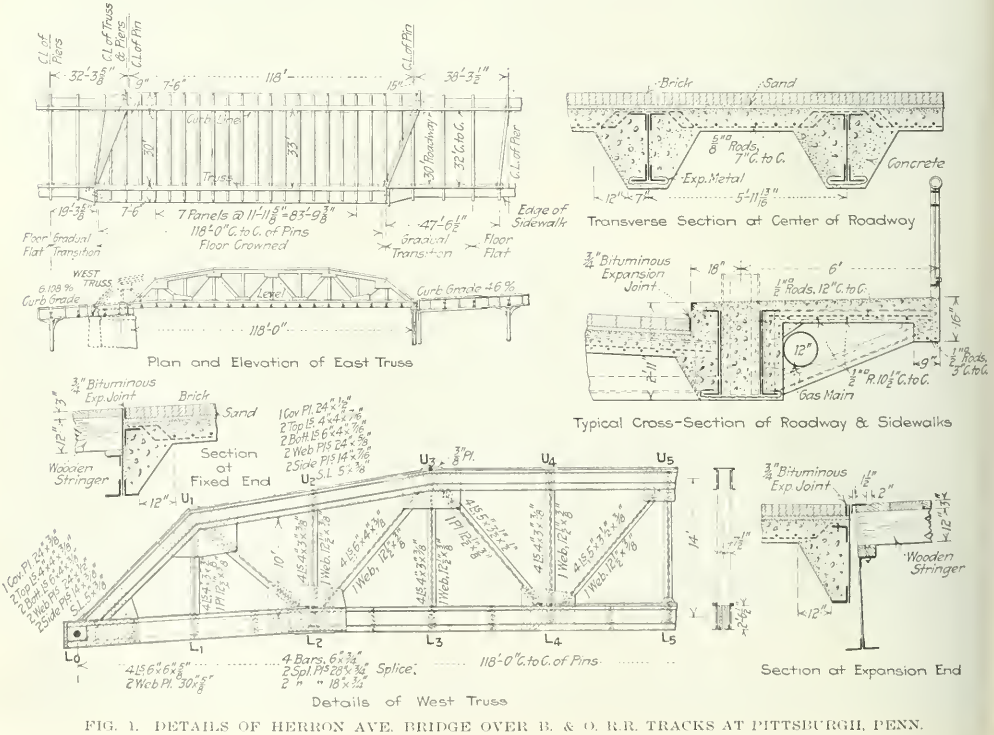

FIG. 1. DETAILS OF HERRON AVE. BRIDGE OVER B. & O. R.R. TRACKS AT PITTSBURGH, PENN.

FIGS. 2 AND 3. HEAVY 118-FT. TRUSS BRIDGE OVER B. & O. R.R. TRACKS, HERRON AVE., PITTSBURGH

decided to lengthen the span. Leaving the grade of the span the same and shifting the foot of the approach to the new end of the span would have made the approaches steeper. One approach was already on a 6.1% grade, and therefore the grades were left undisturbed and the break made within the length of the span.

Both the grade and the crown transition are shown in the drawings herewith. The detail elevation of one end of the bridge brings out clearly how the situation is affected by the skew of the bridge and the fact that the break in grade necessarily is at right angles to the center line of the street.

Very complete protection against corrosive locomotive gases has been provided. The floor is shallow; steel floor-beams spaced about 6 ft. apart support a reinforced-concrete deck which carries brick paving. The incasement of the floor-beams was detailed so as to permit thorough working of the concrete and effective attachment of the concrete layer under the beam. Floor laterals are omitted, in view of the bracing furnished by the floor concrete, which is unusually heavy.

The span contains 3,200 lb. of steel per lineal foot and the entire dead-load weight is 13,600 lb. per lin.ft.

In constructing the new bridge in place of the old the girder approaches were in large part retained. As the new floor level of the span is about 4 ft. above the old, however, it was necessary to raise the approach columns by varying amounts. This was done by increasing the pedestal height, except where the columns were built into a building, as occurred in the south approach. In this case jacking beams were bolted to the columns at the top, the girders raised, and short lengths of columns spliced on. It had been expected that it would be necessary to provide beveled plates at the tops of the columns because of the increase in floor grade, but it was found that in most cases the old columns were so badly out of plumb that the change of angle merely made them more nearly vertical.

On account of the skew of the bridge it was not possible to provide expansion by supporting one end on a rocker bent. Instead, a fixed steel bent had to be provided and expansion bearings placed upon it. This bearing is equipped with specially designed self-locking rockers to prevent tipping in case of over-expansion, as illustrated in *Engineering News*, September, 1916.

Robert Swan is Director of Public Works, N. S. Sprague, Chief of the Bureau of Engineering, and T. J. Wilkerson, Division Engineer of the Division of Bridges, in charge of design and construction.

* * *

Illinois Engineer Corps on the Mexican Border

Interesting information as to the work of Company A, Illinois Engineers, with the troops on the Mexican border is given in the September number of the "Journal" of the Western Society of Engineers (Chicago). This company was called out June 18 and left for the mobilization camp at Springfield, Ill., on June 20. On July 4 the men were mustered into the service of the United States, and (with the Illinois Signal Corps) entrained for San Antonio, Tex., where they arrived July 7.

The first work given them was to design and build a drainage system for the entire camp. The designing and superintendence of this were done by the men of Company A, and the labor was performed by civilian laborers. Culverts were built at all road crossings.

The company was divided into four sections—the Reconnoissance Section, the Bridge Section, the Demolition Section and the Fortification Section. The Reconnoissance Section made a complete survey of the entire camp and a detailed contour map showing the location of all buildings, etc. At New Braunfels a lieutenant and 10 men of the Demolition Section laid out a complete brigade camp.

The next important work was the making of a map from San Antonio to Austin, 85 mi., the map covering one mile on each side of the road. This was done by the Reconnoissance Section, it being divided into four parties, each equipped with motor trucks, automobiles, motorcycles and horses.

The company roster shows that over one-third of the men are technical graduates, and nearly every man has had considerable engineering experience. Ever since the company has been in camp, they have been going on a "hike" each morning before the regular work of the day begins. Each afternoon, when not on special work, two hours' instruction is given to each section. Four men from the company have been authorized to take the examination for second lieutenant in the regular army. Company A is not attached to the Illinois troops, but is under direct orders of the division headquarters and may be assigned to duty wherever the commander may desire.

Notes from Field and Office

Mixer charged by two bucket conveyors—Three methods of surfacing loose sandy soil—Five ways to waterproof drawings—Errors in new type of precise level—Steel transfer plate for muck-cars, instead of switch—What a Mississippi flood can do to a pipe-laying job—Cutting up steel stacks and heavy machinery

Bucket Conveyors Feed Mixer

A conveyor-fed mixing plant, in use in the construction of a four-story addition to the Hume-Fogg High School at Nashville, Tenn., permits rapid charging of the mixer and reduces the force required at the feeding end.

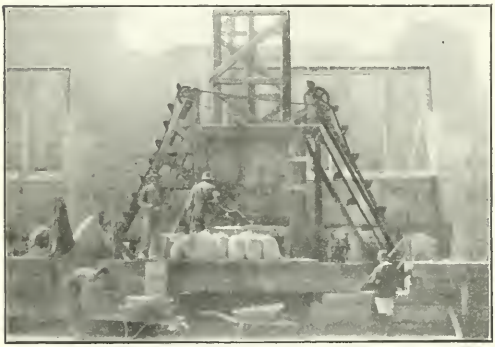

FIG. 1. SHOWING CONVEYORS LEADING TO MIXER

One bucket conveyor is used on each side of the mixer, each descending into a pit, which is surrounded by a bulwark. There is a gate in the bulwark, against which the material—the sand on one side and the gravel on the other—is dumped from motor trucks. On raising the gate, the material slides steadily into the conveyor. It is carried to a storage bin, 14 ft. above the ground, partitioned to hold 5 cu.yd. of gravel and 3 cu.yd. of sand. This is fed through hoppers to measuring hoppers from which the mixer is charged. The feed has a capacity considerably beyond that of the mixer.

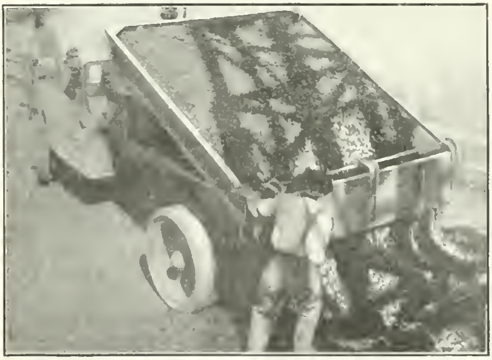

FIG. 2. FIVE-TON TRUCK DUMPING STONE AT SITE

One 6-hp. vertical engine is used to drive the conveyors, one being belt-driven and the other being driven by a connecting sprocket gear above the bin. The mixer is driven by a similar engine, there being a central steam plant.

Two men are used for light shoveling on the gravel pile and one man on the sand pile. One man controls the material hoppers and another is required to discharge the batch. An engine runner and fireman work on both the hoisting engine and the boiler for the other engines. The equipment used in rigging the plant was old machinery, and the entire cost is figured at $100. Two 5-ton motor trucks, each delivering a load from the material yards about 1¼ mi. away, in about 30 min., operate continuously.

The contractor is the Foy-Proctor Co., of Nashville, and the plant was devised by the superintendent, Gordon Jones.

⁂

Good Road Surfacings for Loose Sandy Soils

[CONTRIBUTED]

The following is a description of a broken-stone macadam road 16 ft. wide and over 3 mi. long, built on loose sandy soil. The stone used for the bottom course was 2½ in. in size and averaged about 5 in. in depth. Care was taken not to trench and not to prepare any more subgrade than could be covered with a day's run of stone.

The shoulders were kept high and were not trimmed until the stone in the road had bonded together. The top course was an asphaltic concrete of gravel and binder, mixed hot, and averaged about 2½ in. in depth. The crown of the road was 3 in., and the shoulders had a drop of 10 in. in their width of 8 ft.

Rolling was done with a 10-ton steam roller of the three-wheel type. By working the roller forward, the front wheel was used to compact the loose stone in advance of the heavier back wheels. On a 300-ft. stretch of particularly loose sand, logs were buried in the shoulders to hold the macadam from spreading.

Extraordinarily heavy hauling was done over the bottom course. Because the work was started at the point nearest the base of supplies and carried forward, hauling was done over all new work. The top course was started at the end of the prepared bottom course and worked back toward the beginning. Two Buffalo-Pitts traction engines and eight stone cars of about 5 cu.yd. capacity each constituted the outfit for hauling all materials, which were brought by boat to within 1½ mi. of one end of the job.

The bottom course stood the strain of two winters and all the hauling and did not require any repairs before applying the top. It held its shape so well that it looked like a completed top course when finished.

It would seem that a good road can be obtained over sandy soil by using broken stone filled with limestone screenings and puddled, with a cold-oil and fine-gravel cover wearing course. The cost of such a road will depend upon available materials.

Another example of a road constructed over light sandy soil is one that runs for a considerable distance along the lee of sand dunes and is built of loam. This is an inexpensive and at the same time durable type of road for light traffic. When weathered down, it is shaped and oiled at small expense.

At the present time there is under construction a road 1 mi. in length over sand dunes, cinders alone being used for road metaling. They are placed about 1 ft. in depth by 14 ft. in width. This road is across Nepeaque Beach at the eastern end of Long Island and will make Montauk Point accessible to motorists.

* * *

How To Waterproof Drawings

By F. W. Salmon*

Referring to C. F. Bell's letter in *Engineering News*, Oct. 26, 1916, let me state that at different times I have found each of the following methods very useful and satisfactory for waterproofing drawings, and I believe that they will serve Mr. Bell's purpose.

A. Give the drawing several light coats of white shellac dissolved in a grain alcohol, letting each coat dry before the next is applied. Orange shellac and even wood alcohol may be used; but I much prefer the "white" or bleached shellac, and I object to the wood alcohol because of its injurious effect on the eyes.

B. Give the drawings several light coats of "Zapan" varnish, which, I understand, is made of scrap trimmings of clear sheet celluloid dissolved in acetone and is produced by several Eastern chemical factories and firms manufacturing celluloid articles.

C. When a heavier protective covering is desired than A or B will provide, the drawing may be made wet with the thin celluloid varnish and pressed down evenly on a sheet of thin sheet celluloid, then allowed to dry. This process gives a beautiful clear mounting with 0.01 in. of celluloid on the face.

D. Drawings may be made waterproof with paraffin wax, which is applied hot (melted) with a flat bristle brush. The drawing is then put between two sheets of blotting paper, and a hot (electric) sad-iron is passed over the upper blotter, thus causing the paraffin to be distributed more evenly and the surplus to be absorbed by the blotting paper. The blotters must be removed before they cool. If the wax is thick and white over any part of the drawing or print, sponge it off with benzine.

E. Drawings may be paraffined by dissolving the paraffin wax in benzine and then thoroughly painting the drawing with this liquid or passing the drawing through a bath and hanging it up to dry.

Some of the solvents mentioned are very inflammable and even explosive, so all open lights should be kept away from them. Sometimes they affect certain people injuriously; accordingly, such work should be done only in a well-ventilated room, with a fan to keep fresh air moving over the work.

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*526 North 20th St., Birmingham, Ala.

Bubble-Reading Mirror Proves Source of Error in Leveling

By George Bevier, Jr.*

The merits and faults of surveying instruments form a subject of perpetual interest to engineers, particularly when a discussion of them attempts to point out means of avoiding errors and of attaining greater precision. For that reason I submit a few unofficial observations of leveling instruments.

Several of the engineering parties engaged in the preliminary location of the new railroad now being constructed by the Federal Government in Alaska were provided with levels of the "precision" type, i.e. equipped with a mirror that permits observation of the level bubble from the telescope eyepiece, and with a vertical adjusting screw for precise setting just before reading the rod.

The value of this arrangement was conspicuously evident in attempting to run accurate levels over the many muskegs and quaking bogs encountered in that work, where the only available spots for setting up an instrument afforded such insecure support that the movement of the observer's body from the bubble to the eyepiece of an ordinary wye-level caused the instrument to be thrown out of true level.

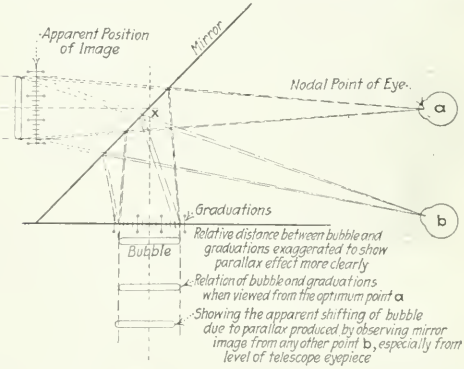
Apparent Position of Image
Mirror
Nodal Point of Eye
a
x
b
Graduations
Bubble
Relative distance between bubble and graduations exaggerated to show parallax effect more clearly
Relation of bubble and graduations when viewed from the optimum point a
Showing the apparent shifting of bubble due to parallax produced by observing mirror image from any other point b, especially from level of telescope eyepiece

FIG. 1. DIAGRAM SHOWING POSSIBILITY OF ERRORS DUE TO PARALLAX

In fact, the potential merits and faults of any instrument may never be fully revealed until it is subjected to a test demanding the preservation of its precision, strength and facility of manipulation under unusually rigorous conditions of climate, topography and transportation. It was possible to obtain opinions from quite a number of the men who were actually using these instruments on the work in the North. Without exception they agreed in their expressions of high praise for the level as compared with the ordinary railroad levels they had used before.

There were two faults, however, that eventually showed up—their elimination will greatly increase the value of the instruments. In two cases the bottom leveling plate, which screws to the top of the tripod head, broke off at the base of the collar that holds the joint. Rough handling—possibly, but not necessarily, careless handling—revealed the weak spot under severe conditions.

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*Stanford University, California.

The more important fault has been with the mirror. Some took it off altogether; others found it a source of error unless given constant attention.

We found that there was a sufficient distance between the bubble and the etched graduations on the surface of the vial to permit parallax in lining them up, of from one to three scale divisions, depending upon the position from which the observation was made. This, of course, is true for any level, as it is of a burette or mercury barometer. The mirror renders the necessity for observing the bubble from a constant point less evident.

If the eye is at *a* and the angle between the mirror and the bubble is 45°, as shown in Fig. 1, the reflected readings of the bubble will be true. If the eye is at any other point, as *b*, the effects of parallax become evident. This is clear from the diagram. If a prominent line were etched on the mirror at the point *x*, it could be lined up, when observing, with another line across the middle of the bubble, and the parallax error avoided.

As long as the mirror is in good condition, one is apt to read it from near the proper position (*a*). But there is a danger of its being sprung out of adjustment.

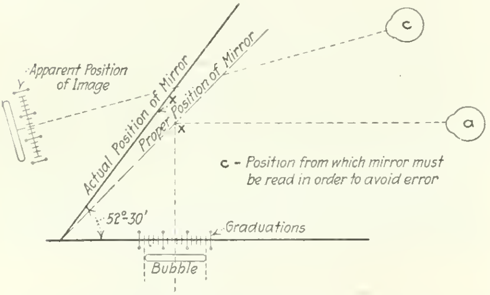
Apparent Position of Image
Y
Actual Position of Mirror
Proper Position of Mirror
x
x
c
a
c - Position from which mirror must be read in order to avoid error
52°-30'
Y
Graduations
Bubble

FIG. 2. DIAGRAM SHOWING POSSIBILITY OF ERRORS IN INSTRUMENT WITH MIRROR OUT OF PLACE

In order that the mirror may be folded down out of the way, it is attached by a ball-and-socket joint—the advantages of this particular type of joint have not been entirely obvious to us. The mirror is raised from its folded position until stopped by a shoulder at an angle of about 45° with the bubble. It is supposed to be held in this position by friction, but the joint soon wears so that the mirror is apt to sag, making the angle smaller.

In order to counteract that tendency the operators have learned that, before taking a reading, they must push the mirror up to the proper position against the shoulder. Now this frequent though gentle pressure is sufficient to bend or spring the mirror eventually, so that the angle it makes with the bubble is greater than 45°. On one instrument it was measured and found to be 52° 30' (Fig. 2).

This gradual change is not readily noticed, and on finding persistent errors one is apt to overhaul every other adjustment before surmising the possibility of error from this source. It could be easily remedied by strengthening the mirror with a rib or heavier support and by using some other form of joint, as, for instance, one in which a small shoulder engages a notch, producing a "click" at the proper point. This would insure the accurate position of the mirror and yet obviate the strain produced by bringing to a sudden halt the motion of raising it.

Transfer Plate for Muck-Cars

A steel transfer plate for muck-cars in place of a switch is proving very satisfactory in the West Side water intake tunnel under construction by the City of Cleveland. Superintendent G. C. Van Duzen introduced the arrangement. The trackage in the tunnel is generally single track, with switch turnouts at occasional passing points. Approaching the heading there is a double-track section which at its shortest—that is, when just shifted ahead—is long enough to take a string of empties sufficient for mucking the excavation for one lining-ring advance (18 in.) for half the height of the face.

Back of the shield, under the lining-erector gantry, is a single track accurately aligned with one of the two tracks of the double track. Between the rear end of this single track and the forward end of the double-track siding is a space about 10 ft. long, which has no rails, but is floored with a steel plate. The plate is set at the right height to take the wheel flanges as a car is rolled on from the track, and to deliver the car to the track opposite.

A car is loaded on the single track under the erector gantry. When full, it is pushed back and rolls across the plate, taking the aligning track without assistance. The adjoining track holds the empties, and the forward one is quickly pushed ahead onto the plate, slewed diagonally and rolled over to the loading track, then pushed to loading position. The whole interchange takes only a very few seconds, the interruption in the mucking being hardly noticeable.

Mississippi River Plays with Pipe-Laying Job

By George H. Herrold*

Some of the pranks the Mississippi River can play with a pipe-laying job have been shown with emphasis since a start was made to lay a 48-in. riveted steel pipe in a trench across the river at Minneapolis last spring.

The crossing is located about a thousand feet below the lower tailrace of St. Anthony Falls.[1] The river bed at this point is filled with broken limestone to a known depth of some 40 ft., this stone having been deposited in the gorge as the falls broke it down and receded.

The trench was started as planned, using a clamshell dredge, but the broken rock proved too large for it to handle, and the excavator shown in Fig. 1 was substituted. A crib bridge was built across the river to operate the machine on. These cribs were 8 ft. long, made of 10x12-in. timbers, with bottoms, each holding about two tons of stone. They were built and filled behind the excavator, then lifted by the boom and swung around and landed in position in the river bottom ahead of the excavator. I-beams were laid to form a track on which the excavator moved. Another crib was then built and placed, and so on until the river crossing was completed, Feb. 16, 1916 (See Fig. 1). The excavator then began digging the trench approximately 6 ft. deep, the center line of the river crossing being the center line of the trench. The track and cribs were removed as the excavator moved back, and the trench was completed, section

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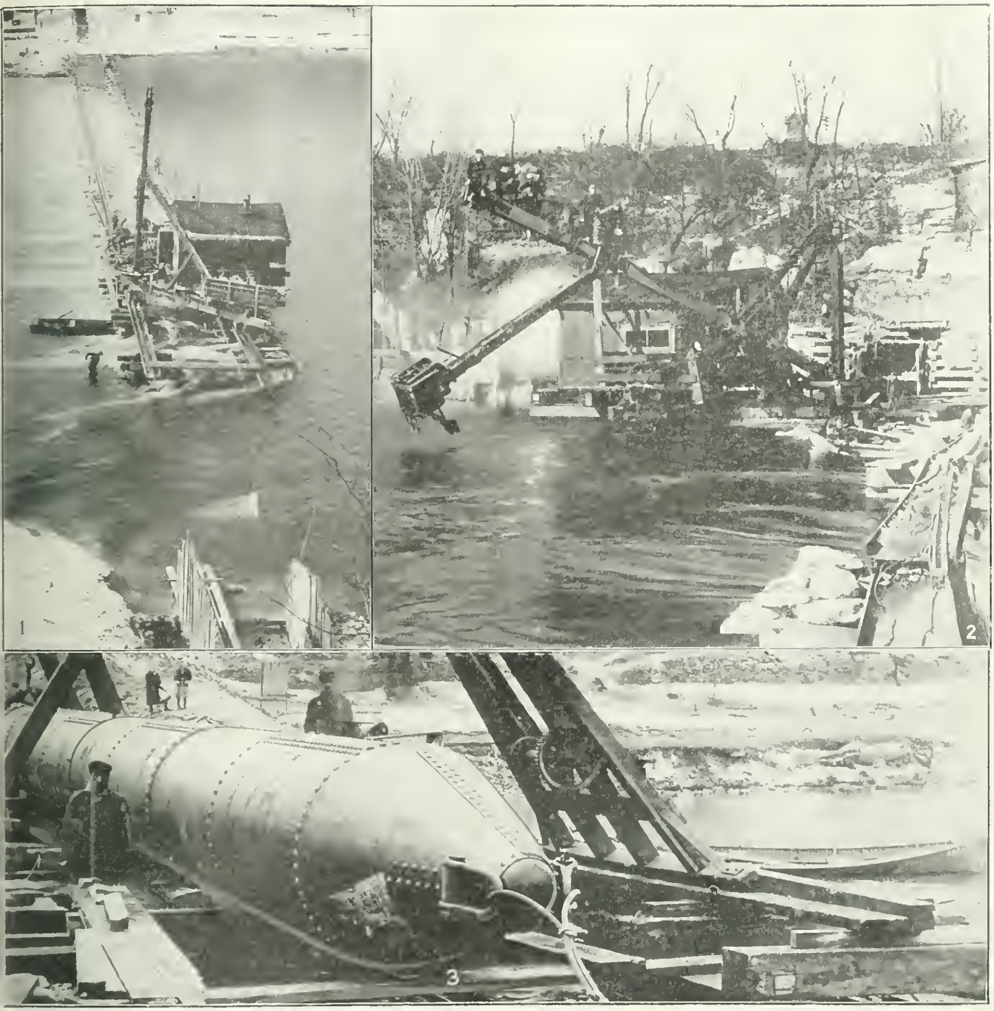
*City Engineer's Office, St. Paul, Minn.

[1] See "Engineering News," Feb. 10, 1916, p. 291, for a description of the project, and Apr. 20, 1916, p. 759, for a description of the shafts sunk on either side of the river for this crossing.



FIGS. 1 TO 3. DIGGING TRENCH AND LAYING MAIN ACROSS MISSISSIPPI AT MINNEAPOLIS

Fig. 1—Track for excavator to work on. Fig. 2—Excavator in operation. Fig. 3—Ready to haul first section of pipe out into the river trench

y section, the rock being thrown on a spoil bank on the downstream side. Fig. 2, a photograph taken Mar. 17, shows the excavator in operation at the finished end f the trench, the I-beams in the foreground forming a footpath on the spoil bank. The material excavated was in every conceivable shape and size. In many cases large rregular-shaped pieces of limestone were simply dragged nd nosed out by the inverted shovel from their position n the trench onto the spoil bank.

Fig. 3, a view taken Mar. 21, shows the beginning of perations for laying the 18-in. pipe in the trench. Just t this time the ice broke in the upper Mississippi River, nd an ice gorge that had formed above St. Anthony Falls roke, allowing a great flood of water to go over the falls. This rush of water carried the pipe and all the laying appurtenances up on the shore. The crest of the flood was at such height that it simply picked the pipe up and laid it horizontally along the shore line without damage. This flood condition continued several days. Then, on Apr. 6, ten million ft. of logs broke away from the Anoka boom, came over the falls and carried away every vestige of the stone spoil bank. As high water continued until July, no further attempt was made to clear the trench or lay the main.

At the present time a low-water stage exists and the trench, which was filled with sand, is being cleaned out with a drag-line excavator operated from a cable stretched across the river. The main will be laid during the extreme low-water stage of the winter. J. Arthur Jensen is supervisor of water-works, and F. W. Cappelin is city engineer.

Wrecking Heavy Machinery by Cutting Torches

The removal of the old Harrison St. power plant of the Commonwealth Edison Co., at Chicago, was necessary in connection with the construction of the new Union Station. The plant was large and included very heavy machinery, but as this equipment was of obsolete type it was not considered worth the cost of removal to another station. The entire machinery equipment was sold therefore at its scrap value to a dealer in scrap iron.

In view of the size and weight of the parts (many of which weighed from 35 to 50 tons each) the necessity of prompt removal and of doing the work at low cost made a problem for the purchaser. The method adopted was to use oxyacetylene torches to cut up the machinery in place, reducing it to sizes that could be handled conveniently. The purchaser contracted with expert operators to do this cutting, and five complete outfits of gas tanks, torches and other apparatus were employed in the work. These oxyacetylene outfits were made by the Imperial Brass Co., of Chicago.

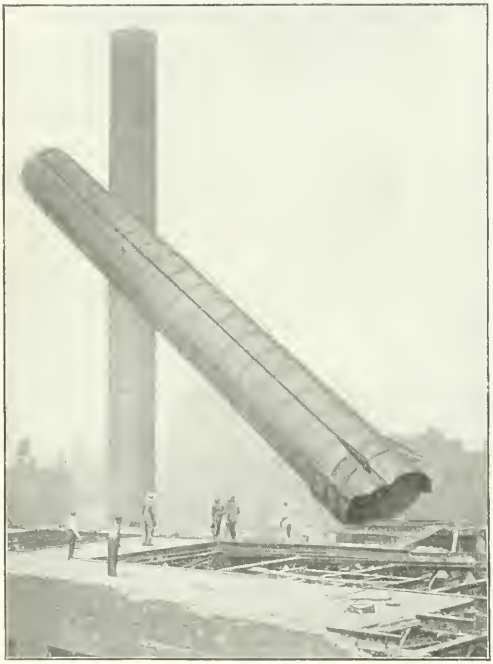


FIG. 1. WRECKING STEEL SMOKESTACKS 12x125 FT. AT THE HARRISON ST. PLANT, CHICAGO

Six steel smoke-stacks 12 ft. in diameter were supported by the steel frame of the building and were 125 ft high above the roof. These were cut at the base (just above the roof) and thrown over bodily. The fall was started by jacking under one side, this being done in such a way that the stacks fell in a predetermined position. They were then cut into lengths. Fig. 1 shows one of the stacks falling. It will be seen that it had vertical stiffeners, with gusset-plate connections to the supports. The time for cutting and overthrowing each stack was less than two hours.

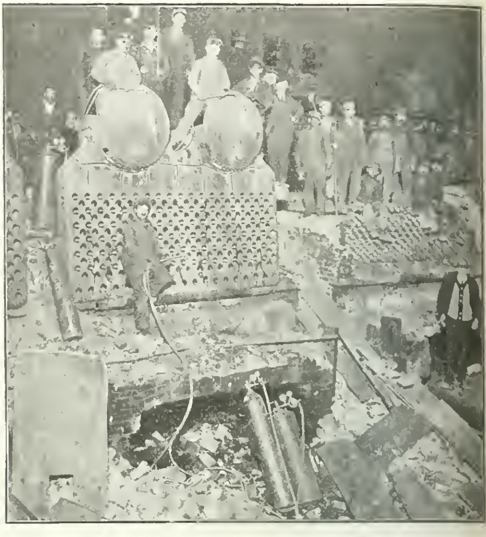


FIG. 2. CUTTING UP WATER-TUBE BOILERS FOR SCRAP

There were 24 water-tube boilers, averaging about 500 hp. each. The headers were cut apart, as shown in Fig. 2, and these were then forced outward by jacks, falling into the pit and leaving the nest of tubes behind. The man at the right is standing on one of the header sections, and above him is the group of tubes. To remove the huge steel coal bins above the boiler room, men went inside and cut loose the hopper bottoms, letting them fall to the

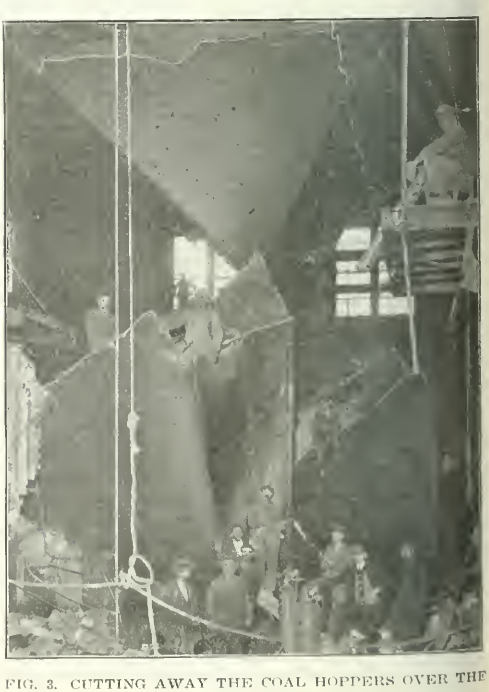


FIG. 3. CUTTING AWAY THE COAL HOPPERS OVER THE BOILER ROOM

floor below, as shown in Fig. 3. There they were cut up into pieces of size suitable for removal.

The big engines were wrecked in the same way. The 35-ft. built-up flywheels were easily handled. The dumb-bell-shaped locks or clamps in the rims were cut away, allowing the segments of the wheel to be taken apart. The 36-in. shafts were tough propositions. Each was cut into three lengths, and Fig. 4 shows the work upon one of these great shafts. At the right is a cut nearly completed, leaving just enough metal to carry the weight, while the operator is making the second cut (at the left), just outside the heavy flanges for the hub of the flywheel. The work was done during the summer and fall and occupied less than three months.

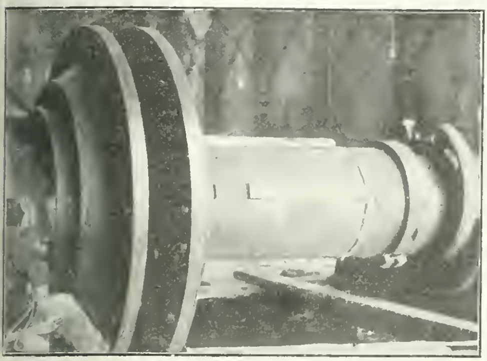


FIG. 4. CUTTING UP 36-IN. ENGINE SHAFTS (TWO CUTS PER DAY)

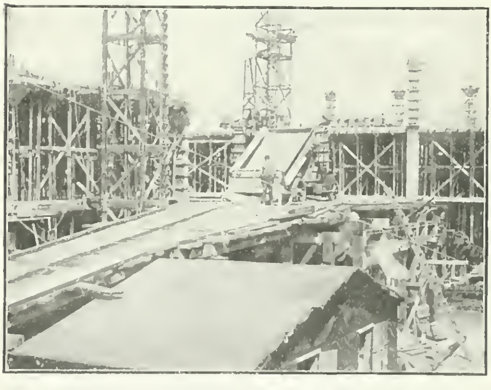
FINE AGGREGATE

New Precise Leveling Record—John H. Peters, in charge of a precise leveling party of the United States Coast and Geodetic Survey operating in Michigan between Mackinac and Jackson, made a progress of 159.6 mi. during September, 1916. The number of miles actually run was 340. The leveling is divided into sections of approximately 1 mi. each, and each section is leveled over twice—once in the forward and once in the backward direction. If the results of the two runnings do not agree very closely, then extra runnings are made until the differences in elevation between the ends of the section are nearly the same by each of two runnings. The criterion used is that the two lines shall agree within 4 mm. into the square root of the distance in kilometers. If the section is a kilometer in length, then the acceptable difference will be 4 mm. If the section is 4 km., then the allowable difference will be 8 mm., etc. As a matter of fact, the average discrepancy between the two runnings of a section is only about half the allowable limit. Mr. Peters had to rerun only about 6% of his lines, on account of failure to keep within the prescribed limits. That this record was not the result of excessive hours in the field is shown by the fact that the average time per day between the first reading and the last one was eight hours and one minute. It is not known exactly how much time was taken for noon, but Mr. Peters reported that it was probably a little over an hour. It is safe to say that the average observing period for a day was not more than seven hours. Like the other observers, during the present year, Mr Peters is using the tripod and instrument mounted on one of the motor cars; and the adding machine, on which the rod readings are recorded, is mounted on the second motor car used by the leveling party. These two innovations (due to suggestions made by Mr. Peters) were described in "Engineering News," July 13, 1916, p. 74. —William Bowie, chief of the Division of Geodesy, United States Coast and Geodetic Survey, Washington, D. C.

Subway Costing $10,843,536.13 per Mile—New York's dual system of rapid-transit lines has the distinction of including the most expensive railroad in the world. This is the so-called Centre St. Loop, the cost of which to the city to June 30, 1915, as figured by Chief Engineer Craven, of the Public Service Commission, was $16,080,964.09. This is at the rate of $10,843,536.13 per mile of subway, and $3,050,837.43 per mile of track. The amount does not include the lessee's contribution toward the cost, or its expense for equipment, or additional payments for interest yet to be charged by the city. When these are added, the aggregate cost is likely to be nearly $2,000,000 more. Of the $16,080,964.09, however (the total cost to June 30, 1915), only $11,846,145.67 was for labor and materials. The remaining $4,234,818.42 was for salaries and expenses of the Public Service Commission's employees and for interest. This scant mile and a half of subway contributes practically no new additional revenue to the system. The interest on its cost and the expense of its operation must be met almost entirely by the other rapid-transit lines operated by the New York Consolidated Railroad Co. This is one of the misconceived transit luxuries which that company is obliged to carry under its contracts with the city, and is one of the factors which make the company's burden severe.—"B. R. T. Monthly."

Tractor and Plows Dig Out Gravel Layer—When excavating for the construction of a wood-block teamway, in the Illinois Central Main St. yards, Evansville, Ind., 18 in. of conglomerate gravel (known as Paducah gravel in the lower Ohio region) was found under 6 in. of broken stone. The contractor made several unsuccessful attempts to start a rooting plow with three teams, but it was impossible to break the gravel. The plow was finally attached to a steam tractor and the gravel loosened. Several plows and chains were broken during the work. It required four days with the tractor on 1,500 sq.yd. of surface. The necessity of using the steam tractor in a small space and the difficulty of loosening the gravel so that it could be shoveled on flat-cars cost the contractor almost double the original estimate, which had been made without a thorough examination of the locality.—E. W. Bullard, Building Inspector, Mechanicsburg, Ill.

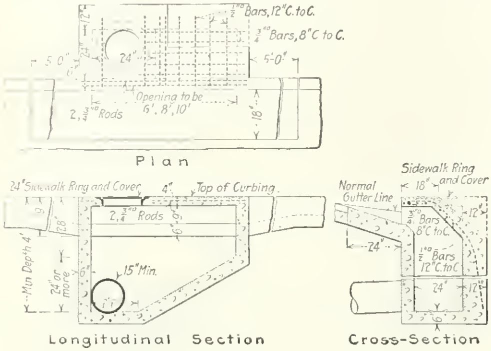
Motor Trucks Dump at the Second-Floor Level of the $500,000 building now being erected in Cleveland for Richman Brothers. The Cleveland Builders' Supply Co., which has the contract, has erected a wood platform at the level of the second story and has connected platform with ground by two plank inclines having a grade of about 10%. Concrete materials are delivered on the platform by a fleet of nine White power-dumping trucks. Having two inclines keeps the trucks running continuously.



TRUNKS DUMP AT SECOND FLOOR LEVEL OF NEW BUILDING, CLEVELAND

Economizing Compressed Air—A useful little expedient was adopted in the Milwaukee water intake shore tunnel by the O'Brien & Jackson Co., contractors. The tunnel is being driven under compressed air and in addition air chisels are used in some of the headings for excavating in hardpan and hard clay. The intermittent operation of the tools is apt to produce considerable waste of power in blowoff from the receiver. To avoid this waste, a blowoff valve set at 90 lb. was placed on the high-pressure air line within the tunnel, on the heading side of the air lock. Whenever the demand of the air chisels is low the excess high-pressure air escapes into the tunnel via this valve, and thus increases the low-pressure air supply and reduces the load on the low pressure compressors.

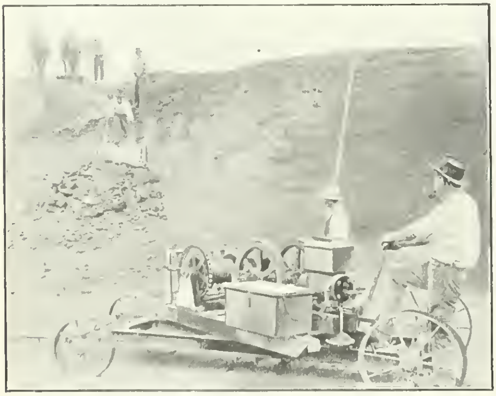
Reinforced-Concrete Curb Inlet—The accompanying figure gives the details of a reinforced-concrete curb inlet and catchbasin used as a standard in San Antonio, Tex. It is essentially a narrow rectangular box, with 6-, 8- or 10-ft. opening in the curb. At the manhole opening the width of the box is 3 ft., but at the other end only half that amount. Only the top and the overhanging part of the side of the box are reinforced. The bottom is rounded to an arc of a circle and is sloped as shown in the longitudinal section. The sewer engineer of San Antonio is M. E. Erwin.



DETAILS OF CONCRETE CURB INLET, SAN ANTONIO, TEX.

Well-Hole Quarry Blasting—The following changes were recommended by S. R. Russell in a recent issue of the "Du Pont Magazine": In hard rocks a combination of 60 and 40% dynamite is advisable; a little 60% should be loaded in the bottom of each hole and 40% used on top. In softer flat limestones a 40% explosive will usually be found strong enough and often a lower grade can be used for top load. If the work is very wet and the toe heavy it may be necessary to use a gelatin dynamite from 40 to 60% strength. Sand, clay or fine screenings should be used for tamping and holes filled up to the collar. In holes up to 35 ft. deep a tamping pole or stick can be used handily. If of greater depth it is necessary to use a rope and block as a tamper.

A Monthly Postcard Picture, showing some work under construction by Bent Bros., engineering contractors of Los Angeles, Calif., is sent out by that firm for publicity purposes. The August postcard is shown herewith. The view is of a power backfiller, used to trim the inner slope of a large circular earth reservoir recently completed for the Standard Oil Co. at El Segundo, Calif. The reservoir is 403 ft. in diameter at the bottom and 19 ft 2 in. deep, having a 1½ to 1 slope. After the slope was trimmed and thoroughly rolled, a 3-in. concrete lining was placed. In the space for writing, on the reverse side, under a heading "Contracts in Progress," is a list of contracts now under way by Bent Bros.



CONTRACTOR'S POSTCARD ADVERTISEMENT

Interest Rate in Loan Repayment—Virgil A. Eberly, of 2728 Pennsylvania Ave., Washington, D. C., has solved the problem in interest rate on a loan repaid by installments, as given in "Enineering News," of Nov. 2, 1916, p. 852. If the total debt is A and the number of equal annual payments extinguishing it is n, and if the interest percentage is 100 ÷ b, then the general formula is

$$\text{One payment} = A\left[\frac{(b+1)^n}{b(b+1)^n - b^n + 1}\right]$$

With b as the unknown, this formula must be solved by trial, but with seven-place log tables a solution can be obtained to within $1, in not over five or six trials. In the particular problem given, the fractional period at the beginning makes a little further complication. The $1,000,000 loaned today will draw interest at the rate of $\frac{100}{b}$ % for $\frac{13}{24}$ year. The debt at the end of 6½ months will therefore be 1,000,000 $\left(1 + \frac{13}{24b}\right)$ dollars. At this time, however, $120,000 is paid, reducing the debt to 1,000,000 $\left(1 + \frac{13}{24b}\right)$ — 120,000 dollars, which represent A in the above formula. The statement of the problem will therefore be

$$120{,}000 = \left[1{,}000{,}000\left(1 + \frac{13}{24b}\right) - 120{,}000\right]\left[\frac{(b+1)^{11}}{b(b+1)^{11} - b^{12}}\right]$$

This may be reduced to

$$12b - \frac{12b^{12}}{(b+1)^{11}} = 88 + \frac{1{,}300}{24b}$$

which by approximation gives b = 15.05 ±0.01 — (on sixth trial). By further trials a value correct to seven places should be sought; b = 15.05 gives the rate at 6.6445±%.

Laying Water Main with Locomotive Crane—In the work preliminary to the West Side track depression of the Nickel Plate railway at Cleveland, Ohio, it was necessary to lay two new water mains of large size along West 41st St., passing under the present surface tracks at a depth sufficient for the separation of grades soon to be started. The two mains are a 30-in. low-pressure and a 36-in. high-pressure. The railway crosses the street at nearly a right angle, and the grades are to be separated by raising the street and depressing the tracks, approximately equal amounts. Instead of taking the water mains across on the viaduct they are to pass under the depressed railway tracks. This required their being lowered 24 ft. from the present street level. The trench was dug one-half the necessary depth as an open cut with 1½ to 1 slopes. The remaining 12 ft. was excavated between rows of 2-in wood sheet-piling. A 10-ton locomotive crane with a 1-cu.yd. Owen clam-shell bucket was used for excavating. A track was laid parallel to the trench to operate the crane. A second track, connecting with the crane track, was used for the dump-cars that removed the spoil. Below 12 ft. the trench had to be kept pumped out by an electric motor-driven centrifugal pump. The pipe is of riveted steel, in 30-ft. sections, with flanged couplings. Each section weighs nearly 10,000 lb. Each end section is bent upward at an angle of about 33°, the horizontal part being about 24 ft. long. The trench was made 10 ft. wide, and the rangers and struts were placed in such a way that it was possible to snake the pipe under them without moving a timber. This was accomplished by placing the three end struts and rangers at such an inclination that a section of pipe could be slipped under them into the bottom of the trench. The work was carried out by F. W. Claflin, field engineer, under A. J. Himes, engineer of grade-crossing elimination of the New York, Chicago & St. Louis R.R.

LOCOMOTIVE CRANE LAYS 36-IN. STEEL WATER MAIN IN 30-FT. SECTIONS

Editorials

Rapid Changes in Market Prices Affect Engineering Problems

The engineer engaged in design and construction, laboring at his perpetual task—to quote the famous definition—of making a dollar earn the most interest, has had his work greatly complicated during the past two years by the rapid changes in prices of engineering materials. In the past, practicing engineers have generally come to rely on standard relations that engineering practice has pretty well established as to the relative cost of structures of different types.

For example, in *Engineering News* of Nov. 9 were published statements by two prominent men in the structural field on the relative cost of factory buildings of reinforced concrete and of standard timber mill-building construction. One of these men reported the reinforced-concrete type as costing 30% more than the timber construction; the other reported the excess as only 17%.

Which of these figures is the more accurate as a general guide it is not our present purpose to discuss, but it does seem worth while to call attention to the fact that comparative figures that were accurate six months ago or even three months ago may, under present-day market conditions, be very far from accurate. At the present time, for example, the phenomenally high cost of steel, coupled with the difficulty of obtaining prompt delivery, is greatly stimulating the use of reinforced concrete instead of steel, where the two materials are in competition with each other.

In the extensive railway reconstruction work now in progress on the main line of the Southern Ry. the engineers had planned to build a steel viaduct 200 ft. high at the crossing of Broad River. On account of the high price of structural steel the plans have now been altered, and the structure will be made up of high towers of concrete, made hollow, with circular interior and rectangular exterior, spaced 120 ft. apart on centers, with 100-ft. girder spans between the towers. But concrete as an alternative for steel may even show a smaller margin of economy in the future, because it is more than probable that cement will go to record prices. It has held remarkably firm during the past year, but a reduction in the surplus stock and the tremendous increase in cost of coal and of labor point indisputably toward a marked rise in the cost of cement.

Another alternative in some lines of construction is earthwork. On the railway work mentioned before, at the crossing of another broad valley a fill is being made 1,500 ft. in length and 100 ft. in height, with a maximum width of 533 ft., instead of crossing this valley by a steel viaduct, which would be the plan adopted if steel were available at the ordinary prices.

Two very potent factors that the engineer has to consider today in making comparative estimates of cost are the low price of timber compared with most other engineering materials and the high price of capital. It appeared likely a few years ago that the standard timber-frame factory building, developed in such admirable fashion by the Mutual Fire Insurance Companies of New England, was destined to disappear and be replaced by the reinforced-concrete structure. Under present market conditions, however, the case for the timber building is more favorable than it has been for a long time. The first cost is far from being the only consideration. The engineer who is putting up timber mill buildings at the present day needs to take advantage of the latest information in order to protect such a building from the dangers of dry rot and of attacks by fire.

The effect of high prices for capital is to stimulate the use of lower-priced materials, even though the resulting structure is of shorter life. Unless a structure on which an engineer is figuring is to be erected for a state or a municipality, the engineer is seldom able at the present time to figure on an interest rate less than 5½%; and on most capital raised by either railway or industrial companies today the final cost, with brokerage charges included, is apt to be from 6 to 7%.

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Engineers Who "Butted In" on a Public Question

Those who are following the debate as to whether engineers should take an active interest in public questions will find a valuable record of experience in the report elsewhere in this issue of a committee of engineers who investigated the municipal water-power enterprise on which the City of Montreal has been at work for some years. The committee shows that the $12,000,000 enterprise which the city has about half completed will fall so far short of returning a profit on its cost and has so many serious defects that it will be far better for the city to lose all it has thus far expended than to incur the additional outlay necessary to complete the work.

It appears that this work was undertaken by the city in the first place without any thorough investigation to determine beforehand whether or not the scheme would be profitable. The Canadian Society of Civil Engineers took up the matter a year ago and made strong representations to the city authorities, urging that an independent investigation of the project should be made. The society's efforts were fruitless, however, the intelligent city fathers very likely construing the appeal as merely a scheme to obtain appointments for engineers.

As the city authorities paid no attention to the representations made by the national engineering society, 31 engineers who were citizens and taxpayers of Montreal joined in urging upon the city authorities an investigation. Very likely this appeal also was construed as a scheme to obtain appointments, for it is stated that some of the aldermen suggested that if the taxpaying engineers chose to make an investigation and report free of cost to the city it might be considered. This challenge was promptly accepted. A committee to investigate was named by the association of engineer-taxpayers, and its report has just been presented. Its logic is so unanswerable that the city authorities will probably be obliged to abandon the work in accordance with the committee's recommendations.

It is of course easy to present arguments on the other side and to say, for example, that the failure to heed the protest of the Canadian society shows how little weight is given to the opinion of professional engineers by the average municipal official. It may be said also that the protest ought to have been made years earlier, before the city embarked on the enterprise and expended the $5,000,000 or so which now promises to be a dead loss. The eminent engineers who have made this report free of cost to the city may be criticized for having rendered a professional service for which the city ought to have paid a fair price.

One has to deal always, however, not with ideal conditions, but with practical conditions. It very often happens, unfortunately, that cities and states and even the Federal Government undertake enterprises without any proper engineering investigation in advance, and often even against the advice of experts. It is true also that many times the technical and financial questions in connection with such enterprises are so complicated and involved with so many questions of personalities, vested interests, etc., that an engineering society cannot safely undertake to express a formal opinion upon the matter. There are, however, plenty of cases, of which this Montreal work is an example, in which the evidence is so clear as to the infringement of sound engineering principles that the engineers and the engineering societies who are most conversant with the situation may well consider it a duty to use their influence for the public benefit.

Canada and its cities cannot possibly afford just now to waste any money in unprofitable municipal enterprises. The Montreal engineers who as citizens and taxpayers have come forward to warn the city as to its dangerous extravagance have rendered a patriotic service quite as valuable to their city and to their country as if they had volunteered for military service.

The Daylight Saving Movement and Standard Time

Those who are taking part in the agitation to move forward the hands of the clock one hour during the summer months ought to clearly understand some of the difficulties that are involved in any such tampering with the present standard time. Few, probably, of those who are taking part in this agitation are old enough to recall clearly the chaos in the matter of time, which prevailed in the United States prior to 1883. The confusion and danger resulting from this condition was so great that it led the railway companies of the United States to form the first general organization to undertake coöperative action. That organization was known as the General Time Convention, and was the predecessor of the American Railway Association. Its leading spirits were two eminent engineers, the late Sir Sandford Fleming, then one of the principal officials of the Canadian Pacific Railway, and the late W. F. Allen, who later became the Secretary of the American Railway Association.

Prior to the adoption of standard time it was common to have three or four different times in use in a city. Besides the city time there would be the times used by different railways entering the city. Some of these standards would differ as much as fifteen or twenty minutes from each other. At the celebration of the 25th anniversary of the establishment of standard time on Nov. 18, 1908, Mr. Allen, in recounting the conditions that prevailed before standard time was established, said:

> There were then 53 times of various cities in use by American railways and by the people generally. It is doubtful if there were more than a dozen railway officials in this country who could have stated from memory what time was used by any road other than their own, and the few with whom they had direct business connections. So crude were some of the time standards used, that one railway superintendent reported, in response to a circular of inquiry, that the standard used by his road was the superintendent's watch.

The committee on standard time of the American Railway Association, reporting on the daylight saving movement this week, declares that the present zone system of dividing time is absolutely correct. Any change in it would result in endless confusion and would be disastrous to the railways. The committee recognizes that if by *nation-wide* action the hands of the clock could be set forward one hour on a certain day, the change would be practicable, but it believes that the change is not warranted from the scientific standpoint.

If, however, the result of the daylight saving agitation should be to cause a number of different cities in various parts of the country, following the bad example of Cleveland, to establish a local time different from the railway time, a long step would be made toward reëstablishing the confusion in time standards that prevailed in the United States prior to 1883.

The ends sought by the promoters of the "daylight saving movement" are commendable enough; but it is yet to be proved that in order to bring about a readjustment of the working hours of factory employees, it is necessary to tamper with accepted standards of time.

No Bidders for City Contracts

At a recent meeting of the Board of Public Works of Indianapolis to open bids for various municipal work, it was found that on five contracts that had been publicly advertised for letting, no bids whatever had been received. On two other contracts there was only a single bid, and on three other contracts there were only two bids in each case. These figures undoubtedly reflect accurately the labor scarcity prevailing through a large part of the Middle West and to a greater or less extent in other parts of the country. Contractors doing public work have in many cases found it difficult to secure the labor necessary to carry out their contracts already in hand. Under these conditions they are not at all disposed to submit bids on additional contracts on the chance that conditions may change so that they will be able to secure the necessary labor.

There is no doubt whatever, looking at the question from a broad standpoint, that it is wise public policy at the present time to cut down expenditures for municipal improvements to the lowest point possible. Most materials for construction are at the highest prices known since the Civil War. Labor is not only high priced, but, owing to the necessity of taking anything and everything, with the fact that the men realize if they lose their job another one is waiting for them around the corner, the amount of work done is comparatively small.

Nothing can be more certain than that this condition must change, sooner or later, and the change when it does come will probably be rapid and extreme. Less than two years ago city councils all over the country were wrestling with the pressing problem of finding work for the unemployed. This problem will again recur and very likely at no distant day. All the public work that can be postponed from the present time to be undertaken then will serve to relieve the present market stringency, will give the workingmen something far better than charity when the pinch comes and will make the taxpayer's dollar yield a far greater return in the work accomplished than will be the case if it is spent now.

On the other hand, there is a very large amount of public work that does not admit of postponement. The present era of prosperity has brought a great influx of population to dozens and hundreds of cities and towns. It has become necessary not only to build houses to shelter these additional city dwellers, but the streets where these houses are built must be furnished with paving, sewerage and lighting.

The public is demanding that money be spent on road construction and maintenance now. In maintenance especially, much work must be done to prevent the loss of large investments in road improvement already made. A large proportion of municipal work is carried on by assessments on the property holders. It is much easier to carry on such work on a large scale in prosperous times than it is at times of business stringency when the city authorities are deluged with appeals not to impose assessments on those who are unable to pay.

All these conditions point to continued activity in municipal and other public work, notwithstanding the high prices and scarcity of both materials and labor.

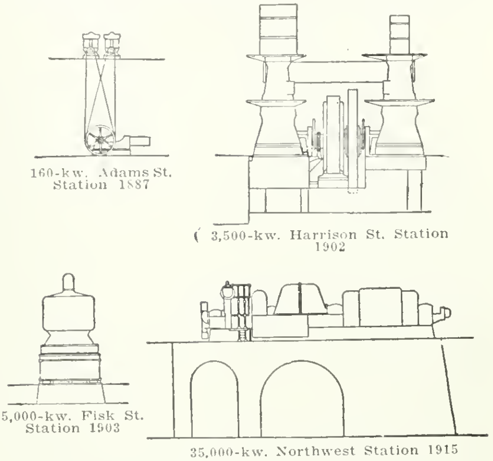
* * *

Rapid Changes in the Electric Lighting Industry

The article printed on page 1040 of this issue, describing the methods used in cutting up for scrap the huge steam engines, water tube boilers, and other equipment of the Harrison St. power plant of the Commonwealth Edison Co. at Chicago, may cause some readers to ask the question why this machinery, much of it in good condition, was not worth saving? As stated in the article, one reason for its being scrapped was the heavy cost that would be involved in its removal and reërection on another site, but the more important and really controlling reason was that the machinery had become obsolete.

A notable address by Samuel Insull, President of the Commonwealth Edison Co., before the American Society of Mechanical Engineers, which is printed in that Society's "Journal" for November, reviews the rapid changes which have taken place in the electric central station industry. The accompanying cut, reproduced from Mr. Insull's paper, shows the relative size of the power generating units used by the Commonwealth Edison Co. at four different periods in its history. As shown in that cut, the power equipment in the Harrison St. station was the huge reciprocating engines direct-connected to slow-speed generators which only fourteen years ago were considered a marvelous achievement in power development, and rightly so considered when one compared them with the little steam engines belted to dynamos with which the electric lighting industry began. A special feature of Mr. Insull's paper is his emphasis on the "lag" in the mental attitude of engineers and others toward improvments in practice. Mr. Insull said:

> One of the most up to date steam railroad systems in the United States today is probably the New York Central line. I think they have two stations equipped with precisely the same kind of apparatus as that which we discarded several years ago.
>
> There came out to Chicago some years ago a very distinguished engineering commission for the purpose of gathering information to be used in designing a large plant. The commission decided to duplicate what we had and for fear they would not be able to run it they purloined one of our men to run it and are still running it. What they copied has been in the scrap heap for years.


160-kw. Adams St. Station 1887
3,500-kw. Harrison St. Station 1902
5,000-kw. Fisk St. Station 1903
35,000-kw. Northwest Station 1915

FOUR TYPES OF GENERATING MACHINERY USED BY THE COMMONWEALTH EDISON CO. OF CHICAGO

By way of illustration of the great advantage the large size turbine generator has over the reciprocating engine of about one-tenth its capacity, Mr. Insull stated that their standard 30,000-kw. turbo-generators with horizontal shafts are run at 1,500 r.p.m. giving the revolving field a peripheral speed of 20,000 ft. per min. It is the practice to run a machine of that type practically all the time. The best results and the lowest repair costs are obtained if such a machine runs continuously, provided it is shut down a few hours a week for inspection to see that everything is in order. The contrast between such a machine and the older type of machinery which required frequent stops and overhauling to keep it in adjustment, provide for lubrication, etc., can be readily appreciated.

* * *

Selling Good City Government the City Manager's Job

Since Galveston led the way after the great flood of 1901, perhaps 500 cities of the United States have adopted the commission plan of city government. By and large, the change has brought a great gain over results under the older forms, but it has generally left much to be desired in the way of further improvement. In so far as this deficiency is not due to the unreadiness of the people for good city government it may be explained largely by an inherent weakness in the commission plan. This weakness, often mentioned in these columns, is the attempt to select the heads of executive departments by popular vote and then to run a city with five coördinate executives and no one official in supreme command.

It is a significant fact that only two or three of the 500 commission-plan cities have gone back to their antecedent types. Instead, many of the commission-plan cities and a considerable number of cities and towns under the older plans, have made a more or less clear separation of legislative and executive functions by the employment of a single executive head, called the city manager.

Save for a very few isolated pioneer cases the adoption of the city-manager plan has taken place during the last three or four years. Today nearly a hundred cities have city managers or have taken steps to secure them. Such rapid progress is gratifying, but the fact still remains that the body politic of most cities is not ready for as good city government as might easily be got with its party support out of the particular form in vogue, be it mayor and council, commission or commission-manager.

The city managers seem to have a clearer vision of the current indifference if not opposition to good city government and of the way to overcome it than have any other class of city officials. The case was put in new form and strength by H. M. Waite, retiring president of the City Manager's Association, at Springfield, Mass., last week.

> We are selling good government to the public. It must be wrapped in attractive packages and offered with civility and patience. Some of the things have to be sold first to a few chosen easily interested citizens, then to some not so much interested and to the newspapers. Public confidence must be obtained and never abused.

The city managers are right. They must sell good government to the public. But this is not enough. The public should demand good government from the managers. Otherwise the fundamental principle of the city-manager plan falls to the ground. That principle is that the commission or council is elected by the people to frame policies and that the function of the manager is to execute the policies determined by the commission. Until the people realize and act upon this principle the city managers must not only work against great odds to produce good city government but must also devote a large part of their time and energy to selling it to a more or less reluctant public.

More Success in Converting Hindsight to Foresight

The full description and frank discussion of a canal-lining failure in Massachusetts, printed elsewhere in this issue, as willingly contributed by the engineers most closely concerned in the work, is another of the accumulating evidences of a truer realization of the real benefits of recording failures for the instruction of other members of the profession. Here the record of early failure and final success in securing, at low cost, stability of steep slopes makes a noteworthy professional contribution. It actually turns these men's hindsight into others' foresight—and that is the prime object in giving as much space as we do to various accounts of failures.

Hardly an issue of this journal appears that does not give the details of some such accident—now it is a fallen bridge span, again it is a washed-out dam or a collapsed building. All such matters are carefully investigated, that their lessons may be fully comprehended and not that blame may be fixed or that any morbid delight in post mortems may be satisfied. We believe it is obvious that as much advance comes out of engineering failures as from apparent successes.

Naturally we are gratified by the acceptance of this principle by the men who have to face these trying circumstances. The repetition of such cases in recent months seems to present growing evidence of a better spirit among engineers—more of an *esprit de corps* which uplifters have nearly despaired of securing. Where we have failed to find such openmindedness, it has sprung usually from the instructions of some legal counsel, naturally secretive and suspicious.

Letters to the Editor

Five Essentials of Effective Business Letters

Sir—It may interest your readers to hear of a new grouping of the rules governing the composition of effective business letters. As far as I know at the present time, the following grouping, simplified to assist the memory, is a new one. This grouping is known as the five C's of business correspondence. The five C's are: Clearness, Accuracy, Conciseness, Courtesy and Conviction.

The order is not accidental. Clearness is the first requisite of good composition, it is achieved by means of accuracy and conciseness. Conviction is the ultimate aim of the business letter. A letter cannot, however, be convincing if only clearness, accuracy and conciseness have been achieved. Courtesy is the leaven without which the first three C's would never rise to conviction.

ADOLPH C. BAEBENROTH,
Professor of English, Syracuse University.
Syracuse, N. Y., Nov. 16, 1916.

Plotting the Catenary

Sir—Frederick R. Honey, in *Engineering News* of Aug. 10, has indicated a method of plotting and rectifying the catenary that involves much needless labor.

Taking the parameter c as the unit of measurement, with the origin at the vertex, the equation of the curve becomes

$$y = cosh\ x - 1$$

and the length of arc from vertex to point (x, y) is sinh x. The essential data may therefore be obtained directly from a table of hyperbolic functions, and the laborious approximation for the length of the curve by means of small circular arcs is, of course, unnecessary.

There are other well-known and simple methods of plotting and rectification that necessitate neither the use of hyperbolic tables nor the evaluation of the expotential.

R. C. STRACHAN.
Municipal Building,
New York City, Aug. 11, 1916.

Water Filters and Typhoid at St. Louis, Mo.

Sir—Enthusiasm over the new filter plant in St. Louis has led the officials in charge of the plant, in their annual report just received, to ascribe to the plant credit that the tables and the diagrams contained in the report flatly contradict.

The writer is of the opinion that modifications and improvements could have been made in the clarification process which would have substantially bettered the output of the plant at a fraction of the cost of the new filters. Filters, however, were considered essential, and it goes without saying that the statement of the results obtained therefrom should be accurate. The report says:

> The decrease in death rates in 1905 as compared to 1903 and 1904 was no doubt largely due to the installation of the clarification process, while the decrease occurring in 1915 followed the filtration of the entire water-supply, which began in May, 1915.

According to the tables in the report the sharp break in the typhoid death rate began in December, 1914, or six months before the filter plant was put in operation, and the percentage reduction in the death rate for the six months preceding the operation of the filters is greater than that for the six months following the introduction of filtered water; but even if the opposite condition prevailed, no such sweeping statements should be made based upon a six months' period of operation.

While the filters will undoubtedly give a more highly polished water than was obtainable from the excellent clarification method employed for 11 years, the writer questions that any marked decrease in death rate will result from the introduction of filters. Consequently, the incorrect statement in the paragraph above quoted and the error in the diagrams themselves, which show that the date of the introduction of the filtered water was coincident with the sharp reduction in death rate in 1915, should be pointed out. ALEXANDER POTTER.

50 Church St., New York City, Nov. 18, 1916.

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Chemicals for Weed Killing

Sir—In your issue of May 25, 1916, p. 1000, we note your article headed "The Cost of Track Weeding," as compiled by Edward Karow, Assistant to the Vice-President of the Twin City Rapid Transit Co. We aided Mr. Karow in getting at some of the figures given under the heading "Chemical Weeding," and from our experience we believe the average figures under all headings to be approximately correct.

We disagree with the comment, that manual labor weeding leaves the track in the cleanest condition. It must be remembered that hand weeding in no way permanently kills the vegetation and, therefore, regrowth will start within a very few days, while, on the other hand, chemical weeding leaves the track comparatively clean for the entire season. It is also the object of chemical weeding to repeat the second year and following years' treatments sufficiently early to prevent regrowth establishing itself in that season.

Hand weeding gives a clean track for possibly ten days to a month after the work is accomplished, but never averages clean track during an entire season.

R. M. CHIPMAN,
General Manager, Atlas Preservative Co.
New York, Nov. 16, 1916.

Salt Water Causes Cracking Concrete in Philippines

The cracking of reinforced-concrete structures is markedly prevalent in the Philippine Islands, according to a report by J. L. Harrison, District Engineer, Iloilo (in the "Bulletin" of the Bureau of Public Works, October, 1916). The accumulation of evidence of this trouble became so serious about two years ago that it was decided by the authorities to make some studies into the cause. They proceeded first on the assumption that the rusting was wholly chemical—stimulated by appreciable quantities of some determinable material; and a number of samples of concrete taken from structures in trouble were subjected to chemical analysis.

The samples submitted showed one foreign substance—chlorine—and that indicated the presence of salt. At first not much attention was paid to this, as it was known that it was largely used in the United States to prevent freezing of concrete during setting; but it was soon realized that the climatic conditions in the Philippine Islands are so different from those in the United States that the effect of the salt could not be neglected. The collection of analyzed samples has gone on for something over two years and not a single structure showing rusted steel has been found free from salt. The percentage of this salt has varied considerably—from that high enough to show that beach sand and sea water must have been used in making the concrete, to a figure low enough to indicate that either brackish water was used or that salt water was used to wet down fresh-water concrete after the forms had been taken off. A typical sample (from the Constabulary Headquarters building, Iloilo) showed 0.07% chlorine. This was computed to be equivalent to 1.44% salt in the water, assuming 12.5 lb. of water used per cubic foot of concrete. This is considered fairly salt water.

The presence of 0.10% chlorine in the iron rust indicated too small a percentage of ferric chloride to explain all the indications of rusting to be observed; but it was realized that ferric chloride is not stable and that it readily oxidizes to ferric oxide, releasing the chlorine for further attack. High temperature and moisture are the only conditions necessary for the indefinite continuation of the process, and both of these conditions prevail throughout the Philippine Islands.

Not every structure in which salt water has been used, or in which salt is found, goes to pieces in this way. There are several such buildings in good condition. However, the concrete in them is unusually dense, and it is thought that their success in withstanding the influence of the salt is due to the density of the concrete.

Engineers in the Philippines have been accordingly advised that all use of salt water in concrete structures is dangerous and that the use of beach sand and beach gravel should be permitted only after thorough washing with fresh water.

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The Volume of Coal Traffic at four principal Atlantic seaports has been investigated by the United States Geological Survey. The figures are approximate only and give the totals in net tons for the year 1915. New York leads with 27,000,000 tons, Hampton Roads comes next with about 16,000,000 tons, then Philadelphia with something over 13,000,000 tons, these figures not including the bituminous coal consumed in Philadelphia itself. The total receipts at Baltimore were about 7,600,000 tons.

Engineers Condemn Montreal's Municipal Power Plant

SYNOPSIS—Voluntary commission of local engineers reports that Montreal's proposed municipal water-power project is ill advised.

One of the most frequent sources of large loss in the works carried on by the Government—Federal, state or municipal—is the undertaking of enterprises without sufficient preliminary information to determine whether they are worth while. A remarkable example of this has just been brought to light at Montreal through the work of a voluntary commission of engineers, organized under unusual circumstances.

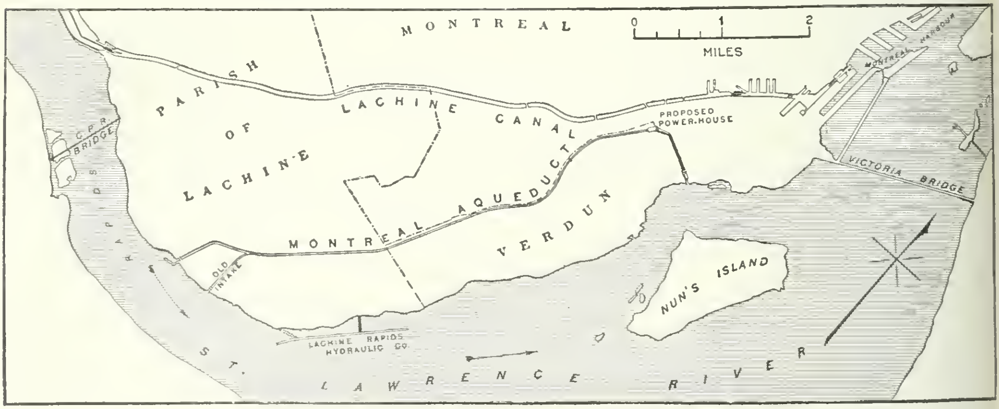
As briefly summarized in the last issue of *Engineering News,* this commission of engineers finds that the city has about half completed a water-power project that will cost when finished at least $11,000,000, but which is so expensive and so unreliable that the city had better lose all the money it has already spent rather than carry the project farther.

The story is such an excellent illustration of the way in which taxpayers' money is frequently wasted through the failure of public authorities to employ competent engineering advice that we present herewith the following particulars from the commission's report:

About the middle of the last century the City of Montreal secured a new water-supply from the St. Lawrence River, taking water from the river near the head of the Lachine Rapids, carrying it in an open canal about five miles toward Montreal and discharging back into the river such part of the flow as was not required for city consumption. The power developed by this surplus water discharged back into the river at the lower end of the canal was used for pumping the city supply.

As every engineer familiar with water-power developments in northern latitudes is aware, ice troubles in winter from frazil or floating ice are very frequent. Much trouble was experienced at the city pumping plant, so that steam power was gradually substituted for water power. In 1905, Georges Janin, who was then superintendent of the water-works, recommended to the city authorities that in order to save the cost of pumping by steam the canal should be enlarged sufficiently to produce water power amounting to 5,000 hp. in summer and 2,000 hp. in winter, in addition, of course, to the amount of water required for municipal purposes. It was computed that the saving over steam power would be sufficient to pay a large return on the cost of enlarging the canal and other expenses made necessary in connection with it.

In order to enlarge the canal, however, it was necessary to provide a water-supply for the city while the enlargement was going on, and a closed reinforced-concrete conduit was constructed alongside the canal. This closed conduit was completed in 1909, and work on the enlargement of the open canal then commenced. While this work of enlargement was going on, Mr. Janin recommended that the size of the canal be further increased so that the water discharged by it would be capable of developing 10,000 hp. This recommendation was also accepted, and part of the work was put under contract in July, 1913.



MAP SHOWING LOCATION OF AQUEDUCT FOR WATER-SUPPLY AND POWER DEVELOPMENT AT MONTREAL

The city authorities appear to have decided upon carrying out this enterprise solely upon the recommendation of Mr. Janin. No engineer or body of engineers was engaged by the city to investigate and report upon the merits of the enterprise, and even Mr. Janin himself appears never to have thoroughly investigated the whole enterprise. Although the work is now half finished, no complete plans and estimates have ever been made of such essential parts of the project as the river intake, the power house or the necessary outlet works in the river below the tailrace.

Public attention was called forcibly to what was going on on Dec. 25, 1913, by the breakage of the reinforced-concrete conduit supplying the city with water. Investigations made by a board of engineers, called in by the city authorities, showed that the excavations carried on in enlarging the canal were seriously endangering the concrete conduit alongside. The City of Montreal was put in perilous condition by the cutting off of its water-supply, and the emergency would have been even more serious, except that a large part of the city is supplied with water by a private company.

About this time criticism of the project as a whole appeared in the public press, and it was pointed out that the saving promised by the construction of the power plant was not at all likely to be realized. The city authorities, however, made no move in the matter, and the engineers who were called in to investigate the break in the conduit, while they recommended to the city that the whole project should be carefully studied, had no authority to make such an investigation.

As no action had been taken on the report of these engineers, the Canadian Society of Civil Engineers, in July, 1915, urged the city authorities to order a full investigation of the project. This recommendation was ignored, and in October the society renewed its appeal. Its criticism was further emphasized by a comprehensive article in the *Canadian Engineer.*

As the city authorities ignored these criticisms and recommendations, 31 engineers who were citizens and taxpayers of Montreal signed a protest to the city authorities in April, 1916, urging that an engineering commission be appointed to investigate the project. Later, a delegation of these engineers appeared before the Board of Commissioners on May 12, 1916, and before the aldermen on June 22.

When some of the aldermen suggested that these engineers should have an investigation and report made free of cost to the city, the proposition was accepted. The 31 taxpayers selected a committee, made up of W. S. Tye, chairman, Sir John Kennedy, Ernest Marceau, J. A. Jamieson, R. A. Ross, Arthur Surveyer and Walter J. Francis.

The report of this committee was presented and approved at a meeting of the taxpaying engineers on Nov. 13, of which Phelps Johnson was chairman, and H. M. Mackay was secretary. This report was laid before the mayor, Board of Commissioners and City Council of Montreal on Nov. 20. The situation as presented in the report of this committee may be briefly summarized as follows:

So far as the city's water-supply is concerned, the original aqueduct was ample. The whole work must be viewed solely as a project for power development. The project which the city has undertaken is substantially the building of a canal, about five miles in length, to bring water to a power house where it would be discharged under a head probably not greater than 25 ft. This canal would furnish water enough to develop about 11,000 hp. in summer and about 7,000 hp. in winter, when the canal is covered with a thick sheet of ice. Troubles from frazil would probably reduce the winter output much below 7,000 hp. and cause complete shutdown of the plant more or less of the time every winter. This was the previous experience with the hydraulic power formerly in use at the city's pumping plant.

As another illustration: The 10,000-hp. hydro-electric plant of the Lachine Rapids Hydraulic Power Co., situated on the same rapids and less than two miles away from the aqueduct intake, is practically closed down for three or four months every winter. Conditions at the intake of this plant are similar to those at the proposed city power plant, and the facilities for removing frazil and other ice at the Lachine plant are much superior to those at the city intake, where no means whatever have been provided for this purpose.

Further than this, the engineers point out that the tailrace of the city power plant as now designed cannot safely discharge water for the development of more than about 6,000 hp., and no estimates whatever have been made for dredging in the St. Lawrence River below the outlet of the tailrace, which dredging would be necessary for about half a mile.

The first estimate of cost prepared by Mr. Janin was $4,975,000. The city has already spent nearly $5,000,000, and it will require at least $5,600,000 more to complete the project. This estimate does not include the cost of works for water filtration, of pumping plants and steam auxiliary plants, nor claims by one of the contractors amounting to over $900,000. Neither does it include any allowance for parking, nor the usual allowance for contingencies.

As an instance of the inadequacy of the original plans and estimates, the concrete retaining walls at first designed for the canal were found too light and had to be redesigned at an estimated increased cost of $675,000.

For the money that this project will cost, the City of Montreal could have purchased and developed any one of a number of water powers within easy transmission distance of Montreal, each of which has a capacity of at least 100,000 hp.

If the City of Montreal carries out and completes the present power plant, it will represent an investment by the city of at least $1,515 per horsepower capacity. In contrast with this, the 125,000-hp. hydro-electric plant built by the Laurentide Paper Co. at Grand' Mère, Quebec, cost only $52 per horsepower. The great plant at Cedar Rapids cost only $90 per horsepower, and when developed to its ultimate capacity this will be reduced to $75 per horsepower. The plant at Shawinigan Falls cost considerably less than $100, and the additional power developed there cost only $50 per horsepower.

It was not necessary for the city, however, to undertake its own power development. At any time during the last 15 years the city could have purchased power in the open market sufficient for all municipal purposes at a small fraction of the cost of its present power development. Twenty-four-hour power suitable for pumping can be purchased in Montreal for not more than $20 per horsepower per annum. The minimum fixed charges and operating expenses of the city's power plant now under construction will be at least $108 per horsepower per annum. The commission says: "The present project should never have been started, and we are firmly of the opinion that all thought of completing it along the present lines should be abandoned."

⁂

A National Industrial Conference Board has been organized to secure coöperative action in legislative and other matters by twelve important industrial organizations, including the National Association of Manufacturers and other organizations representing the foundry, metal and structural steel manufacturers, printers, the paper and rubber trades, and four of the leading textile organizations. Frederick T. Fish, of Boston, is Chairman of the Board, and Magnus W. Alexander, of West Lynn, Mass., is Manager. The organization of the board was announced at the 20th annual convention of the National Founders Association on Nov. 15.

Concrete Floor Falls After Early Removal of Forms

Disregard of the elements of safe reinforced-concrete construction has once more caused a concrete building collapse with fatal results and considerable material damage. Practically the whole roof of a large building under construction in New York City fell while the forms were being stripped from under concrete hardly a week old—a week, too, in which on four days the thermometer dropped below the freezing mark. The bare facts of the case are told as follows by E. B. McGuire, an engineer in the office of District Attorney Swann, who is now making an investigation of the collapse and has placed the facts before the Grand Jury. The district attorney's office furnished the photographs herewith:

"The concrete roof of a building being constructed by George G. Wilson & Co., Inc., of 25 West 42nd St., New York City, for the Havre Holding Company, Inc., of 141 Broadway, situated on the southeast corner of 64th St. and Third Ave., New York City, collapsed about eleven o'clock on the morning of Nov. 23, 1916. One laborer was killed and several others severely injured. The men were on the floor below at the time, engaged in stripping the forms and supports from the roof slab. Débris falling to the street below injured a woman and child. The entire upper floor will probably have to be replaced.

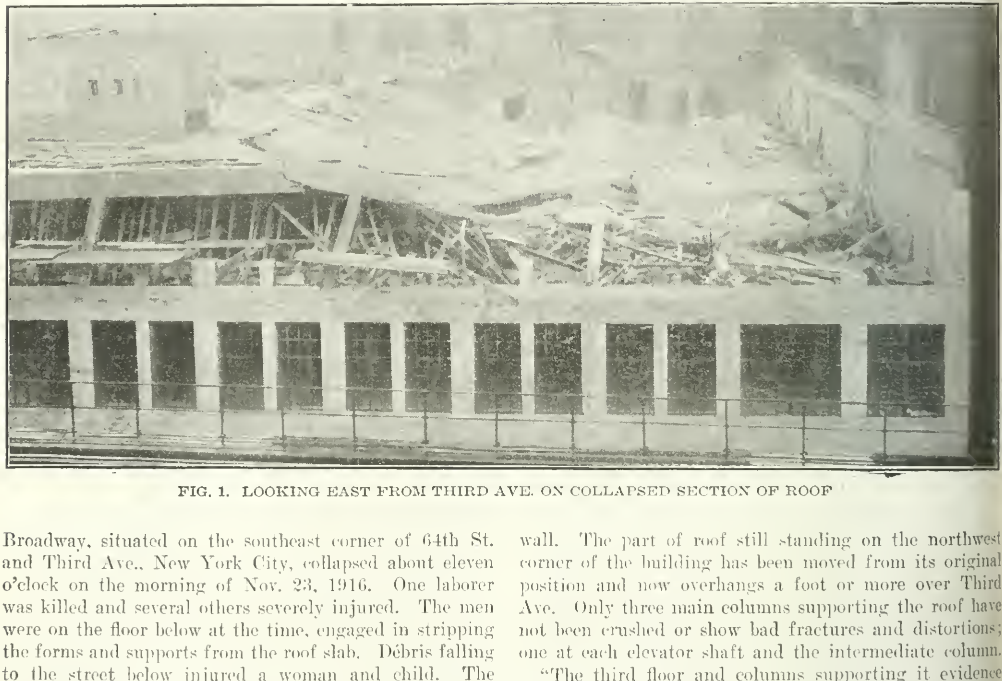


FIG. 1. LOOKING EAST FROM THIRD AVE. ON COLLAPSED SECTION OF ROOF

"The structure is a three story and basement corner building, 100 ft. wide on Third Ave. and extending down 64th St. 130 ft. The first or ground floor is fitted up as stores, the second and third floors being intended for garage purposes. The exterior walls, two elevator inclosures and fire wall around the main stairway inclosure on east end of building extending to 64th St. side, are of brick, and the small stairway on south side is inclosed in firebrick.

"The main structure is of reinforced concrete, a special type of girderless floor construction being used. This comprises circular straight rodded columns carrying the usual conical capital and dropped head but having also a shallow wide beam between columns. Wall columns were 12 in. square. Typical roof panels were 21 ft. 9 in. by 22 ft. 10 in. with the following dimensions:

Diameter of columns	12 in
Diameter of capital head	6 ft
Width of cross-beam	10 ft
Height of capital	3 ft
Total thickness drop head	10 in.
Total thickness cross-beam	6 in.
Total thickness slab	4 in.

"That portion of the roof between the fire wall and the east end of building is supported on reinforced-concrete beams about 10 in. deep and 10 in. wide, approximately 6 ft. 6 in. on centers. This part of roof shows no injury. The roof covering, which was in place, consists of a 6-in. cinder fill, sloped toward the east and west to provide drainage, the intention having been to finish it off with mortar topping.

"The collapsed portion of the roof extends from the southerly wall for a distance of about 73 ft. to the edge of the square slabs over the first row of columns on the north side and from the front of the building to the rear wall. The part of roof still standing on the northwest corner of the building has been moved from its original position and now overhangs a foot or more over Third Ave. Only three main columns supporting the roof have not been crushed or show bad fractures and distortions; one at each elevator shaft and the intermediate column.

"The third floor and columns supporting it evidence no signs of cracks or injury from the impact of the fall.

"From the information at hand it appears that the men began pouring the roof on Nov. 9 and finished on Nov. 16, starting from the easterly side and working toward Third Ave. They began removing forms on Nov. 16 at easterly end, and this was in progress when the accident happened on Nov. 23."

A later investigation of the building and its design by a member of the editorial staff confirms Mr. McGuire's report except in regard to the time of beginning the roof form stripping. This date will probably be brought out in the inquest, but evidence now at hand seems to show that the form stripping started Nov. 21, the concrete at the east end then being not quite two weeks' old and on Nov. 23 reached the west end of the

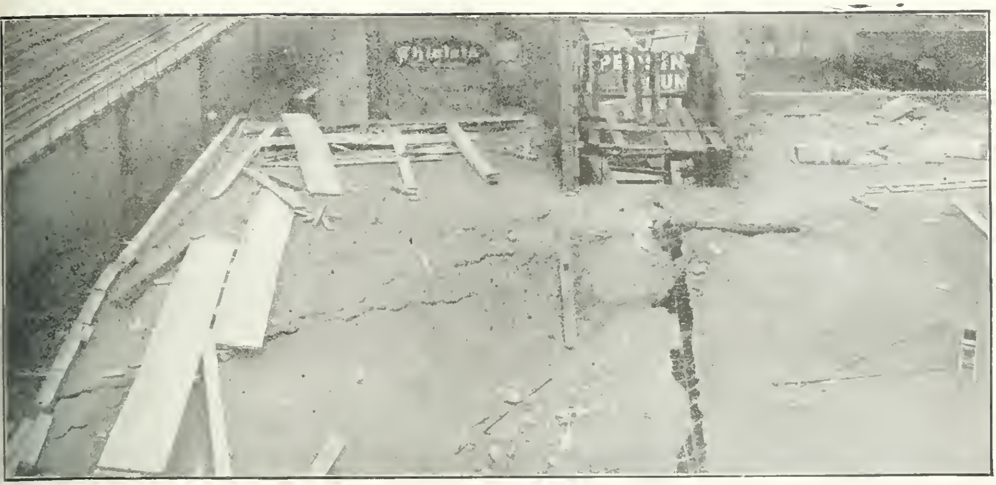


FIG. 2. LOOKING NORTH ALONG THIRD AVE., SHOWING ROOF PULLED AWAY FROM BRICK WALL AT ELEVATOR SHAFT

oof where the concrete was barely one week old. The Veather Bureau report of temperature during this period s as follows:

AILY TEMPERATURES AT NEW YORK CITY, NOV. 10-23, 1916

(Degrees Fahrenheit)

Nov.	Max.	Min	Mean
10	60	47	54
11	54	45	50
12	52	41	46
13	51	45	48
14	55	33	44
15	40	31	36
16	40	28	34
17	46	32	39
18	47	36	42
19	49	31	40
20	53	36	44
21	42	27	34
22	43	28	36
23	59	38	48

It appears that the collapse is to be made the subject f rigid inquiry and perhaps of criminal prosecution, so hat more than a preliminary or cursory report on it is ot now feasible. The design will be examined closely, ut at present that is a secondary consideration when t is recalled that the third floor, of similar design and about four weeks old, safely carried without underpinning—the struts having been removed from under it—the impact of the whole falling roof. This also exonerates the concrete of that section from criticism. The roof concrete on Nov. 26 after two weeks' setting appeared to be satisfactory, but eye witnesses state that on the day of the collapse the firemen cut into this same roof concrete with their axes as though it had been clay. While the trial or inquiry may bring out unexpected facts, the collapse now appears to have been due to criminal conlessness or ignorance in the removal of shores under concrete which with the best of conditions could hardly have reached a safe set but which with the prevailing weather was not concrete at all but merely a potential concrete awaiting time and warmth to make it solid.

The collapse was progressive. The initial failure was about the middle of the brick wall shown at the right of Fig. 1, and the first four rows of columns are all down. From that line north the columns all have a gradually decreasing inclination, but all bow out to the west.

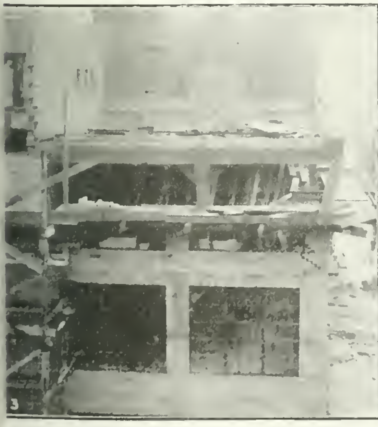


FIG. 3. LOOKING SOUTH LONG THIRD AVE., SHOWING LEANING WALL COLUMNS

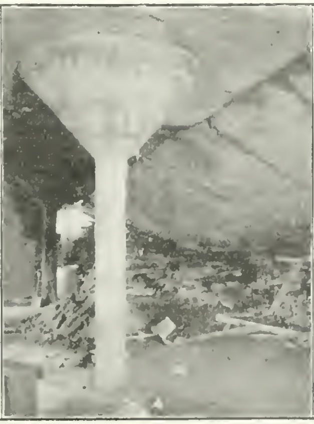


FIG. 4. ONE OF THE REMAINING COLUMNS UNDER ROOF

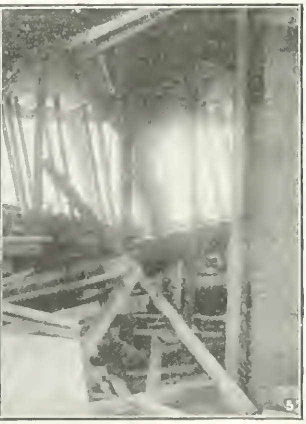


FIG. 5. BENT INTERIOR COLUMN UNDER NORTH END

Velocity Coefficients for a Dredged Drainage Canal

By Paul V. Hodges*

In the article entitled "Some Better Kutter's Formula Coefficients," *Engineering News*, Feb. 24, 1916, the following paragraph was noted:

> Experience shows that the coefficient of roughness for excavated channels of the same slope and cross-section is dependent upon the method of excavation. Additional experiments are needed to determine the specific coefficients for channels in earth excavated by different methods of dredging, etc

The purpose of this article is to present the coefficients obtained on the Blitzen canal in Oregon and to show the adaptability of different formulas to the flow in this particular class. The results of this experiment show that Bazin's formula applies to the flow in this canal better than the other well-known formulas, but that the formula $V = 229.6\ (RS)^{0.68}$ derived for this canal applies somewhat closer than Bazin's. The average value of n in Kutter's formula was found to be 0.0255.

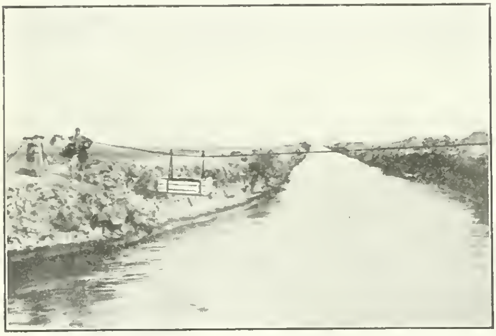


FIG. 1. BLITZEN CANAL SLOPE-STUDY COURSE

The Blitzen drainage canal, with a length of 25 mi., is located near Narrows, Ore., and was built to carry off more directly the total flow of the Donner und Blitzen River, thus partly reclaiming 20,000 to 25,000 acres of tule swamp. At Grain Camp, about 5 mi. from the lower end of this canal, headgates are installed to hold the water at the proper height for diverting to irrigation ditches. The canal was excavated, in a surface peat soil underlain with clay, by means of a floating dipper dredge with a bucket capacity of about ¾ cu.yd. The section as originally excavated was as nearly rectangular as it was possible to make it. At the present time the sides are somewhat irregular, being vertical or overhanging, as a rule. Many lumps or blocks of peat have fallen into the channel, thus causing more resistance to the flow, but the canal has been pretty well evened up by the floods that have passed through it since its completion.

The United States Geological Survey gage is located in the pool directly below the Grain Camp headgates, and the cable installation for making discharge measurements with the current meter is 100 ft. downstream, as shown in Fig. 1. Three thousand feet below the gage a benchmark is set, which is used for the determination of the elevation of water surface at Station *B*. Fig. 1 shows the canal looking downstream from the Station *A* to Station *B*. Two cross-sections were measured, as shown in Fig. 2—one near the gage, or at Station *A*, and the other at Station *B*. The average of these two cross-sections was used in the computations.

The readings of the water surface were somewhat inaccurate on account of small wave action; for this reason the gage readings at Station *A* were assumed correct, and the readings at Station *B* were corrected to show a uniform increase in slope with increase of gage height. This is shown in Fig. 3, in which the gage heights are plotted as ordinates and the slopes as abscissas. For example, the points as plotted for Station *A* are moved horizontally, as shown by the arrows, so that they will fall on the curve. This changes the slope values, and from these new values the elevation of water surface at Station *B* is computed. The measured area of cross-section and the wetted perimeter were corrected to comply with the correction for the elevation of water surface noted before.

In Fig. 4 are shown the rating curves for both stations. The measurements of discharge were made carefully with a small Price current meter. Readings of depth and velocity were taken at 2½-ft. intervals, from the cable at high stages and by wading at low stages. The velocity was obtained by taking readings at 0.2 and 0.8 of the depth at each section. The mean velocity at each vertical was taken as the average of these two readings.

In testing the application of different formulas to the flow in this channel the coefficients in the following formulas were computed from the data obtained in this experiment, as shown in Table 1. The coefficient n of Kutter's formula varies from 0.0253 to 0.0259, and the velocity as computed with these values has a variation of 2½% within the range of this experiment. The coefficient m of Bazin's formula,

$$V = \frac{87}{0.552 + \frac{m}{\sqrt{R}}} \sqrt{RS}$$

varies from 1.127 to 1.164, and the velocity as computed with these values has a variation of 2%. The coefficient C in the exponential formula $V = CR^{0.67}\ S^{0.54}$ varies 4%.

To obtain a formula that applies more closely to the law of flow in this canal the formula $V = K(RS)^{0.68}$ was derived, in which $K = 229.6$. The value of the coefficient K varies 1.8% within the range of this experiment.

BLITZEN DRAINAGE CANAL AT GRAIN CAMP, ORE.

Station	No.	Date, 1916	Gage Height	Slope, S	Area Section	Average Area, A	Wetted Perimeter	Average Wetted Perimeter	Hydraulic Radius, R	Discharge, Q	Average Mean Velocity, V	Kutter Coefficient, n	Bazin Coefficient, m	Experimental Coefficient, c	Chezy, C	Blitzen, K	$(RS)^{0.68}$
A	2	May 4	2.23	0.000345	43.6	39.0	27.7	27.1	1.44	50.5	1.30	0.0257	1.127	75.41	58.3	229.4	0.00566
B	..	....	1.19	....	34.3	...	26.5	...	...	...	...	.....	....	....	...	....	......
A	1	May 2	2.92	0.000386	64.0	57.6	32.5	31.6	1.82	94.0	1.63	0.0259	1.164	76.07	61.5	227.2	0.00717
B	..	....	1.76	....	51.1	...	30.8	...	...	...	...	.....	....	....	...	....	......
A	4	June 10	3 60	0 000425	88 0	78.6	37.2	35 9	2.19	158	2.01	0.0253	1.138	78.66	65.8	231 4	0.00868
B	..	....	2.32	....	69.2	...	34.6	...	...	...	...	.....	....	....	...	....	......
A	3	May 23	3.80	0.000435	95.1	85.4	38.5	37.0	2.31	180	2.11	0.0253	1.148	78.68	66.6	230.6	0.009151
B	..	....	2.49	....	75 6	...	35.5	...	...	...	...	.....	....	....	...	....	......

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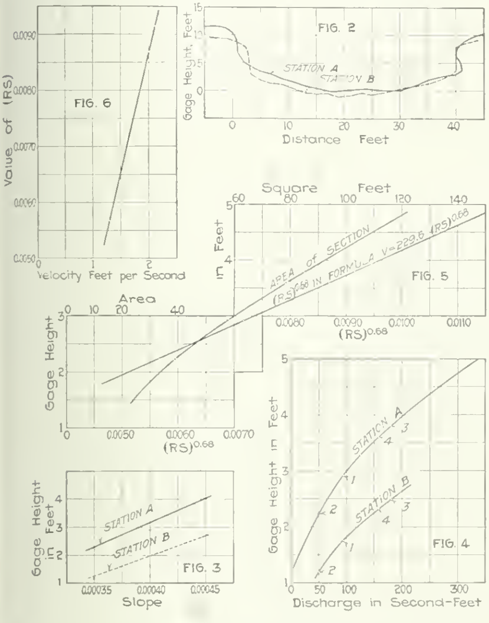
*Junior Engineer, United States Geological Survey, 403 New Post Office Building, Denver, Colo.

It has been contended by some writers that the value of *n* decreases as velocity or hydraulic radius increases, the condition of the channel remaining the same. The results of this experiment show this to be true in this canal.

Additional experiments are needed to show the law of variation of *n* in Kutter's formula and *m* in Bazin's formula with a change in velocity or hydraulic radius for different classes of canals. In Bulletin 194 of the United States Department of Agriculture is a diagram showing the variation of *n* with velocity and hydraulic radius from experiments on many different classes of canals.

In Fig. 5 curves are drawn showing the relation between the gage height and area of cross-section, and also gage height and values of $(RS)^{0.68}$. In Fig. 6 the relation between velocity and values of $(RS)^{0.68}$ is shown. Great care was taken in the measurements and computations, and the results are considered reasonably accurate. A larger range of stage in the measurements would have increased the value of the experiment, however.



FIGS. 2 TO 6. CROSS-SECTION RATING CURVES, ETC., BLITZEN CANAL

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The Municipal Electric-Light Plant of Wallingford, Conn., although a small plant of only about 600-kw. capacity, has shown remarkably good financial results, according to the annual report for the year ended July 31, 1916, just issued. The gross earnings last year were $52,000, and the net earnings $22,700. The balance sheet shows a total valuation for the plant at the present time of $280,000. The plant was built 17 years ago by an issue of bonds and it has earned profits since its construction sufficient to continually enlarge its capacity and to pay interest and sinking-fund charges on the bond issue, so that at the present time only $55,000 in bonds are outstanding, and there is $38,000 in the sinking fund. The accumulations of this fund in another year will be sufficient to wipe out the bonded indebtedness. The general manager of the plant, A. L. Pierce, in his annual report states that the plant has never, in the 17 years of its operation, received any money from the taxpayers. The total interruptions to service have amounted to 45 min. in 17 years.

City Managers Exchange Ideas

A unique convention program was carried out with eminent success by the City Managers' Association at Springfield, Mass., last week. Not a single formal paper was presented, yet a dozen subjects were quite fully discussed. This was the plan: There was a roll call on each subject. Responses were limited to five minutes, but some of the fifteen managers present took less, thus giving extra time to the few who needed it. The retiring officers—Henry M. Waite, of Dayton, and Ossian E. Carr, of Niagara Falls—kept the convention well in hand, even to starting most of the meetings on scheduled time when only two or three members were on the floor.

The city managers met first in New York City, where they put in a busy and instructive day visiting city offices and works, attending a dinner followed by addresses. At Springfield, round-table lunches and dinners merged into discussions, making virtually four sessions a day, and on the third day the City Managers' Association and the National Municipal League joined with representatives of still other municipal organizations at lunch, after which about a dozen managers told of their most notable achievements during the year. A part of an evening session was devoted to addresses on the public works of Springfield, Mass., followed the next morning by an automobile ride over the city.

Secretary Carr reported that city managership work is an extra-hazardous occupation, as 6 of 36 members of the association had retired from their positions during the year. There is still room for growth, as the number of cities committed to the city-manager plan has increased from about 70 to 90 during the year.

That the city managers stand for adequate budget making, constructive publicity, keeping themselves in the background, a large variety and amount of work for social as well as material improvement, the elimination of partisan politics, favoritism and corruption from municipal government, and that they work with untiring energy for these and all other ends making for efficiency was apparent from the discussions at the convention.

Many if not most of the managers are engineers, but the topics before the convention were, naturally enough, chiefly of an administrative rather than an engineering character. There was a round of expression of opinion regarding methods of cost keeping. This disclosed practical agreement on the desirability of cost keeping, with an apparent difference of opinion as to whether effort should be centered on the amount of work one man accomplishes in a day or the cash outlay for a unit of work. This seeming disagreement may have been due to momentary confusion over efficiency of employees and total cost of work done. One or two managers emphasized the difficulties that beset any attempt to secure unit-cost figures that are of real value for comparing one city with another, owing to differences in various local conditions.

How best to train city managers gave rise to some animated discussion. H. M. Waite was pronouncedly in favor of training in service rather than in any school or university, since the essential thing in a manager is executive ability.

The election of officers resulted in the choice of Ossian E. Carr, Niagara Falls, N. Y., as president, and W. L. Miller, St. Augustine, Fla., as secretary-treasurer. The next meeting place was left for future decision.

News of the Engineering World

Municipal Week at Springfield

With the growing number of technical and municipal conventions, hearty welcome will be given to every successful effort to bring as many of a kind together at one time and place as may be reasonably possible. A notable example of such effort was furnished last week, when the City Managers' Association, the National Municipal League, the Municipal Research Conference, the Training School for Public Service, the Civic Secretaries' Committee and the Intercollegiate Division of the National Municipal League, the Massachusetts Federation of Planning Boards and the Massachusetts Civic League met at Springfield, Mass. A number of these organizations held one or more sessions in common, besides which there were numerous joint lunches, dinners, and, to give full measure, a joint breakfast, followed by discussions of common interest.

A brief report of the meeting of the City Managers' Association appears elsewhere in this issue. The other conventions, while discussing numerous vital municipal questions, brought out little of direct interest to engineers. There was, it is true, considerable discussion of city planning, but this related mostly to topics already presented in *Engineering News.*

⁂

Progress of Federal Aid for State Highway Work

The Secretary of Agriculture has interpreted the Federal aid highway law to mean that in accepting the terms of the act a state, as a matter of course, pledges its faith to a five-year program, because the Federal Government will furnish aid during a five-year period. This he regards as important because it makes possible the arrangement of a comprehensive scheme of road building. The expenditure of the entire amount of money contemplated under the act is to be planned at the outset, so far as possible.

California is the only state as yet which has met every requirement of the law. Georgia and Maine have complied with all requirements except the submission of a general program of road improvements. In Connecticut, New Hampshire, Pennsylvania, Idaho and Louisiana, the pledge of the faith of the states to match the Federal appropriations for five years have not yet been given, but is expected soon. In New York, Vermont and Wisconsin, further legislation is considered necessary by their officials before the Federal coöperation can be utilized. In Virginia, where the State Highway Department has no authority to submit a state-wide project for road improvements, the pledge of the faith of the state to the terms of the act and the submission of a five-year road-building program are particularly difficult matters to adjust.

The states with which formal negotiations looking to early participation in Federal aid have not yet been carried on are Arkansas, Delaware, Florida, Illinois, Indiana, Kentucky, Maryland, Mississippi, Nebraska, Nevada, New Mexico, North Carolina, Ohio, South Dakota, South Carolina, Tennessee, Texas, Utah, Washington, West Virginia and Wyoming. Informal correspondence shows that many of these states will be in a position to take up the subject formally before long. The Office of Public Roads and Rural Engineering has prepared a state highway bill for the consideration of the Texas legislature and is coöperating with the Oregon Association of County Judges in the preparation of an entirely new road law for that state. Drafts of road bills are being prepared for South Carolina, South Dakota and Nevada at the request of officials of those states.

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New Jersey Highway Engineers Tackle Motor-Truck Problem

The second and final hearing of the special committee, appointed by the Commissioner of Motor Vehicles of the State of New Jersey, for the purpose of preparing rules and regulations to govern the use of motor trucks on the highways of the state was held in Newark, Nov. 24. About 100 persons were present and the session was lively and full of interest.

The committee has been studying the problem since May of this year, and for the particular purpose of devising means of saving the roads from destruction. New Jersey being the first state to enter upon systematic highway improvement, it follows that the facilities for studying the effect of motor-truck traffic on the older types of highway pavement are about the best. The chairman of the special committee is Thomas J. Wasser, a civil engineer of Jersey City, and the secretary is Frederic A. Reimer, county engineer of Essex County.

Some of the rules the committee proposes are: To allow no vehicle over 96 in. wide to use the roads without a special permit; to limit the height of vehicles to 12 ft. 2 in., and the length to 26 ft. 6 in.; to prohibit the use of any motor vehicle or trailer with metal tires, or tires with lugs or hobs, etc.; to require every vehicle to be equipped with a sealed governor or other automatic speed control; to allow the use of a single trailer only; to prevent a truck with tires so damaged that the metal rims come in contact with the road from being moved, under a penalty of $500 for each violation; to require a name plate giving the maximum speed and gross weight (loaded) of the vehicle; to make motor-truck owners directly responsible for damage done to bridges where the weight of the loaded truck exceeds the posted safe load for the bridge, and to appoint state inspectors to enforce these rules and regulations by actually testing the speeds and weighing the trucks if necessary.

It is proposed to base all license fees on the maximum wheel load, according to tables compiled from data furnished by rubber-tire manufacturers as proper loads for each size of tire. By the proposed rules separate licenses would be required for tractor and trailer; one-third the gross weight of a truck and its carrying capacity would be such as not to exceed a schedule which also specifies the size of wheel, tire and the speed for each in miles per hour. Thus the maximum wheel load is fixed at 8,625 lb., on two 7-in. tires on 42-in. wheels, and the speed of such a vehicle would not be allowed to exceed 10 mi. per hr. Pneumatic-tired vehicles it is proposed to license as pleasure vehicles and they would not be classed as trucks.

There was much objection made by the motor-truck representatives to the provision requiring rubber tires. A tire manufacturer stated that rubber tires were not now made in larger diameters than 42 in. A severe penalty for speeding was suggested in place of the requirement of sealed governors, which it was said were imperfect and difficult to keep in order. It was said that the speed limit of 10 mi. per hr. was too low for economical operation, that 15 mi. per hr. should be fixed. There was a repetition of the general arguments against discriminatory fees, such as were noted in last week's report of the New York State hearing on motor-truck fees.

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Miami Flood-Prevention Plan Approved by Court

Dayton, Hamilton, Middletown and other Ohio communities in the Miami River valley are to be safeguarded against devastating floods by detention reservoirs and channel improvements. The plan approved is the one described in *Engineering News* of April 6, 1916, as having been adopted by the directors of the Miami Conservancy District. (Edward A. Deeds, president; Arthur E. Morgan, chief engineer; office, Dayton, Ohio.)

To become effective this plan had to be authorized by the county judges of the nine counties included in the district, sitting as a Conservancy Court. The long hearing before this court was reviewed by Col. H. M. Chittenden, one of the consulting engineers to the district, in *Engineering News* of Nov. 9, 1916, and on p. 906 of that issue a map of the district, showing the five detention reservoirs, was printed.

The vote for approving the plans stood 7 to 2, the two adverse votes being limited to dissent as to the need for one of the five reservoirs. On some other points at issue there were also various minority dissenting opinions, but all these were waived in the final approval. The court was unanimous as to the combination of dry detention basins and channel improvements being the only "practical and efficient plan of protecting the Miami valley from the results of defective floods." The full decision follows:

1. The court is of the opinion that the question raised as to the constitutionality of the law by reason of the decisions in the cases of Baumann vs. Dayton in the 66 O. S., and commissioners vs. Gates in the 83 O. S. is not now properly before the court for the reason that it does not appear that any assessment has been made against any specific piece of property and that therefore no one is now in a position to complain; and for the same reason other questions as to the unconstitutionality of the act on account of the method provided for the raising of funds is not now before the court.

To this finding Judge Mathers dissents.

2. The court is of the opinion that the Miami River is not a navigable stream in law or fact.

3. The court is of the opinion that any obstruction that may occur from the adoption of the plan to the public use or navigation of the Miami and Erie canal is authorized by the contract between the conservancy board and the state officials as provided for in the conservancy act.

4. As to the objection that no construction shall be made under the authority of the act which will cause the flooding of any village or city unless the board shall have acquired and paid for the right to use the land affected for such purpose and shall have paid all damages incident thereto, the court is of the opinion that such provision of the law does not prevent the adoption of the official plan.

5. The court is of the opinion that channel improvement alone for the entire conservancy district is not feasible or practicable, and is prohibitive in cost and would not adequately protect the district from flood waters.

Judge Mathers dissents from the proposition that channel improvement alone would not adequately protect against floods.

6. The court is of the opinion that the combination of dams and dry detention basins, together with channel improvement, is the only practical and efficient method of protecting the Miami valley from the results of destructive floods.

7. The court is of the opinion that earthen dams, with concrete conduits and spillways as provided for in the official plan, are safe and will be of sufficient strength to sustain at all times any burden that may be placed upon them by impounded water.

Judges Jones, Mathers and Kyle do not fully concur in the foregoing, but find that a preponderance of the evidence shows that the dams as provided will be reasonably safe.

8. The court is of the opinion that it would not be feasible to reduce the height of the Huffman dam or its spillway.

To this Judges Kyle and Geiger dissent.

9. The court is of the opinion that the Lockington dam should not be eliminated from the official plan.

To this Judges Jones, Mathers and Geiger dissent.

10. The court is of the opinion that the objections filed to the official plan as proposed by the board of directors of the conservancy district should be overruled; that the work proposed in said plans is necessary and that the same will be conducive to and conserve the public health, safety, convenience and welfare of the Miami conservancy district, and the court therefore adopts the said official plan.

To the judgment of the court adopting the official plan, Judges Jones and Mathers dissent by reason of the finding made by the court in the ninth syllable hereof refusing to eliminate the Lockington dam; otherwise concurring with the majority of the court.

The estimated cost of the project is $23,540,000, including $4,000,000 for contingencies.

While means are provided for an appeal, it is thought that the work of the district will go forward without further delay. However, construction can not be started yet as the law requires the appraisers to report, and their report to be reviewed and approved by the court, before construction work can begin. The whole question of the advisability of the conservancy project may, in fact, be reconsidered at that time, and the plan rejected or modified. This in effect gives the objectors a second hearing without resorting to appeal to a higher court.

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Columbus River Widening for Moderate Floods

Under rather unusual instructions from the city council, Chief Engineer Henry Maetzel, of the engineering department of Columbus, Ohio, is making estimates of cost for two river-widening plans, for increasing the flood-carrying capacity of the Scioto channel through the city. This scheme is independent of the larger flood-prevention project which was worked out by Alvord & Burdick, as engineers for the Franklin County Conservancy District.

The conservancy project, which comprises large detention dams and a considerable amount of channel improvement, will be heard before the Franklin County judges sitting as a Conservancy Court on Dec. 6. It is opposed by many residents of the region, and for this reason an opposition scheme was launched in Columbus a few months ago, contemplating only a moderate channel widening through the city.

The advocates of this scheme proposed to widen the channel to 580 ft. from the confluence of the Scioto and Olentangy down to Greenlawn Ave., about 2½ mi. They claimed it would cost the city $3,500,000, and would carry floods greater than that of 1913 (which was 140,000 sec.-ft.). A referendum vote in November authorized the council to expend 3½ million dollars in channel widening.

An earlier investigation having indicated that the proposed channel would carry only 80,000 sec.-ft. and would cost more that its advocates claimed, the city council on Nov. 13 directed the chief engineer to make plans and estimates for two channel-widening schemes, one for a 580-ft. channel, and one for a channel to cost 3½ million dollars. Preliminary studies for this are now being made by R. H. Simpson, under Mr. Maetzel's direction.

The length of river channel under study is about 3¼ mi., extending downstream from the confluence of the rivers. Much land will have to be acquired. New levees must be constructed for over half the length, and a large amount of retaining-wall work is needed.

An unusual phase of the matter is that a project for channel improvement (but to a much larger capacity) was rejected by the voters of the city in 1913. It received a bare majority, but as a two-thirds vote was required to ratify a bond issue the proposal failed. This involved a much higher cost than the present 3½ million dollar project. The failure of that proposal led to the organization of the Conservancy District, and to the subsequent development of a detention-basin project as being much cheaper and of broader benefit than pure channel improvement.

Concerning the city studies now under way, information from several well-informed sources indicates that the 580-ft. project will cost over 50% more than first estimated, and thus will approach near to the cost of the entire conservancy plan, while giving protection only against normal floods, but bound to fail under calamitous floods. No opinions are obtainable as to what flood-capacity can be secured for the 3½ millions authorized.

Ontario Power Commission Will Develop Chippewa Creek

The Ontario Hydro-Electric Commission, it is reported, has decided to undertake forthwith the construction of the projected canal between Chippewa Creek (which flows into Niagara River above Niagara Falls) and Queenston for the supply of 200,000 hp. of electrical energy for the provincial hydro-electric power-distribution system. The work will be carried on under the direct control of the commission, as contractors were not disposed to tender except on the basis of the probable advance in the cost of fuel and on an estimate of 25% over cost as profits. The commission proposes to procure electric-driven excavating machinery, so as to avoid the uncertain element of fuel cost, and to save labor. It is estimated that the electrical equipment will cost between $800,000 and $900,000, as it will call for general excavation machinery of the heaviest type. The cost of the entire construction of the canal, which will be 12 mi. in length, is estimated at $9,000,000.

At a joint meeting of the Ontario Hydro-Electric Railway Association and the Municipal Electrical Association of Ontario, the following resolution was adopted:

> It is hereby unanimously resolved that the Ontario Government be asked to pass an order-in-council forthwith, permitting the Ontario Hydro-Electric Power Commission to exert its functions and powers in expropriating the plant or product of the Canadian Niagara Power Co. and others developing power at Niagara Falls.

Conference on Education in Highway Engineering

Plans have been perfected for a national conference to discuss highway engineering instruction in the civil engineering curricula of universities and colleges. The meeting is to be held Dec. 29, at 8:30 p.m., in the assembly hall of the Automobile Club of America in New York.

The conference is to be held under the joint auspices of the Society for the Promotion of Engineering Education, the American Association for the Advancement of Science, the National Automobile Chamber of Commerce, the Automobile Club of America and the National Highway Association. The papers presented and the discussions upon them will be published in the *Proceedings* of the Society for the Promotion of Engineering Education.

Arthur H. Blanchard, Professor of Highway Engineering at Columbia University and Secretary of Section D, Engineering, of the American Association for the Advancement of Science, has undertaken the work of organization.

Chicago Sewage Treatment and Dilution

Important improvements in the sewage-disposal system of Chicago are to be carried out under an order passed Nov. 23 by the Board of Trustees of the Sanitary District of Chicago. This order directs the chief engineer to prepare plans and specifications for works recommended in a report presented by the Committee on Engineering and designed to improve the condition of those streams within the district that now receive crude sewage. This not only pollutes the water and makes proper dilution difficult, but also causes deposits that are offensive and tend to check proper flow. The works proposed would improve conditions in the north and south branches of the Chicago River, the Drainage Canal (and Sag Channel), the Desplaines River and the Illinois River. With the solids excluded, the disposal of the effluent and the maintenance of the streams in proper condition would be very much simplified. The necessity for this removal of solids before sewage is discharged into the Sanitary District channels has been evident for some time and has been made the subject of extensive investigation. This applies particularly to the stockyards and packing-house section.

A large amount of sewage from suburban towns is now discharged into the Desplaines River, causing offensive conditions and destroying the use of the river for fishing, ice-cutting and pleasure purposes. This sewage, in an advanced state of putrefaction, then flows into the Illinois River. Similar conditions exist in the north branch of the Chicago River, where the amount of diluting water is limited. The remedy lies in collecting the sewage and delivering it to points where the solids can be removed and any other necessary treatment given. The Sanitary District is already operating works at Morton Grove for the removal of solids from the sewage before it is discharged into the north branch of the river.

The report makes plain the committee's view that the treatment recommended for the removal of solids and further purification of the sewage is only supplementary to the dilution and for the purpose of rendering this latter more effective. The Sanitary District Act (1889) requires a continuous flow of at least 20,000 cu.ft. of water per minute for each 100,000 inhabitants of the district. It also requires the removal of solids before sewage is discharged into the channel, and the maintenance of the channel in such condition that the water will be neither injurious to health nor offensive. The committee states that it does not consider it practicable to dispose of the sewage properly without this amount of diluting water.

The report recommends the purchase of land and preparation of plans and specifications for the several proposed works. The recommendations may be summarized as follows:

1. The construction of intercepting sewers along the Desplaines River to collect the sewage of Maywood, River Forest, Forest Park, etc. (now discharged into the river), and the treatment of this sewage by an activated-sludge plant.

2. The treatment of domestic sewage centering at the 39th St. pumping station (from an area of about 22 sq.mi.) by settling basins or an activated-sludge plant in the vicinity of this station.

3. The treatment of sewage from the Calumet region, which will be diverted through the new Calumet intercepting sewer to the Calumet-Sag Channel.

4. The treatment of sewage from Evanston, the north-shore towns and the district along the north branch of the Chicago River. Specific study should be made of methods for remedying the local nuisance now existing in the north branch of the river, where the flow of water is insufficient to maintain scouring velocities.

5. The extension to the Drainage Canal of the sewers east of 52nd Ave. which now discharge into the Ogden Ditch. Negotiations should be taken up with the city authorities for apportioning the cost between the Sanitary District and the City of Chicago.

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The Estimated Population of the United States on Jan. 1, 1917, will be 102,826,000 persons according to the statistics of the Census Bureau based on the Federal census of 1910, with a rate of increase computed on the increase recorded from 1900 to 1910. This is for continental United States. The outlying possessions of Alaska, Guam, Hawaii, Canal Zone, the Philippines, Porto Rico and Samoa bring this figure to 113,309,000.

A Sewer Manhole Cover in State St., Boston, was recently lifted by the teamster of a coal truck who mistook it for the cover to a coalhole and proceeded to dump a large load of coal into the sewer. Just as the last of the load disappeared into the manhole the mistake was discovered, and a hurry call was sent to the Public Works Department. Prompt work by the emergency crew cleared the sewer before the flow in it had backed up enough to do damage.

Flood Lighting of the Statue of Liberty in New York harbor is to be inaugurated on the evening of Dec. 2, at the beginning of the "Electrical Celebration Week," when elaborate ceremonies in connection with the rededication of the statue are to occur. The ceremonies in connection with the completion of the statue took place thirty years ago, on Oct. 28, 1886. The statue was under construction a long time previous to that date however. The hand holding the flaming torch was one of the exhibits at the Centennial Exposition in 1876.

The John Fritz Medal, awarded in January, 1916, to Dr. Elihu Thomson for achievements in electrical invention, in electrical engineering and in industrial development and scientific research, will be presented to Dr Thomson at a meeting to be held in Boston on Friday evening, Dec. 8, the ceremony taking place in the Central Lecture Hall of the new buildings of the Massachusetts Institute of Technology. The program will include addresses by John J. Carty, E. W. Rice, Jr., and R. C MacLaurin. The presentation will be made by Charles Warren Hunt and the ceremonies will conclude with the response of Dr. Thomson.

The Floating Bridge in the City of Lynn, Mass., on the Salem-Boston turnpike, described in "Engineering News," May 4, 1916, is likely to be replaced with a modern structure, according to a report in the Salem "Evening News." The bridge crosses a pond 17 acres in area, underlain by a deep bed of peat. The bridge was originally built of three layers of pine logs laid at right angles to each other and secured together by 3-in. dowels. Additional timber has been added at various times during the century and over, since the bridge was first built, but the whole mass is so water-logged that under a heavy load the bridge gradually settles until the water flows over the floor. When the Salem batteries went to Framingham last June, they were obliged to make a long detour instead of crossing this bridge.

A 36-In. Water Main Broke in Minneapolis at 10:45 p.m. on Nov. 21, making it necessary to shut off the supply from the Camden station which feeds the south and north sections of the city. The east side was unaffected, that section being fed by a 48-in. main from the filtration plant. The remainder of the city is supplied by a 50-in. main which runs from the filtration plant to the Camden pumping station and is distributed thence over north and south Minneapolis by means of three smaller mains of which the 36-in. pipe that broke was the largest. The hole made was 16 ft. deep, 30 ft. wide and 35 ft. long. The repair crew got on the job quickly, but it was not until about 7 a.m., Nov. 22, that pressure was restored. Two months ago this same main broke under similar circumstances only a few joints distant from the present break.

A Settlement of Differences between the City of St. Louis and the local traction system, the United Railways Co., has been proposed by the latter in an open letter to the City Board of Estimate and the Public Utilities Committee of the Board of Aldermen. The company asks that the city repeal the mill-tax ordinance and drop its suits attacking the validity of the system's franchises. The company agrees to pay the mill tax to Dec. 31, 1916, and any more reasonable tax after that date. The company claims that the mill tax (equivalent to 2% of gross earnings) is such a burden that proper service cannot be given under it with present operating expenses. The city suits have clouded the franchise so that new capital cannot be secured. The proposal for a settlement and the accompanying arguments were published as full-page advertisements in the local papers.

The New York Barge Canal, according to the "Barge Canal Bulletin," has $68,700,000 worth of work done on contracts completed and $13,500,000 worth of work done on contracts now in force with about $4,000,000 worth of work remaining to be done on these latter contracts. On the canal terminal work, the preliminary contracts for dredging, dock walls, grading, etc., for 46 terminals have been awarded and construction is under way with about $1,500,000 already expended. In connection with an extended discussion in the report on the barge canal terminal problem, it is stated that the results of a careful investigation two years ago showed that the average terminal charge on freight transported by water in the United States was equal to the cost of carrying the cargo 2,500 mi. On the Great Lakes, where terminal costs have been reduced to the lowest figure by the extensive introduction of machinery for terminal handling, the terminal charge on the cargoes is still about equal to the carrying cost for the 1,000 mi. which the goods are transported by water.

Rebuilding Lower Otay Dam—The question of the validity of the bond election held by San Diego, Calif., on Nov. 17, for the purpose of rebuilding the Lower Otay dam will probably be immediately brought before the supreme court for a decision. In the election the proposition for bonding the city in the amount of $682,200 for rebuilding the dam carried two to one. Included in the same election, however, although on a separate ballot, was a proposition to grant 500 acres of tidelands to the United States Government for military purposes. Many people who voted on this question failed to vote on the bonding proposition. For this reason the Lower Otay bonds did not receive a two-thirds majority of the total vote cast at the election, which many claim is necessary to carry the bonding proposition. The city attorney, however, holds that the bonds will stand, since the granting of the tidelands to the government was not a bonding question, and will bring friendly suit to have the supreme court make a decision in the matter, rather than call for a new election which will delay the work for several months. It is probable that the matter can be settled by the court within sixty days and at a cost not to exceed $50, while a new election would cost the city $6,000. In the meantime no money will be spent at the Lower Otay dam site.

Shipbuilding in the United States has developed during the past year on an enormous scale. Reports by shipbuilders to the Bureau of Navigation show that on Nov. 1, 1916, there were in American shipyards under contract or construction

417 merchant vessels aggregating 1,480,000 gross tons. Of this total, 163,000 gross tons were in shipyards on the Great Lakes, about 56,000 tons on interior rivers, 431,000 tons on the Pacific Coast and the remainder on the Atlantic Coast. The yard having the largest amount of work is the Union Iron Works, of San Francisco, which has 28 vessels aggregating 175,000 tons under way. The New York Shipbuilding Co., of Camden, N. J., has 26 vessels of 134,000 tons in its yards and under contract. These statistics do not include of course the very large tonnage of vessels for the navy, which are under construction in private yards as well as in the Government yards. Not only is the shipbuilding now going on far more extensive than anything ever before recorded in the United States, but the United States now leads all nations in its rate of construction of merchant vessels. The shipyards of Great Britain, which under normal conditions is the great shipbuilding country of the world, are now employed largely on Government work, and their construction of merchant vessels is further limited by the diversion of labor to the military forces and the munition plants.

The Daylight Saving Movement was reported on at the meeting of the American Railway Association in New York on Nov. 15. The Association's Committee on Standard Time, of which E. B. Thomas, President Lehigh Valley R.R., is Chairman, emphasized in its report that any such readjustment would have to be nation wide in order to avoid a great amount of confusion. The committee advised that the railways should take the following stand with reference to the question:

"1. That the present subdivisions, or zone system, of dividing time is scientifically correct.

"2. That any change in such subdivisions of time would result in endless confusion, and would be disastrous to the railroads.

"3. That in the event of a nation-wide movement to change the hands of the clock in order to readjust the hours of daylight to the hours of labor, the railroads should not antagonize the movement. It is the feeling of the Committee that the railroads will not suffer any very serious inconvenience nor disarrangement of schedules by the change as proposed, although such a change from a scientific standpoint is not warranted nor is the Committee in sympathy with the movement.

"The Committee feels that the railroads should not agree to the 'daylight-saving' project until it has been previously adopted by the principal business and municipal centers, together with the state and local authorities. Unless a change of the character proposed can be made on the same date throughout the country it will lead to great confusion and difficulty."

City Bridge Inspection and Repair—Apprehension over the safety of the bridges in Cleveland over the Cuyahoga River, which started when a runaway street car wrecked a bridge on West 3rd St., on Oct. 3 ("Engineering News," Oct. 12, 1916) has led the city authorities to order a general inspection of all the city bridges. This order is being carried out by F. D. Richards, Engineer of Bridges, Harbor and Grade Crossings under Robert Hoffman, Chief Engineer, and some remarkable results have followed. As soon as it was necessary to put up staging for the inspector's use, the iron-workers claimed that this must be done by union men, and it therefore became necessary to employ such a man in addition to the inspector. It was therefore decided to make repairs simultaneous with the inspection, replacing loose rivets or small broken parts. The inspection has been slow on this account, and up to now has covered only one bridge, the old Superior Street viaduct. This structure is badly overloaded. Its swing-span was thoroughly repaired and readjusted about four years ago, and has not deteriorated noticeably since then. Nevertheless the stresses under full loading by heavy street cars run up very high in some members, reaching 30,000 to 35,000 lb. per sq.in. in some of the eyebars under certain conditions. In view of this fact, which was known previously, the city authorities decided to so restrict traffic as to prevent close spacing of street cars on the iron spans. The restriction consists in stopping cars at the abutments when the draw is open or to be opened; this means keeping them three or four hundred feet back of the draw at the east end, where there are several fixed spans. The only risk due to close spacing of cars is believed to occur when the cars stop because of an open draw.

The Channel-Tunnel Project is again under discussion in Great Britain, and the "Engineering Review" (London) describes the project. The scheme dates back to 1874, when a French syndicate obtained a concession and sunk a shaft at Sangatte, near Calais, to the depth of the proposed tunnel and made experimental borings for a mile and a half under the sea. In 1881 the Southeastern & Chatham Railway Co. sunk a shaft at Dover and drove a 7-ft. diameter tunnel at a depth of 160 ft. for 2,015 yd. The Submarine Continental Railway Co. was later incorporated in England to further the enterprise and had driven over 2,000 yd. of tunnel when work was stopped on account of public agitation over the question whether the tunnel would not prove a source of military weakness. No work has been done since July, 1882, but the Channel Tunnel Co., Ltd., is still in existence, with Sir Douglas Fox & Partners as its engineers. The total length of the proposed tunnel would be about 27 mi. The greatest depth reached would be between 250 and 300 ft. below sea level. The plan of construction contemplates two parallel tunnels, each 18 ft. 5 in. in internal diameter, which is said to be large enough for the standard rolling stock of present French and British railways. The stratum through which the tunnel would be driven is said to consist of gray chalk. The tunnels would be driven with shields and lined with cast-iron plates. A separate drainage tunnel 9 ft. in diameter would be driven first. The two parallel tunnels would be connected by cross-galleries at intervals, but these would have air-tight doors. In addition to the longitudinal movement of air in the tunnel, induced by the trains running in the same direction, the air would be forced in at each end in the same direction as the traffic, so that perfect ventilation would be secured. The total cost of the British half of the tunnel is estimated at $40,000,000. The "Review" quotes Arthur Fell, Chairman of the Committee of members of the House of Commons in favor of the construction of the channel tunnel, as stating that the plans for construction are so far advanced that work could be commenced immediately, whenever the necessary legislation is secured.

PERSONALS

Allen Kisinger, formerly with the Water-Works Department of Cincinnati, Ohio, has been appointed City Engineer of Norwood, Ohio, succeeding John G. Schmidt.

W. J. Golden, former Manager of the Jobbing Department of the Lackawanna Bridge Co., Buffalo, N. Y., is now General Manager of the Ferguson Steel and Iron Co., Buffalo.

Oliver C. Sheley has been elected County Engineer of Jackson County, Missouri. According to a local newspaper his campaign expenses were $714 (about half a year's salary).

L. O. Marden, former Chief Draftsman of the city engineering department of Oklahoma City, has been made Chief Draftsman of the State Highway Department of Oklahoma.

M. C. Selden, recently Division Engineer of the Chesapeake & Ohio Ry. at Richmond, Va., has been promoted to be Trainmaster of the Rivanna district, with headquarters at Charlottesville, Va.

Arthur V. Farr, for the past three years Advertising Manager of the S. K. F. Ball Bearing Co., Hartford, Conn., has been appointed Sales Manager of the Hess Steel Corporation of Baltimore, Md.

Jerry W. Gwin, former County Engineer of Jefferson County, Alabama, has been elected President of the new County Board of Revenue, which has supervision over all the public works of the county.

George F. Leslie, formerly with the office of the United States Forest Supervisor at Northfork, has been transferred to the Office of the Engineer of Highways, Forest Service, District No. 3, at Albuquerque, N. M.

Manley Osgood, Assoc. M. Am. Soc. C. E., City Engineer of Ann Arbor, Mich., is President of the Washtenaw Engineering Co., which announces the opening of its offices at 408 First National Bank Bldg., Ann Arbor.

Landon M. Brooks has resigned from the employ of Norton, Bird & Whitman, Chicago and Baltimore, to become Engineer of Construction of the Electro-mechanical Co., of Baltimore, Md. He is a graduate of Cornell University.

A. C. Everham, M. Am. Soc. C. E., has resigned as Engineer of Construction of the Kansas City Bridge Co. to become Terminal Engineer at Kansas City of the Union Pacific R.R. Before going to the Kansas City Bridge Co. he was Assistant to the Chief Engineer of the Kansas City Terminal Ry.

Edward M. Bigelow, M. Am. Soc. C. E., former State Highway Commissioner of Pennsylvania, has been appointed Director of the Department of Public Works of Pittsburgh, Penn., succeeding the late Robert Swan. Mr. Bigelow has been Director of the Department of Public Works of Pittsburgh twice before, from 1888 to 1900 and from 1903 to 1906. He is credited with the construction of Grant Boulevard and has been called the father of Pittsburgh's notable parks. His salary will be $8,000 per annum.

Max L. Cunningham, Assoc. M. Am. Soc. C. E., formerly Consulting Engineer, Oklahoma City, Okla., has been appointed State Engineer of Oklahoma.

R. G. Wyman has been appointed Division Engineer of the Atchison, Topeka & Santa Fe Ry. at Amarillo, Tex., to succeed J. W. Walter.

The Chesapeake & Ohio Ry. announces the following appointments in the engineering department: **W. C. Pearce** has been appointed Division Engineer at Richmond, Va.; **F. D. Beale** has been appointed Acting Division Engineer at Clifton Forge, Va.; **J. W. Gleason** has been appointed Acting Division Engineer at Ashland, Ky., and **R. A. Bertram** has been appointed Acting Division Engineer at Peru, Ind.

The United States Office of Public Roads and Rural Engineering announces the following appointments of ten District Engineers, pursuant to the scheme of organization described in "Engineering News," Nov. 16, p. 961: **L. I. Hewes**, District Engineer, of District 1, including Washington, Oregon and Idaho, with headquarters probably at Portland, Ore.; **C. H. Sweetser**, M. Am. Soc. C. E., District Engineer of District 2, including California, Nevada, Arizona and New Mexico, with headquarters at Berkeley, Calif.; **J. A. Whittaker**, District Engineer of District 3, including Montana, Wyoming, Utah and Colorado, with headquarters at Denver, Colo.; **E. O. Hathaway**, District Engineer of District 4, including North Dakota, South Dakota, Minnesota and Wisconsin, with headquarters at St. Paul or Minneapolis, Minn.; **J. C. Wonders**, District Engineer of District 5, including Nebraska, Iowa, Kansas and Missouri, with headquarters at Kansas City, Mo., or Omaha, Neb.; **J. D. Fauntleroy**, M. Am. Soc. C. E., District Engineer of District 6, including Arkansas, Louisiana, Oklahoma and Texas, with headquarters at Dallas or Fort Worth, Tex.; **J. T. Voshell**, M. Am. Soc. C. E., District Engineer of District No. 7, including Michigan, Illinois, Indiana and Kentucky, with headquarters at South Chicago, Ill.; **J. T. Bullen**, M. Am. Soc. C. E., District Engineer of District 8, including Florida, Georgia, Alabama, Mississippi, South Carolina and Tennessee, with headquarters at Montgomery or Birmingham, Ala.; **Guy H. Miller**, District Engineer of District 9, including Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont, with headquarters probably at Troy, N. Y.; **H. K. Bishop**, M. Am. Soc. C. E., District Engineer of District 10, including Pennsylvania, Ohio, West Virginia, Virginia, Maryland and North Carolina, with headquarters at Washington, D. C.

OBITUARY

Lawton T. Hemans, Chairman of the Michigan State Railroad Commission died Nov. 17, aged 52 years.

L. Marvin Willeroy, formerly of Richmond, Va., died at El Paso, Tex., Nov. 12. He practiced civil engineering in Mexico for many years, and at the time of his death was compiling data from his maps and records for the United States Army.

Col. William E. Craighill, formerly an officer of the Corps of Engineers, U. S. A., died Nov. 26, at his home in Washington, D. C. During the Boxer Rebellion in China he was transferred, at his own request, from the Corps of Engineers to the Infantry.

Leonard C. Rittenhouse, junior member of the firm of James H. Rittenhouse & Son, Civil and Mining Engineers, Scranton, Penn., died Nov. 10. He and his father were the engineers in charge of the interesting foundation work in the abandoned coal-mine workings under the Scranton Armory, described in "Engineering News," Oct. 12, 1916. He was a lineal descendant of Benjamin Rittenhouse, brother of David Rittenhouse, of Philadelphia, one of the foremost scientific men of the Revolutionary period. He was 32 years old and a graduate of Pennsylvania State College.

George H. Bailey, an engineering employee of the District of Columbia, died Nov. 25 He was 89 years old, having been born at Boston, Mass., in 1827 His earliest engineering experience was in the construction of Boston's first municipal water-supply, 1847 to 1852. From Boston he went to Jersey City, N. J., where he was engaged in the construction of the first water-works of that city He is also said to have designed and supervised the construction of the first water-works of Newark, N. J. He went to Washington in 1878 as Computing Engineer of the District Engineering Department; subsequently he was Engineer of Bridges and Assistant Engineer in the Highway Department Up to a few days before his death he was regularly at his office desk.

ENGINEERING SOCIETIES

PAVING BRICK INSTITUTE.
Dec. 5-6. Meeting in Cleveland at Statler. Asst. Secy., H. M. Macdonald, 830 Brotherhood of Loc. Engrs. Bldg., Cleveland, Ohio.

RAILWAY GARDENING ASSOCIATION.
Dec. 5-7. Annual meeting in New Orleans. Secy., Charles E. Lowe, Sewickley, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting in New York City. Secy., Calvin W. Rice, 29 W. 39th St., New York.

NORTHWESTERN ROAD CONGRESS.
Dec. 7-8. In Chicago. Secy., J. L. Long, Moline, Ill.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

The Third Northwestern Road Congress is announced to be held in Chicago, Dec. 7 and 8.

The Compressed Gas Manufacturers' Association will hold its fourth annual meeting at the association offices, 120 Broadway, New York City, on Monday, Jan. 15, at 2 p.m., the meeting being followed by a dinner at the Manhattan Club. The secretary is Otto S. King.

The Brooklyn Engineers' Club will hold its 20th anniversary dinner on Thursday, Dec. 7, at the Hotel Bossert, Brooklyn, N. Y. The club is departing from its usual practice for such an occasion by injecting some entertainment into the program. The secretary is Joseph Strachan.

The American Road Builders' Association announces the Eighth National Good Roads Show, to be held in Boston, Feb. 5 to 9, in the Mechanics' Building. This show is in conjunction with the 14th annual convention of the association, the program for which is now being prepared.

The Southwestern Water-Works Association will hold its 1917 convention at Topeka, Kan., June 11 to 14. This association draws its members from Missouri, Oklahoma, Arkansas, Texas, New Mexico and Louisiana, but all water-works men are cordially invited to attend the meeting, concerning which information may be obtained from E. L. Fulkerson, Waco, Tex.

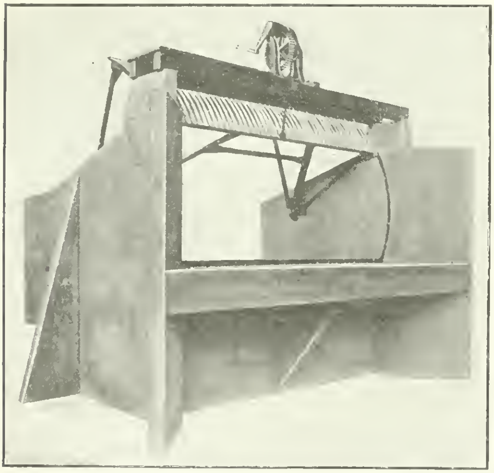
The Alabama Technical Association, newly formed, held a banquet in Birmingham on Nov. 17, following which several prominent men of the state discussed methods for the development of the natural resources of Alabama. An important event at this meeting was the election of 12 directors, two from each of the six national societies represented, as follows: J. S. Sewell, O. G. Thurlow, M J. Lide, Erskine Ramsey J. R. Harris, Hugh Martin, W. S. Keller, J. H. Klinck, H. M Gasman, H. S. Geisman, H. B. Battle, H. B. Wheelock. The secretary is Paul Wright, Birmingham, Ala. Martin J. Lide was elected temporary chairman of the board.

The American Bridge Engineering Club of New York City held a meeting on Nov. 15 at the St. Denis Hotel, at which an address was made on the structural shop and its relations to other departments by R. T. Lewis, Manager of the Elmira plant of the American Bridge Co The club was organized about four years ago by the employees of the American Bridge Co., the object being primarily to increase the efficiency of the company's engineers, accountants and clerks employed in the New York office. It was modeled after the Elmira Plant Engineering Club, organized in 1902. There are about 80 members and the average attendance at meetings is 55. The club holds eight meetings a year, at which a technical committee arranges to have a paper presented by some leading engineer of the club, or by an outside engineer having charge of work constructed by the bridge company. After the lectures there is discussion and then an entertainment is provided either by members of the club or by outside talent. The lecture is preceded by a dinner at a local hotel. An idea of the engineering program can be gained from the following subjects yet to be presented: Jan. 12, 1917, "Barges, Towers and Turntables"; Feb. 8, ladies' night; Mar. 14, "East New York Tunnel of the Long Island R.R."; Apr. 10, "Construction of Donora Plant"; May 11, "Omaha Bridge Over the Missouri River."

Appliances and Materials

New Radial Hydraulic Gate

Under the trade name "Calco" a new radial gate is being manufactured by the California Corrugated Culvert Co., in West Berkeley. This gate is unique in the fact that corrugated sheet metal is used to form the concave surface of the gate. The objection to radial gates is the leakage that occurs along the bottom and sides, which is generally overcome by fastening a strip of rubber belting along the sides and bottom. This gate is made tight along the bottom by means of a metal seat set into the concrete in which the lower edge of the gate is set when closed. At the sides of the gate the corrugations are flattened out so that sheet metal extends beyond the frame. This rides on an angle iron curved to the radius of the gate set into the concrete walls of the structure. The pressure of the water causes the sheet-metal extension to hug the angle iron closely and gives a tight joint. This company at present is endeavoring to equip these gates with an automatic control for maintaining fixed heads in canals. As yet, this device has not been perfected.



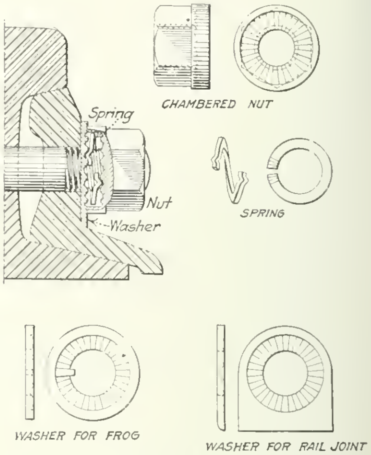
RADIAL GATE WITH CORRUGATED SKIN

* * *

Tight-Grip Nut-Lock

A new spring nut-lock capable of exerting a strong pressure without damage to the thread of bolt or nut is being used in railway track fastenings, bridge work, machine bolts, etc., with very satisfactory results. This device is termed the O. K. nut-lock. It is manufactured by the O. K. Nut Lock Co., Turks Head Building, Providence, R. I. The accompanying drawing shows its application to rail joints and frog and switch work on the Delaware, Lackawanna & Western R.R. This road is using it also on bolts for fastening the rails to the ties, as noted in "Engineering News," of Oct. 19.

Against the splice bar or rail is placed a washer having a corrugated face. For the rail joint this has a horizontal edge which rests on the flange of the splice bar so that it cannot turn. For the frog work; rotation of the washer is prevented by a projection which engages a groove in the side of the bolt. The nut is of special shape, having a recessed chamber with a face corrugated like that of the washer. Between these two parts is fitted a spiral spring of high capacity, having its ends bent so as to engage with the corrugations. The washer is made in a variety of shapes to meet different requirements.

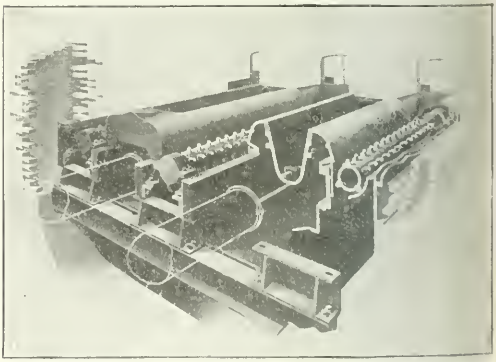


NUT-LOCK FOR RAILWAY TRACK WORK

* * *

New Underfeed Stoker

A new design of underfeed stoker, with open-top horizontal retorts into which coal is fed by horizontal rams, has been developed by the Moloch Stoker Co., of Chicago. There are no grates used with this stoker. The coal is forced by plunger from hoppers into longitudinal V-shaped retorts. The coal, as it burns, passes over the top of the retorts and moves across the furnace bed into the inter-retort zones. Here the refuse is crushed by toothed rolls and is fed past aprons, dropping finally into the ashpit. Under each retort is an air box with preheating tuyere tubes going through the top of the retort walls to the fuel bed. Stoking units are independently supported at the front and at the bridge-wall. The coal plunger is operated by a piston in a double-acting steam cylinder. Automatic regulation of fuel and air supply is secured by varying the speed of the forced-draft fan in accordance with the steam demand; this fan operates a timing device to close electric contacts in the coal-plunger valve-control solenoid circuit, or to work pilot valves to the same end.



TWO-RETORT MOLOCH STOKER FURNACE

For small boiler installations where there is no ash-removal equipment, a type of stoker has been made without the ash crusher and discharge apron. There are instead grate bars spanning the interval between retorts.

Engineering News

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Activated-Sludge Results at Cleveland Reviewed--I

By R. Winthrop Pratt* and George B. Gascoigne†

SYNOPSIS—A comprehensive review of nearly a year's operation of one of the two largest activated-sludge plants in the United States.

Clarification

Cleveland's activated-sludge installation (*Engineering News*, Apr. 6, 1916) has now (Dec. 1) been in operation over nine months. Within 10 days after passing sewage through the plant, activated sludge was produced, but it took about two months to get all the recording apparatus tested out and the plant in shape for continuous operation. Of the remaining period about two months have been used for making alterations in the tanks, which are shown in Fig. 2. (A general view of the tanks is given in Fig. 1.) A number of tests have, however, been completed; and while the results obtained cannot be considered conclusive, they furnish some interesting data pertaining to this new process of sewage treatment.

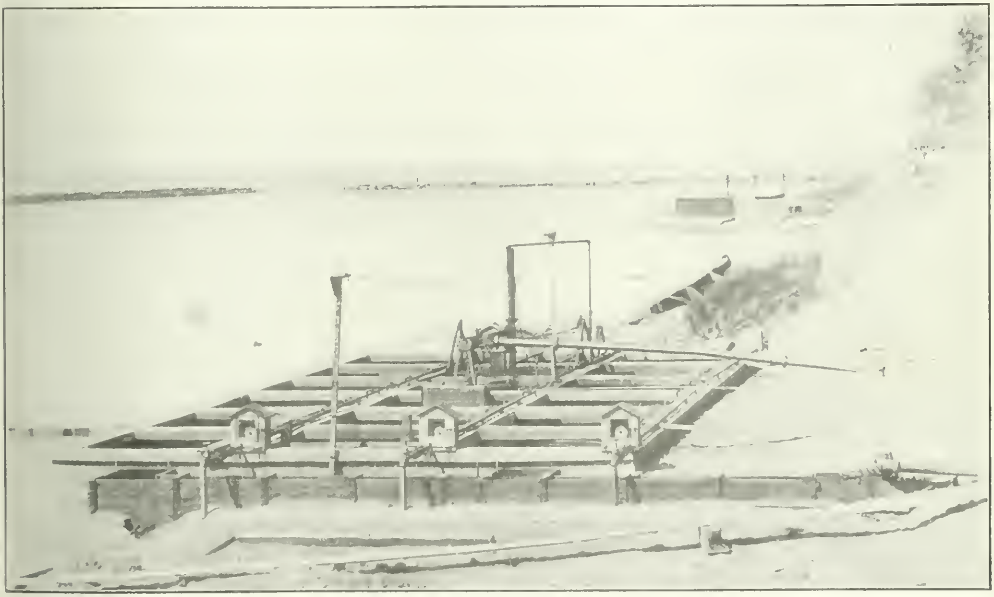

FIG. 1. GENERAL VIEW OF ACTIVATED-SLUDGE PLANT, CLEVELAND, OHIO

For preliminary and comparative studies it was desired to substantiate as quickly as possible and under conditions comparable to those obtained in an actual plant, the data secured with the small experimental units (*Engineering News*, July 22, 1915). A schedule of operation embodying a number of short test runs was determined upon as the most feasible method for studying certain fundamental features of the process. When the results from a run show a consistent trend, the run is discontinued and a new one started. The conditions selected for the runs were such that difficulties that might develop during short-time runs or might give misleading results were reduced to a minimum.

Degree of Purification Required

About 75% of Cleveland's sewage will be treated at two lake-front plants, making possible the use of the lake dilution opposite each. The conditions at these two plants, therefore, will require only a low degree of purifiation. At a third plant, for treating the remaining 25% of the city's sewage, there will be required a high degree of purification, as the effluent is discharged into the Cuyahoga River.

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*Consulting Sanitary Engineer, City of Cleveland, Ohio.

†Sanitary Engineer, Subdivision Sewage Disposal, City of Cleveland.

The first experiments at Cleveland with the activated-sludge process indicated that two important requirements of an ideal method of sewage treatment were being satisfied: The process produced a clear sparkling effluent, and there was an absence of odors. The process, therefore, appeals strongly to the average layman and sanitarian, which fact must be given due weight even though the cost may be high and certain phases of the process still remain undeveloped. To the writers' knowledge, the Cleveland installation was the first to be designed and operated under conditions where the degree of purification involves simply clarification. In other words, this type of plant was considered a competitor of a plant comprising sedimentation, supplemented with disinfection during the bathing season. As regards the results produced by the two types of plants the activated-sludge process not only clarifies the sewage as compared with partial clarification in sedimentation tanks, but eliminates the iron discoloration that occurs near the main sewer outlet and at times spreads over a considerable area. With sufficient data pertaining simply to clarification it will be possible to assume more readily the conditions for Cleveland's third or southerly plant, where the degree of purification must be carried to the point of stability or nitrification.

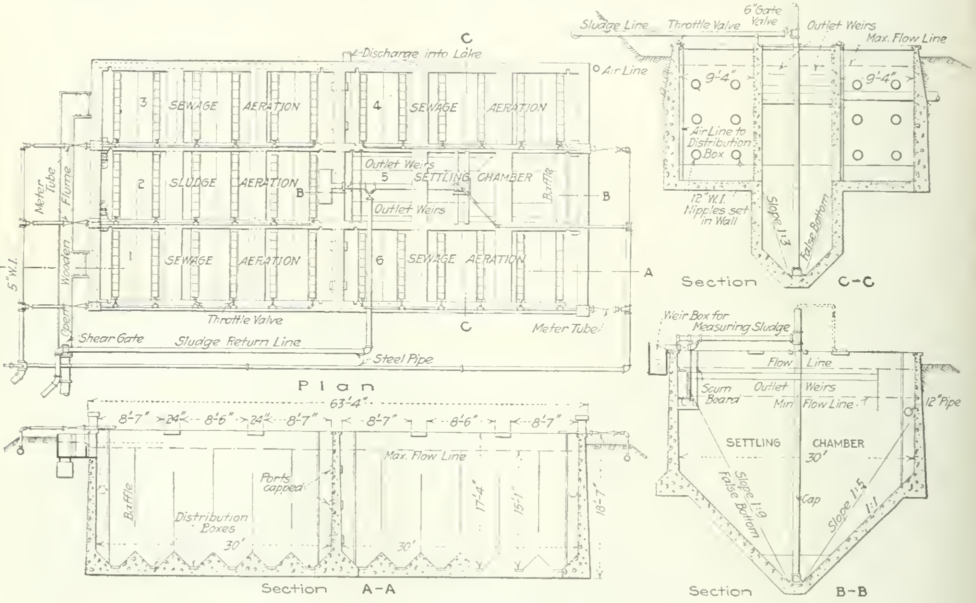

FIG. 2. PLAN AND SECTIONS OF ACTIVATED-SLUDGE TANKS, CLEVELAND, OHIO

The tanks as originally built were shown in "Engineering News," April 6, 1916. Baffles have since been added in tanks 3 and 4, weirs inserted in the settling chamber and the bottom slopes of the settling chamber made steeper

THEORY OF ACTIVATED-SLUDGE PROCESS

The theory of the activated-sludge process involves properly conditioning a bacterial growth and bringing the growth into the most intimate contact with the suspended particles of the crude sewage. The plant, therefore, was divided into six compartments in order that the results obtained at the end of each step could be definitely studied and that, if necessary, the solid matter of the sewage could be aërated longer than the liquid itself.

A more recent development as regards the theory of the process, which is apparently local, owing to the large amount of iron salts in the crude sewage, involves the use of an active caustic, such as lime or its equivalent. Such a method of treatment would then resolve itself into a combination of chemical precipitation and the activated-sludge processes. A complete removal of the iron discoloration requires a longer aëration period by about three-quarters of an hour than is necessary for clarification alone. Apparently, this additional period is used for oxidizing the iron salts, and whether or not the action can be hurried by the addition of the lime is a question. Laboratory experiments in progress indicate that when lime is added to sludge it will settle more rapidly and that its digestion is retarded. Small amounts of lime probably will not reduce the value of the final sludge as a fertilizer ingredient.

The main intercepting sewer, which now discharges off shore near the activated-sludge plant, collects the sewage from the easterly district of the city by means of a combined system of sewers. The sewage for the plant is diverted from a shallow grit chamber about 2 ft. below the flow line and flows by gravity to the tanks. Practically all the grit has been removed from the sewage, but the sewage is distinctly stale, due principally to the average travel of 5 mi. The flow in the main sewer varies from 10,000,000 to 250,000,000 gal. per 24 hr., the normal dry-weather flow being 60,000,000 gal. The suspended solids average 250 parts per 1,000,000; organic nitrogen, 8.5 parts; free ammonia, 12.1 parts, while the iron content at times reaches 350 parts, averaging 21 parts. The excessive amounts of iron are due to pickling wastes, discharged when the domestic flow of sewage is low.

At first the sewage flows to the aërating tanks, where it is agitated with activated sludge supplied by the process. Compressed air forced through filtros plates in the bottom of the tanks produces the necessary agitation and commingling. After an agitation period sufficient to attach the suspended solids and the fine colloidal particles to the gelatinous surfaces of the activated sludge, the sewage passes to the settling compartment. There the sludge settles to the bottom of the chamber, due to a short retention period, the clear supernatant liquid passing off to the lake.

The settled and concentrated sludge in the bottom of the settling chamber is then lifted by compressed air into the sludge aëration or activation tank. Here the freshly made sludge is restored to its proper condition by aërating for a further period, after which it is ready to be mixed again with the crude sewage in the aërating tanks. In some of the tests the sludge was diverted back to the aërating tanks, bypassing the activation tank. Every day or so a certain amount of sludge is diverted from the settling compartment for experimental purposes or is wasted. Measurements are made regularly of the sludge depth in the settling compartment, and an increase or decrease of the same determines whether or not the amount withdrawn equals the amount of sludge produced. The line separating the liquid from the sludge can be definitely located.

Extraordinary precautions have been taken in operating the installation; and while at first they did not seem necessary, time has shown many of them to be well worth the trouble. Reference is made particularly to varying the quantity of sewage treated in accord with the flow in the interceptor; to the separation of the operation and analytical results according to the day- and night-sewage flows; and to the use of indicating meters on the air lines at the entrance of each compartment. The sampling schedule provides that the day- and night-sewage flow be separated into composite samples of 16 and 8 hourly portions respectively, and the analytical determinations are made from the composites. The above separation permits the use of smaller amounts of air during the low flows of dilute night sewage as compared to the greater quantity used with the larger flows of concentrated day sewage. Such a variation suggests controlling automatically the air used during the process and the possibility of loading during the daytime a municipal light plant, a condition that normally does not exist.

AIR-DISTRIBUTION SYSTEM

Air is furnished by a hydro-turbine blower manufactured by the Nash Engineering Co., South Norwalk, Conn., and located in a frame building about 150 ft. from the tanks. The blower is motor-driven "belt drive" and delivers air to a separator and then to a pulsation- and moisture-reducing steel tank 3 ft. in diameter and 6 ft. long. This particular type of compressor makes little noise and eliminates treating the air to remove dust and oil, which might clog the filtros plates in the aërating tanks. The compressor did not deliver a moisture-free air last winter, but when freezing conditions again prevail, an additional separator will be used at the tanks. The air as it leaves the compressor is measured by a General Electric air-flow meter and before its delivery to the tanks is again registered by indicating meters located at the entrance to each compartment. Thermometers and pressure gages are installed in the compressor house and at the tanks, and readings are taken hourly. The compressor operates at a pressure of 9 lb. per sq.in. with 14.5 ft. of sewage above the filtros plates and compresses about 450 cu.ft. of free air per minute. The efficiency of the installation, all told, is about 33%.

The medium used for diffusing the air consists of filtros plates (R-5) set in structural-steel boxes placed in the valleys of the ridged bottom. The plates were furnished by the General Filtration Co., Rochester, N. Y., and were delivered to the work before this company had its own manufacturing plant. The plates are 12 in. square and 1½ in. thick. Eight are set together with sulphur joints in a steel box. The boxes are placed across the tanks and at right angles to the direction of the flow. The ratio of plate surface to the superficial area of the tank is 1 to 5.

OPERATION AND ANALYTICAL RESULTS FOR TWELVE RUNS, CLEVELAND ACTIVATED-SLUDGE PLANT

OPERATION RESULTS—NIGHT AND DAY SEWAGE

No. of Run	Temperature, Degrees C. Atmos.	Comp. Air	Inf	Eff.	Period of Operation	Quantity Treated, M. Gal. per 24 Hr.	Aëration Period, Hr. Liquid	Solids	Settling Period, Min.	Sludge Moisture Content, %	Returned % of Sewage Treated	Free Air Used in Cubic Feet per Sq.Ft. per Min. Sewage	Sludge	Gal Sewage Treated
1	6.3	13.0	13.7	14.0	4/1 to 4/22	472	2.2	3.3	42	97.90	34.0	0.26	0.28	1.30
2	12.0	12.7	17.0	17.0	5/8 to 5/19	408	2.7	4.3	47	97.85	25.4	0.25	0.27	1.29
3	17.0	17.3	18.0	18.0	5/24 to 5/31	429	1.3	2.9	45	97.89	25.0	0.43	0.27	1.09
4	16.7	15.3	19.0	19.0	6/1 to 6/8	458	1.2	2.7	42	97.37	24.8	0.35	0.27	0.92
5	16.7	15.3	19.0	19.0	6/10 to 6/20	481	1.1	1.1	40	97.84	24.9	0.35	..	0.58
6	18.3	17.7	20.0	20.0	6/21 to 6/27	460	1.2	1.2	41	98.00	25.8	0.25	..	0.47
7	22.0	29.6	25.7	25.7	8/10 to 8/15	419	2.0	2.0	45	98.13	25.2	0.40		0.76
8	26.0	30.4	26.7	27.0	8/18 to 8/21	339	2.5	2.5	66	99.10	25.9	0.25		0.61
9	20.6	27.6	27.0	27.0	8/24 to 8/25	435	1.9	3.5	43	98.35	25.4	0.25	0.25	0.47
10	20.2	27.0	26.0	26.0	8/25 to 9/3	398	2.1	3.8	48	98.08	26.2	0.31	0.40	0.62
11	24.4	28.7	25.7	25.7	9/4 to 9/8	383	2.3	4.0	55	99.21	26.6	0.30	0.40	0.68
12	14.3	21.3	24.0	23.6	9/18 to 9/24	282	3.0	3.0	67	98.32	25.0	0.26	..	0.74

Retention periods in activation tank based on 25% displacement, runs 1 to 12 inclusive
Retention periods in aerating tank based on 40% displacement, runs 1 to 6 inclusive
Retention periods in aerating tank based on 75% displacement, runs 7 to 12 inclusive

ANALYTICAL DATA, NIGHT AND DAY SEWAGE

No. of Run	Oxygen Consumed Dissolved Inf	Dissolved Eff	Total Inf	Total Eff	Nitrogen Organic Inf	Organic Eff	Free Ammonia Inf	Free Ammonia Eff	Iron (Total) Inf.	Iron (Total) Eff.	Suspended Matter Inf.	Suspended Matter Eff	Turbidity
1	32.1	14.1	63.5	17.5	9.1	4.4	11.7	11.1			250	38	
2	30.5	12.7	62.1	27.8	8.0	1.4	12.4	9.3			262	15	
3	30.0	12.3	64.5	14.1			11.7	8.8			284		
4	27.4		61.4	13.5			13.3	10.2			229		23
5	29.6	14.6	62.3	13.9			13.6	11.0			274		26
6	33.4	16.6	64.6	13.4			14.5	12.3			252	23	
7	27.1	13.1	55.7	15.8			8.6	6.9	11.7	2.4	210	16	23
8	25.6	12.4	51.7	9.4			8.7	5.9	20.8	2.4	219	27	40
9	21.1	11.5	50.0	11.4			11.0	7.5	20.5	2.0	185	19	31
10	22.8	12.7	57.2	13.7	13.3	6.8	9.2	7.2	14.2	2.0	255	38	38
11	25.8	14.4	62.4	19.2	15.4	9.5	10.7	9.8	15.0	6.2	309	65	98
12	26.5	14.6	60.0	14.8	12.5	5.6	9.6	6.0	21.5	1.1	234	33	35

REMARKS ON EACH RUN—1, 2, 3 and 4. Good effluent. 5 and 6. Colored effluent. 7. Good effluent. Sludge not satisfactory. 8. Good effluent. Sludge darker than normal with slight odor. 9. Ebullition starts in settling tank. Poor sludge. 10. Ebullition in settling tank. Poor sludge. 11. Ebullition in settling tank very active. Sludge had bad odor. 12. Guides for controlling ebullition in place. Sludge satisfactory. Motor trouble 9/25.

No means was provided for cleaning the plates while in place, but it was intended to remove a box of plates without putting the compartment out of operation. This has proved to be impracticable, because in a 14-ft. depth of sewage it is almost impossible to locate with a lifting hook the small hole in the lug attached to the end of the steel boxes. As a consequence, the tanks are shut down when it is desired to change or inspect the plates. The position of the plates can be noted during operation by the greater amount of ebullition at the surface, but the writers consider that the distribution has been fairly satisfactory.

The filtros plates have been in continuous use for eight months. The surface of the plates clogs with either fine particles of sludge or a bacterial growth, and about a $^1/_4$ lb. more pressure is required to force the air through the plates after this period of operation. When the plates are wet through, they crumble easily, while some flake off; but upon drying they again harden. The surface of the plate next to the compressed air remains clean and porous.

At the present time (Dec. 1) 1-in. perforated pipes are placed in the bottom of aërating tank No. 1. The holes are $^3/_{64}$ in. in diameter, 4 in. apart, staggered and located on the under side of the pipe at the 45-degree point. It is intended to lift the pipes out of the tanks for cleaning, as no steam or water connections are provided. It will not be necessary, when removing the perforated pipes, to shut off the flow to a tank.

DISCUSSION OF RESULTS—GENERAL

The schedule of operation as regards clarification provides, first, for a number of runs when the aëration period for both the liquid and the solids is equal, and, second, when the activation tank is used or when the aëration periods differ. A survey of the runs already completed indicates that the first four were used in establishing the maximum capacity of the settling tank. Runs 5 and 6 were then started and conform to the regular schedule. Due to an accumulation of bad sludge on the bottom of the settling tank it was necessary to stop run 6 and remove the sludge. At this time the effectiveness of the aëration tanks was increased by installing vertical baffles and the false bottom placed in the settling tank. By Aug. 10, after a reconstruction period of six weeks, the plant was again ready to operate. Since Aug. 25 the plant has been out of operation three weeks, due to motor trouble. The plant was designed to treat $1\frac{1}{2}$% of the normal dry-weather flow in the intercepting sewer, which is equivalent to 900,000 gal. per 24 hr. An allowance was made for a fluctuation in the flow of 25% and a return of activated sludge equaling 25% of the sewage treated. With such a high flow it was impossible to secure an effluent free from fine sludge particles. Consequently, the capacity of the installation has always been controlled by the quantity of sewage that the settling compartment can satisfactorily treat. A flow varying from 280,000 to 480,000 gal. per 24 hr., with a 25% fluctuation, has been treated at times by one-half and at other times by two-thirds of the entire installation. The results indicate that about 2,500 sq.ft. of superficial tank area with a sewage-aëration depth of 15 ft. is sufficient to treat 1,000,000 gal. of sewage. This figure applies for conditions occurring during run 12 and contemplates the production of a clarified effluent.

The Cleveland sewage-testing station is located on the lake front and is consequently exposed to the most severe weather conditions. Sewage was for the first time passed through the plant on Feb. 10, 1916, when the temperature was 22° F. and the bottom of the tanks was covered with ice. Within 10 days activated sludge was produced—during a time when the temperature of the atmosphere varied from 14 to 13° F. and that of the treated sewage from 54 to 59°. The sludge was typical in appearance and settled as rapidly as any produced since then. There appears no reason why an activated-sludge plant cannot be placed in operation during the coldest months of the year. As regards the effect of temperature on efficient operation the results of the coming winter are looked forward to. During that time a final schedule of operation comparable to that obtaining under actual plant conditions will be in force.

The installation as designed and constructed provides for four sewage-aërating tanks, each rectangular in shape and with the flow horizontal. The displacement volume was assumed at 100%, due to the agitation, but salt tests have shown that the effective displacement was only 40%. In order to prevent short-circuiting through the tanks and to increase the effective displacement, vertical baffles were installed during July in compartments 3 and 4. The tanks then became vertical-flow instead of horizontal-flow tanks, and according to the salt tests 75% of their volume was made effective. It might be possible to again increase slightly the volume displacement of the tanks by decreasing the depth of the opening beneath the baffles. The baffles at present are 3 ft. above the ridges. They have been installed (Dec. 1) in the activation tank with the flow areas above and below them restricted to 18 in.

The original experiments indicated that an aëration period of half an hour was sufficient to produce clarification, but such a short period is not enough to condition the sludge properly, and has not as yet been attempted with the present installation. This is due to the facts that the activation or sludge-aërating tank was not considered efficient without vertical baffles and that it was desired to determine first what results could be obtained without using this tank. Run 12, with an aëration period for both liquid and solids of 3 hr., had only been in progress a little over a week when motor trouble put the plant out of operation. The results secured during this run are, however, considered representative when operating a plant without the use of the activation tank. The schedule of operation provides for a longer run during winter conditions and after data as conclusive are secured with the activation tank in use.

SEDIMENTATION RESULTS

The settling tank is rectangular, of the horizontal-flow type and made so as to fit in with the other tanks of the unit. Its bottom was hoppered with the end bottoms at a slope of 1 to 1. In order to provide these slopes and in addition get sufficient capacity the tank is 30 ft. deep at its lowest point. Under such conditions it has been possible to secure a sludge continuously with a 98% moisture content, but impossible with such slopes to collect all the sludge at the discharge pipe. An accumulation was found to collect on the bottoms and sooner or later, depending upon the time of the year, to interfere with the operation of the tank. Before the installation of the false bottoms during July it was frequently necessary to pump down the tank and remove the bad sludge. The new slopes prevent any deposit on their sides, but ebullition from the sludge behind the false bottoms produced the abnormal results shown in run 11. This ebullition has been con ved to gas vents by guides along the walls of the tank and the trouble eliminated. Since the installation of the steeper slopes the moisture content of the sludge has been increased about $\frac{3}{4}$%, a result which is in accord with its reduced retention period. The settling compartment has never been operated with a blanket of sludge to act as a sieve for removing fine suspended particles from the effluent. The best results as regards a clear and sparkling effluent have been obtained when the sludge line was from 16 to 19 ft. below the flow line in the tank.

As mentioned before, the capacity of the settling tank has controlled the quantity of sewage treated by the installation. The three most important factors regarding the design and operation of the settling tank are the retention period, flowing-through velocity and the necessity of having the sludge in a settleable condition. With flows varying from 300,000 to 675,000 gal. per 24 hr., the effective depth of the tank both with the new and the old slopes remains about constant, or 8 ft. With a flow of 675,000 gal. per 24 hr., which is the maximum rate at which there is an absence of fine sludge particles in the effluent, the actual velocity is 1 ft. per min. and the retention period 35 min. Whether or not a shorter period of retention will suffice is an open question pertaining to an efficient settling tank of the horizontal-flow type. Two long effluent channels have been placed in the tanks, as shown. They will permit an examination of the liquor at various periods of settling, the liquor flowing into the channel near the baffle at the inlet having a very short period, while the longest period occurs for the liquor entering the troughs at the opposite end.

Proportion of Sludge Returned

The proportion of sludge returned to the aërating tanks has remained practically the same in all the runs—about 25% of the sewage treated. The proportion can no doubt be reduced; but the solution of this phase of the matter is left to the final schedule of operation, when it will be the only condition varying. The moisture content of the sludge returned was determined from one sample taken during the daytime. The quantity is measured by a weir, no allowance being made for a slight variation in the moisture content. In order to check the operator's work in regulating the flow over the weir a composite sample is taken from the aërating tanks and the solid matter determined by the evaporation method. There is a maximum variation in the solid matter returned to the sewage of about 30%.

Naturally, a great deal of thought has been given to the quantity of air necessary to produce certain results. The original experiments indicate that the use of 0.2 cu.ft. of air per square foot of aërating surface was the minimum permissible, while the improvement due to the use of 0.3 cu.ft. instead of 0.25 did not appear justified. The results obtained with the large installation have, in the main, verified those obtained with the experimental units. Special mention is made of runs 7, 8 and 12, in which the aëration period has varied from 2 to 3 hr., the quantity of sewage treated varying from 282,000 to 419,000 gal. per 24 hr., while the quantity of air used per gallon of sewage treated is practically constant.

In comparing the work accomplished by aërating tanks of different depths it is evident that the unit "cubic feet of air used per gallon of sewage treated" is not a true index of either the power units required or the purification obtained. It is generally recognized that the amount of air required to produce certain results is inversely proportional to the aërating depth. An absolute unit that is proportional to the power units used, irrespective of the aërating depth and to the degree of purification expected, is badly needed. The product of the cubic feet of air used per gallon of sewage and the aërating depth gives such a unit. A. G. Husted has suggested the name "foot-feet" for this unit. To illustrate: An installation using $1\frac{1}{2}$ cu.ft. of air per gallon of sewage with an aërating depth of 10 ft. will use 15 foot-feet per gallon of sewage flow. An installation using $\frac{3}{4}$ cu.ft. of air with an aërating depth of 20 ft. will also use 15 foot-feet.

Cost of Activated-Sludge Process

A cost consideration of the activated-sludge process resolves itself, primarily, into a study of the life of such a plant, the initial expenditure necessary for its construction and the fixed and operation, or maintenance, charges. The following data pertain only to the operation, or maintenance, charges, but recent estimates indicate that the annual fixed charges about equal the operation charges, exclusive of the sludge-disposal and land factors of the problem.

The first published data concerning the activated-sludge process mentioned the possible high cost of operating a plant of this type. Sufficient data have been secured with the present installation for estimating fairly accurately just what this cost will be when the degree of purification involves only clarification, and the liquid and solids are aërated equally. Operation charges may for convenience be divided into the following items: Supervision, labor, power, repairs and supplies and incidentals, with the unit cost of power and labor usually governing. Cleveland conditions as regards the cost of electricity are favorable to this method of treatment, a figure of $\frac{3}{4}$c. per kw.-hr. being considered conservative. With the following assumptions, which are considered the best to expect with present data, a minimum cost of operation for power alone is $3.75 per 1,000,000 gal. of sewage treated:

Normal flow of sewage per 24 hr	25,000,000 gal.
Depth of sewage above air diffusers	15 ft.
Working pressure per square inch	8 lb.
Air-installation efficiency	50%
Average aeration period of liquid and solids	3 hr.
Quantity of air per gallon of sewage	$\frac{3}{4}$ cu.ft.

In operating sewage-treatment works it is of import that the grade of operators and workmen required for different types of plants varies. An activated-sludge operator must be intelligent, able to write, and trustworthy in the extreme. Common laborers are not satisfactory for performing the duties of an operator around an activated-sludge plant. It may also be said that the degree of supervision should vary with different types of plants. It is therefore evident to the writers that the advantage in simplicity of management does not lie with the plant involving the activated-sludge process of sewage treatment. In estimating recently the labor item for a 25,000,000-gal. plant a figure of 75c. per 1,000,000 gal. of sewage treated was used, the same involving 50 man-hours every day of operation.

Summarizing, the minimum cost of operation per 1,000,000 gal. of sewage treated is $4.50 for the labor and power items. The uncertainty attached to the cost of repairs, supplies and incidentals makes it impossible to give an accurate estimate of what they will be. A conservative estimate of their cost, including supervision, is 50c. Consequently, the minimum operation cost to be expected is estimated at $5 per 1,000,000 gal. of sewage treated, exclusive of sludge disposal.

A number of points in connection with the process have developed as the work progressed. The most important of these involve the use of fine screens prior to activation, the possibility of a revenue from the grease skimmed from the settling tank, an efficient depth of aërating tank and the necessity for bacterial determinations when only clarification is involved. Preparations at this time are being made to secure the data pertaining to the latter point.

As regards the use of fine screens (mesh less than ½ in.) prior to activation it is believed that the results produced do not warrant the cost of operation. Two sets of bar screens with 1½-in. openings and in series are sufficient to remove the coarser particles that decrease the manurial value of the sludge and yet pass all particles that may aid in rapidly settling the sludge.

At the inlet to the settling tank a baffle that extends down into the tank about 7½ ft. provides a means for concentrating the scum liberated by the air agitation. Every week the scum has been removed, weighed and the grease determined. About 65% of the scum is grease, the same averaging 20 lb. per 1,000,000 gal. of sewage treated. As time permits, it is intended to make the data pertaining to this phase of the problem more conclusive.

The efficient depth for aërating tanks depends upon the area available and the foundation encountered. In order to prevent placing the tanks on piling, it would appear advisable to deepen them. A recent design by the writers for an activated-sludge plant provided that the depth of sewage above the air diffusers be 25 ft. The additional head against which the air must be forced is compensated for by the greater amount of work accomplished.

SUMMARY AND CONCLUSIONS

The activated-sludge process of sewage treatment produces a clear, sparkling effluent with an absence of odors.

There appears to be no reason why an activated-sludge installation cannot be placed in operation during the coldest months of the year.

The use of a hydro-turbine blower, whereby the air is washed, prevents the clogging of air diffusers with oil or fine particles of dust or other impurities.

The activated-sludge process does not have the advantage of being simple to operate.

When the treatment involves simply clarification and when the liquid and solids are aërated equally the minimum period required is 3 hr., and

Three-fourths of a cubic foot of free air per gallon of sewage treated with an aërating depth of 15 ft. is required. Apparently, such a long period of aëration is only necessary to condition the sludge properly.

An acre of land provides sufficient aërating and settling space to treat daily approximately 15,000,000 gal of sewage with an aërating depth of 15 ft

With a large installation the minimum operation cost of sewage treated is $5, exclusive of the sludge-disposal cost This figure is based on the use of electricity for power purposes at ¾c. per kw.-hr. The fixed charges would be an addition to the figure stated

If the sludge is re-aërated separately, the period necessary to aërate the mixture of activated sludge and fresh sewage is less than 3 hr.

The maximum velocity permissible in a settling tank of the horizontal flow type is 1 ft. per min. The question of the proper retention period required remains undecided. The results indicate that 30 min. is ample, if not more than necessary.

Storing and Measuring Oil from a California Gusher

By George D. Roalfe*

An unexpected and an unprovided for gusher on the property of the Lake View No. 2 Oil Co., in the Sunset Midway oil fields 25 mi. southwest of Bakersfield, Calif., flowed at about the average rate of 20,000 bbl. per day for over 150 days, producing 3,000,000 bbl. of oil emulsion. Storage had to be provided quickly for this immense flow, as well as for oil that has subsequently been produced, at intervals, at the rate of 30,000 bbl. per day.

When the well came in the first time, its force was so great that it carried the string of tools, weighing several thousand pounds, through the top of the derrick. The oil in addition to flowing under great pressure became mixed with at least one stream of groundwater. The result was about as perfect a mechanical mixture as one could conceive of. This mixture or emulsion, as it is called, contained about 65% by volume of water and base sediments.

USE OF OLD RESERVOIRS

The conditions were such as to make the problem of storage a vital one. This oil field had had a similar well, for which the owners had constructed earth-banked reservoirs having a capacity of 1,500,000 bbl. But these reservoirs or sumps were about 3 mi. from the new gusher and in addition were slightly higher. To utilize them a ditch was dug from the well, for a distance of about 1½ mi., to some sumps of several hundred thousand barrels capacity. A pumping station was placed here, and an 8-in. pipe line was run to a treating plant and then on to a large sump with a branch line to a smaller one. A 6-in. line was also run to a larger sump higher in the hills, which, however, it was not found necessary to use.

All these sumps could be used with slight repairs. An additional sump was formed by building 950 ft. of embankment from 1 to 25 ft. high. Five of the sumps were s located that they came in at least two pieces of property, complicating the determination of rental. To determine the amount of stored oil in the settlement of the rentals, Daniel S. Halladay, consulting engineer, Los Angeles, Calif., was retained. The writer was in charge of the fieldwork for Mr. Halladay.

CROSS-SECTIONING RESERVOIRS

An interval of 25 ft. was decided upon as the prope distance between cross-sections. In the case of each separate sump a base was laid out in a direction generally parallel to the longer axis of the reservoir. The reservoir was then inclosed in a rectangle. Stakes were set every 25 ft. on both the base line and on the line parallel to it on the opposite side of the sump, forming a system of rectilinear coördinates.

In some cases it was considered advisable to place stakes on the bank opposite the base line at locations other than those on the side of the rectangle as described; in this event the stakes were placed at the nearest points outside of the sump area whose values of x and y were some even multiple of 25 ft.

All elevations, whether taken with a rod and level or with the sounding tape, were referred to a plane passing through a point at some even foot of elevation. To this elevation the fixed point on the permanent gage rods was afterward set as described farther on. The distance of any point below this plane was the value of the ordinate z.

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*Los Angeles, Calif.

To get measurements across the sump a cable was constructed of No. 12 steel wire in 25-ft. links. Each joint was tagged; and as it often fell into the heavy black oil, instead of stamped numbers a system of notches was used for graduation. One notch on the side represented 25 ft.; two, 50 ft., and so on, while each notch on the bottom represented 100 ft. When 500 was reached, instead of making five notches a hole was punched in the middle of the tag. Then 600 became a hole in the center and a notch at the bottom; $6 + 25$ was a hole in the center and one notch each on the bottom and the side, etc.

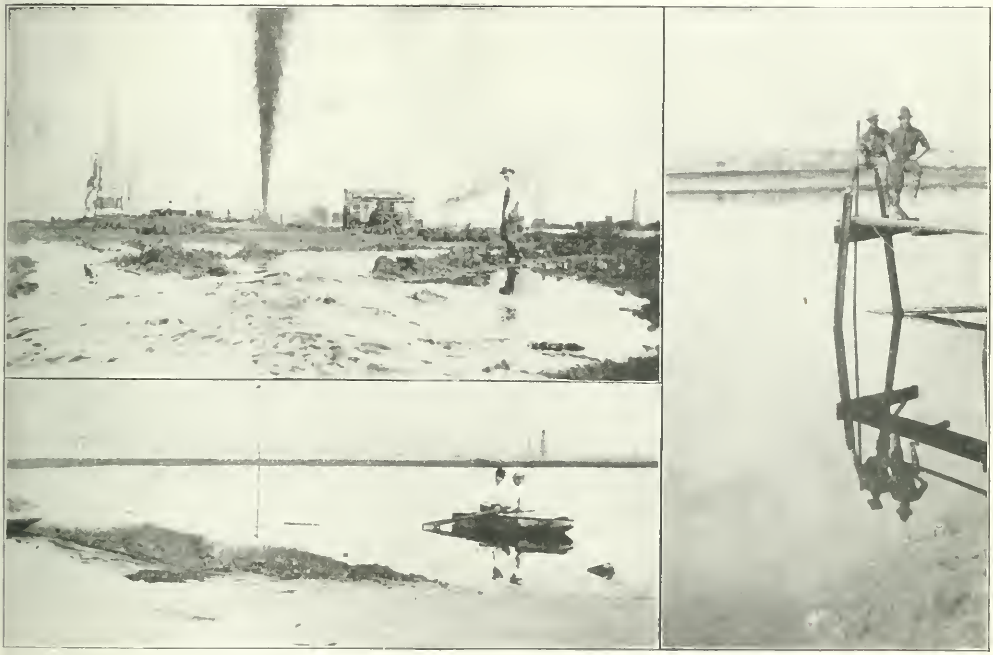
When the sump was over 300 ft. wide, it was found necessary to place floats about every 75 ft. to keep the wire from dropping under the surface of the oil. This was not so important in the summer as in winter, nor so essential in sounding as in moving the cable. During the summer months the oil was quite liquid, especially during the working day; but in winter, when some rain occurred, the oil had the consistency of firm butter and it was necessary to use a horse in drawing the gaging boat across the sump.

Sounding in Thick Oil

For sounding, when the oil was liquid, a steel tape and 6-oz. lead bob were used. At first, as the weather grew colder, the oil hardened on the surface only; and when the sun had shone for a short while, this crust was softened so that the tape could be used. But when this layer became thick, only the top was melted and a rod had to be used for the sounding. This rod was made up of sections of $\frac{1}{4}$-in. pipe about 3 ft. long. On the bottom of the lowest section was a hook so placed that when the ring in the sounding tape, to which the bob was attached, was placed over it, the zero on the tape would coincide with the bottom of the rod.

The sections of the pipe were each fitted on one end with a coupling; and as the soundings were taken in greater depths, additional sections were added. To hold the tape in place against the rod and at the same time make the removal of a section simple, rings were used that were very similar to the ordinary key ring, enabling the tape to be slipped in or out.

The boat used in taking the soundings was made of galvanized iron. It was flat-bottomed, square-ended and reinforced around the top with a piece of $\frac{3}{4}$-in. channel put on with $\frac{1}{4}$-in. rivets. A piece of 2x4-in. timber was fastened along the gunwales; two large spikes driven into this acted as oar locks. When drawing the boat with a horse, a sling of cable was carried completely around near the top and fastened about a foot in front.



MEASURING OIL STORED IN EARTH-BANKED RESERVOIRS, CALIFORNIA

The floats for buoying up the cable were made of two pieces of 2x4, about 2 ft. long, nailed at their centers to the ends of a 2-ft. piece of 1x12. (Smaller ones were tried, but were not stable.) In the center a large spike was driven and the cable fastened to this with a piece of wire.

Before the oil was sounded, an elevation was taken on its surface. This was done by driving a stake flush with the surface of the oil and then taking a rod reading on this stake. (Benchmarks, of course, had been previously established.) Next, a gage rod was set with which it was possible to determine the variation in the surface of the oil. This was necessary because in nearly every instance the measurements were taken while the sump was being filled, emptied or both. Owing to the solvent action of the oil on the paint of an ordinary level rod, temporary rods were made of a piece of 1x3-in. planed lumber notched with tenths completely across, and half-tenths halfway across one of the 3-in. surfaces.

The cable with 25-ft. graduations was next set between the two stakes, and readings were taken with a rod or sounding tape, depending on whether the point fell on the bank or in the body of the sump. In only one case did negative values of y appear. The layout was intended to eliminate them. If the contour of the ground necessitated it, shots were taken at other points than those on the 25-ft. intersection lines, as $y = 0 + 5$; $x = 1 + 51$, etc.

The cable was moved to the next pair of stakes and the operation repeated on the return trip. A sample of the method of keeping notes both for level and rod and for soundings is shown.

SAMPLE OF SURVEY NOTES—OIL-STORAGE DETERMINATION

George D. Roalfe SUMP NO. 10
J. W Howard
G. H Robertson Chainmen

Sec. 34, T. 32S, R. 24E, M. D. B. and M.

Sta.	+R	H.I	—R	Ele.
B M No. 1	3.82	610 82		607 00
T.P.			4 08	606 79

X	Y	Z	+R	H I.	—R	El.
0+57 30	0+38 10	1 93	. .	610 82	4 75	606 07
0+75.00	0+28 50	1 53	.	.	4 35	606 47
1+00.00	0+22.10	1 63			4 45	606.37

X	Y	Z	O.S.	Sounding	El.
1+02.2	0+25 0	3 21	604 79	0	604 79
1+25.0	0+22 3	3.21		0	604 79
1+12 5	0+25 0	4 46		1 25	603 54
1+25.0	0+25 0	5 92		2 71	602 08

Computing Quantity Tables

The notes on each sump were plotted on a scale of 20 ft. = 1 in., and the 1-ft. contours were sketched in. The area included by each contour was determined with a planimeter. The volume between contours was computed in barrels and for every $\frac{1}{4}$ in. of elevation.

In order to use the tables it was necessary to have a fixed datum to refer elevations to, for the scheme was the reverse of that applicable to steel tanks (where the distance between a plate on the bottom of the tank and the surface of the contents is measured). Any sediment that might be deposited would soon render measurements based on that method more or less inaccurate.

Instead, a datum above the oil was used. A 2-in. iron pipe with an iron clamp attached to the top was driven firmly into the bed of the sump. The point of this clamp was set to a proper elevation. Thus the zero point would be always accessible and any movement would soon be detected and remedied. The pipe was driven at the end of a small pier (see accompanying illustration).

A study to determine the accuracy of the tables resulted in a check of within 1% on three successive days. Three sumps were used containing, when full, 111,119 and 113,249 and 512,518 bbl. respectively. The oil was moved from one to the other. Taking the volumes that corresponded to the elevations from the tables gave results that agreed within 1%. The method of measurement was such that the probable error was small in the upper portions of the sump at least. In the lower portions it was greater; but as the volumes were relatively small, its effect would not be great on the total figures. It is believed that the figures were generally within 3% of the truth.

The cost of the survey and office work is estimated as follows:

Sump No.	Contents, Bbl.	Cost of Field Work per Bbl., Cents	Cost of Office Work per Bbl Cents
19	514,920	0 114	0.006
4, 5, 6, 9, 10, 11 and South Midway.	2,010,324	0 085	0 030

In the case of sump No. 19 a different method was used. Control lines were run up the bottom of the gullies and around the perimeter of the sump. From the points on these lines random shots were taken, using the rod and tape and the rod alone, at points where slope of the ground changed. The office work followed the method given above. In the costs given the office work for sump No. 19 does not include a table, only the quantities for even feet of elevation being computed.

The gaging piers and rods were made of used stuff, but if made of new material would have cost on an average about $50. In these costs the chainmen were figured at $3.50 per day, the prevailing rate for labor in the field. All the help had to be broken in, as none had had any experience.

In the case of the sumps that were on several pieces of property, tables were computed for the several portions as well as for the total contents. To get the portion in a given property the dividing lines were platted and measured with the planimeter, as already described. These costs are included above.

Machine Trenching for Long Telephone Conduits

The adaptability of trenching machines for excavating the comparatively narrow and shallow trenches for telephone and telegraph conduits has been proved in several cases, although contractors for such work are generally inclined to employ hand labor. With the present scarcity of labor, however, the use of machinery offers special advantages. During 1916, highly successful results were obtained in about 35,000 ft. of trenching for the Wisconsin Telephone Co., of Milwaukee, Wis. This work was done by the company's forces, under the direction of C. W. Wilson, Superintendent of Exchange Construction.

The work was mainly in macadamized streets and to some extent along country roads. In streets having a concrete base the work was done by hand, as the machine would be too slow and it would damage the surrounding pavement. The materials were mainly earth, gravel and tough clay, with some sand and soft loam. Boulders and niggerheads that were encountered were generally disposed of by burying in holes dug in the sides of the trench, but in some cases they were broken up by blasting.

An objection commonly made to the use of a trenching machine on such work is that it cannot be operated continuously, as long stretches of open trench are undesirable and the conduit laying and backfilling must follow as soon as possible. The usual practice is to cut the trench between two manholes (average distance, 500 ft.) and then stop the machine until the tile laying and backfilling gang has this stretch of work completed and the paving relaid. Thus the machine is idle about 66% of the working time but the results have shown that its use would be economical even if it were idle 75% of the time. This is for a machine with internal-combustion engine and would not apply with a steam-operated machine.

The machine used is of the wheel type, built by the Pawling & Harnischfeger Co., Milwaukee, for this kind of work. It is similar to the company's drainage excavator, described in *Engineering News*, Sept. 2, 1915. It has a cutting wheel 7½ ft. in diameter, digging a trench 15, 18 or 21 in. wide and with a maximum depth of 5½ ft. The width is usually 15 in., but for depths of over 4 ft. the cutters are shifted so as to make an 18- or 21-in. trench, as the men cannot work conveniently in the narrower deep trench. Where the depth exceeds 5½ ft., the additional cut is made by hand, for while machines are made that will cut deeper, the amount of such work is so small as to make it unnecessary to incur the extra expense for such a machine.

The trenching machine is mounted on four wheels and weighs about 9 tons. It is driven by a 25-hp. 4-cylinder kerosene engine, which uses gasoline for starting. It has six speeds from 2½ to 7½ ft. per min., but is operated mainly on the gear for 3½ ft. per min. This is equivalent to 210 ft. per hr. There are two men—an operator and helper. When the machine has finished its stretch of work, these men are assigned to other duty with the gang; but this would not be practicable with the men in charge of a steam-operated machine. Repairs have been insignificant, and after six months' work the cutters on the buckets were still in serviceable condition.

With the machine and gang of 20 men, about 600 ft. of conduit can be laid per day. This includes trenching, tile-laying, concreting, backfilling and paving. With handwork, a gang of 60 men would do about 600 ft. per day.

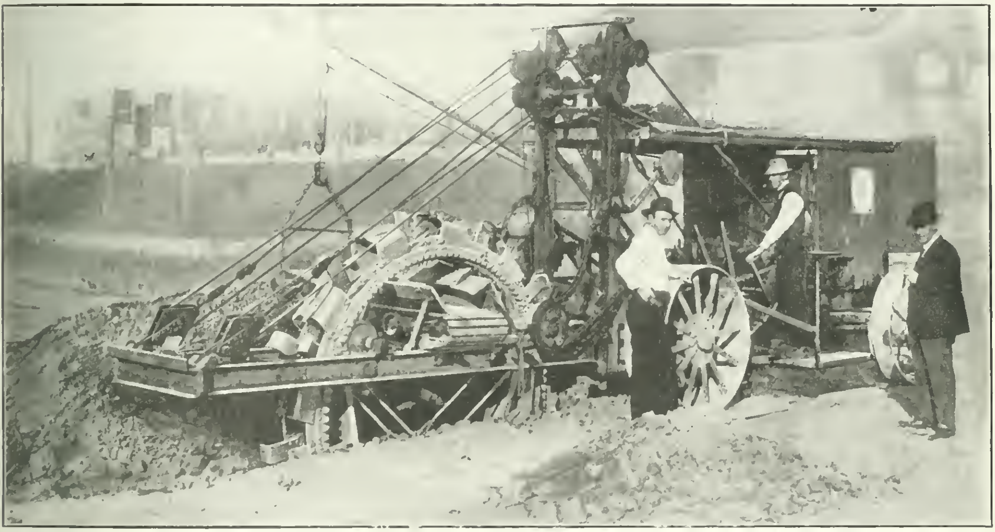
It was thought at first that there might be trouble from tearing up the gas-service pipes. But their location is shown by the shut-off boxes inside the curb, and their depth is determined by sounding. It is then easy to raise the excavator wheel to clear the pipes. On the 35,000 ft. of trench only half a dozen service pipes were damaged by the excavator. In each case the gas company was notified, and the telephone company paid the cost of repairs.

The backfilling is thrown in by a gang of six to eight shovelers and is machine tamped. This tamper has a vertical ram that is raised and dropped by power, and a 3-hp. gasoline engine operates the ram and the propelling gear. Its travel is about 8 ft. per min. The material is tamped dry, and there have been no complaints on account of settlement of the trench. With handwork there are three shovelers to one tamper, and 24 men are required in order to do the same amount of work as the nine men with the machine (including operator). Besides this, the work is not so well done.

The total number of men in the conduit gang is about 30 (including those building the manholes), and most of them do different parts of the work, as required from time to time. With the trench completed between the manholes, the concrete base is first laid. For this work there are two men in the trench for each tile-laying crew. Then two tile-laying crews are started at the middle (the summit) and work toward each end. Each crew has four men—two laying tile, one helper above to handle tile and one cementing the joints. Then the earth filling is packed against the sides of the conduit, the concrete cover is placed, and the backfilling is done.

All paving is relaid, except asphalt, the relaying of which is done either by a contractor or by the city's asphalt-repair plant. There was considerable trouble in organizing the work, as the men were continually changing. With the much larger force required for handwork this trouble would have been greater. The use of the machines for trenching and tamping not only facilitated the progress of the work, but effected a material saving in cost as compared with hand labor. On this particular work the saving was about 60% on the trenching and 75% on the backfilling.

The operation of the trenching machine on the work above described attracted considerable attention from the officials of telephone and telegraph companies, and similar wheel-type excavators have since been employed on other conduit lines.



TRENCHING MACHINE ON CONDUIT CONSTRUCTION FOR THE WISCONSIN TELEPHONE CO., MILWAUKEE, WIS.

Concrete-Revetment Machine for the Mississippi*

By E. M. Markham†

SYNOPSIS—Large reinforced-concrete slab or mat is cast on sloping-deck barge. Barge is run up under trusses overhanging from power-equipped barge anchored with length extended into stream from bank to be revetted. Slab is attached to many lines hanging from trusses, and as mat barge is backed away the mat slides into water, each line taking load as its point of suspension reaches water. All lines released at once and mat, held at end to shore, drops to bottom. Continuous process of same sort "shingles" the subaqueous slope.

Some three years ago, after service of a year or more on the Lower Mississippi River Improvement under the Mississippi River Commission, the writer was aroused to the thought of the feasibility of developing a reinforced-concrete revetment to supplement or replace the willow fascine construction now employed. This thought was suggested primarily by the fact that the willow supply throughout the lower river is inadequate to meet prospective revetment needs; and secondarily by the obvious conclusion that a concrete revetment would be more effective and durable than a fascine structure, without necessarily being more costly. Again, the employment of concrete would result in an important reduction of manual labor and be capable of development by units in such manner that very desirable flexibility of organization and of output would be possible.

It was acordingly conceived that a scheme might be devised whereby large sheets of concrete, or of blocks, suitably disposed and secured, could be satisfactorily handled to appropriate position and relation upon the bed or bank to be revetted, with the result of a more durable, more efficient and more economical structure than now obtains. It was known that satisfactory and, from the nature of the case, inexhaustible deposits of sand and gravel for concrete purposes are spotted throughout the river and that a suitable river run product can be inexpensively dredged.

Presenting the matter for the consideration of the Mississippi River Commission, the latter allotted $2.500

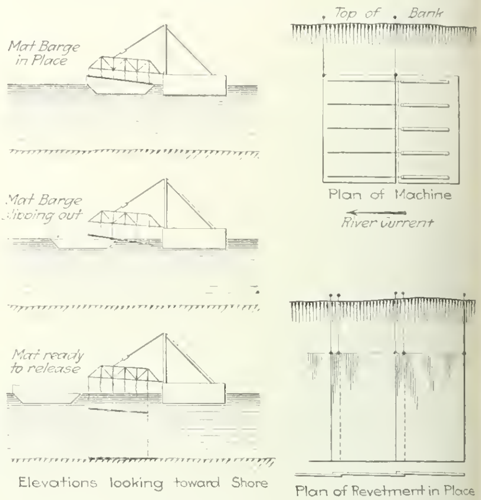


FIG. 1. DIAGRAMMATIC OUTLINE OF OPERATION OF MAT-LAYING MACHINE

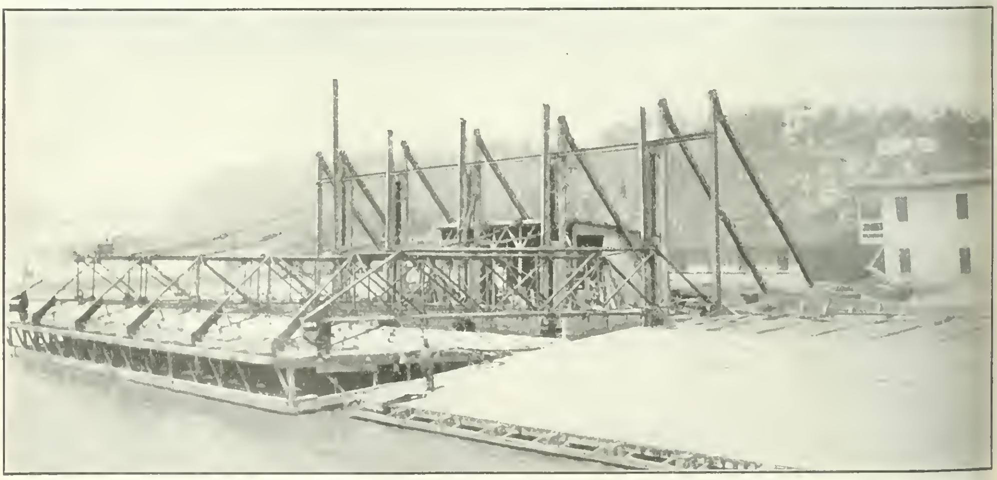


FIG. 2. VIEW OF EXPERIMENTAL CONCRETE REVETMENT PLANT BELOW MEMPHIS BRIDGE

for "experimental revetment" in the fall of 1914 and, based upon the results obtained thereunder, made a further assignment of $25,000 in the spring of 1915.

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*From "Professional Memoirs, Corps of Engineers, United States Army, etc.," November-December, 1916.

†Lieutenant Colonel, United States Army; Major, Corps of Engineers, West Point, N. Y.

Under the allotment first referred to barges with inclined decks were prepared, upon which were formed and from which were launched eight concrete slabs, such control being provided as could be applied by lines handled manually. The smallest of these slabs were 14x18.6 ft., of which five were formed and launched; the largest were 100x40 ft., of which two were constructed; a fifth slab of intermediate dimension, 18.6x19 ft., was also employed. All slabs were 4 in. in thickness, reinforced by strand and mesh, variously clipped and wired together.

These slabs were handled somewhat crudely, the barges utilized being out of all relation to the problem; nevertheless, the results verified the thought that concrete sheets of large area and small thickness, heavily reinforced, can be considerably "man-handled" and directed to the river bed in such manner as to insure their effectiveness for revetment purposes. A diver, employed to investigate the condition of the two of the largest slabs, launched in inshore depths of 8 ft. and outer depths of 40 ft., reported the structures to be intact, subject to anticipated cracking, to be hugging the bottom closely and to be generally in very satisfactory condition.

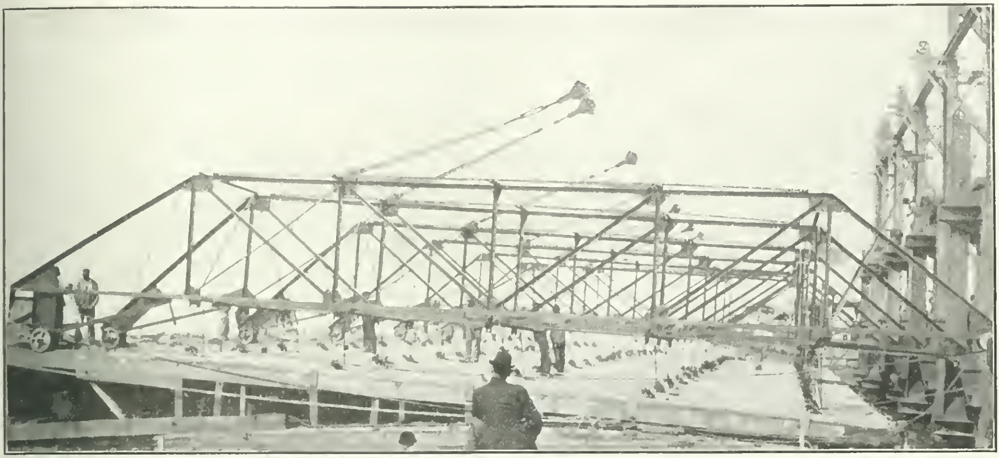


FIG. 3. CONCRETE REVETMENT SLAB JUST BEFORE BARGE IS SLIPPED FROM UNDER IT

Under the allotment of $25,000 for further experimental work, a plant was developed consisting of two barges upon which to construct concrete slabs or mats, and a third barge upon which were mounted the necessary machinery and structural work to handle the same from their position of formation to the bed of the river (Fig. 2).

The general proposition contemplated the formation of a concrete mat upon the inclined deck of a barge, the latter to be withdrawn under mechanical power after sufficient

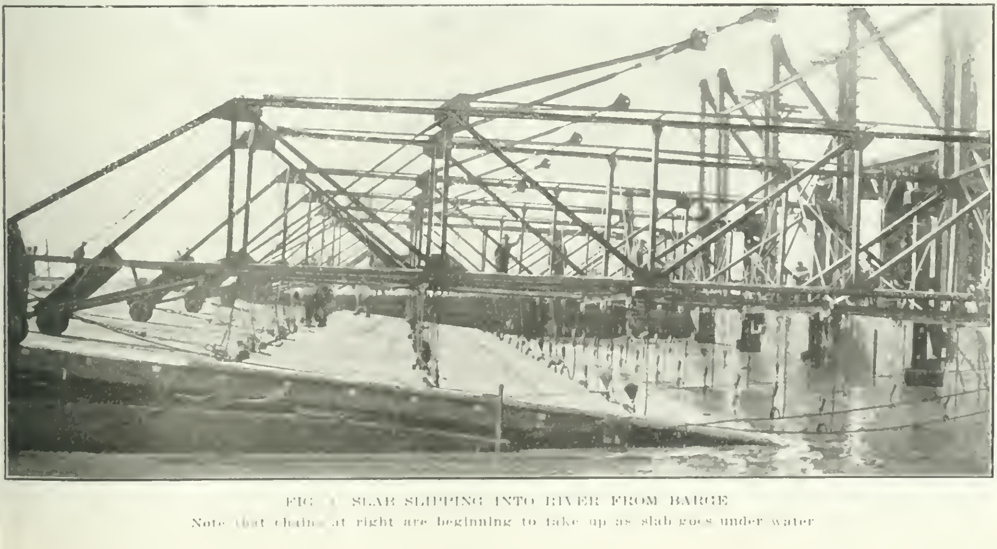


FIG. 4. SLAB SLIPPING INTO RIVER FROM BARGE

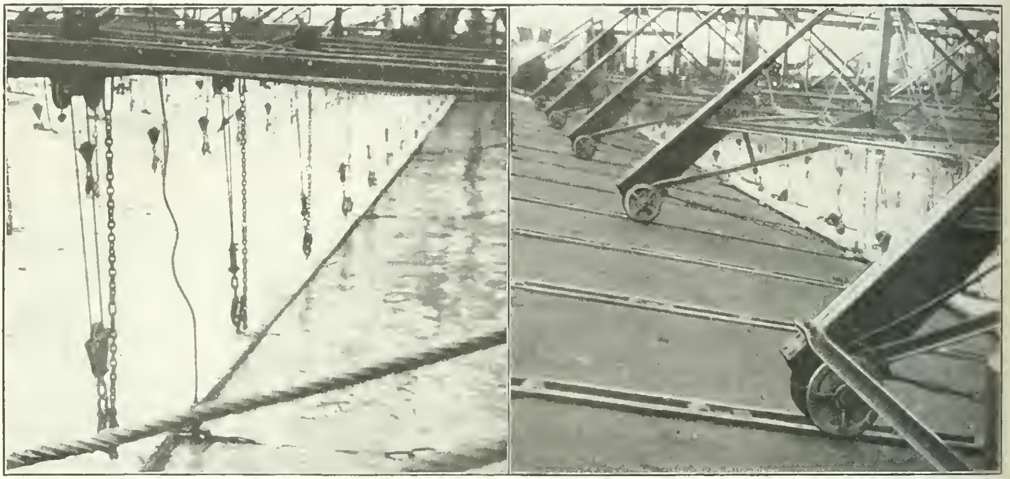
Note that chains at right are beginning to take up as slab goes under water air hardening of the sand mat, substitute support being simultaneously provided from a series of overhead trusses hinged upon a fixed mooring barge and having wheel bearings upon ways of the barge withdrawn. During and after withdrawal, this substitute support would be arranged for by a proper number, disposition and attachment of lines running from the overhead trusses to trigger or trip connections with rings or loops formed in the mat. A situation would thus be developed wherein the latter would be suspended as a weight in water, between mooring and mat barges, and might thereafter be lowered to position upon the supporting lines or tripped to freedom therefrom. After tripping, control and direction to position would be provided by shackle connections from the upstream edge of the mat by trolleys mounted upon mooring barge spuds or by upstream and shore cables. By resetting the mooring barge to accord with desired relation or overlap of successive sheets, a continuous interposition would be provided between the river and the caving bank under treatment. In other words, the caving bank would be "shingled" with large concrete slabs, or mats, each of such size and weight as to insure successful resistance against destruction by the hydraulic forces to which subjected. The slabs were to be reinforced with strand and mesh, such that maximum flexibility would be assured. Upon encountering check to their momentum in settlement toward final position they would crack into irregular areas and thus conform to whatever inequalities were involved. The several areas, however, would be held in juxtaposition by the embedded strand and mesh, ample virtue being thus retained for satisfactory compliance with revetment requirements. Subsequent undercutting or erosion would be closely followed, due to the deficiency of cantilever value, resulting from the relation of area to thickness, such deficiency to be additionally regulated, if need be, by the creation of planes of weakness of any desired position and number. Satisfactorily long life would be assured by the galvanization to desired degree of any or all the reinforcement. The principal strand of the latter would be extended upon the upper, or high-water bank, and securely anchored in its pavement. Such a revetment would thus be essentially monolithic from top bank to deepest water. To provide for maximum plant capacity, an accelerator would be sought to hasten the hardening of the slab sufficiently to withstand launching, final hardening to continue, of course, upon the bed or bank revetted.

Experimental plant was designed to handle in the fashion described sheets 125x50 ft. by 4 in. Slightly lesser sizes have been employed as a matter of precaution and of convenience.

Details of the Equipment

The mat barges were provided with inclined decks subdivided transversely by ways on 8-ft. 4-in. centers, between which platform sections were so mounted upon supporting timbers as to be readily lowered or raised by about 4 in. In the raised position these platforms are flush with butter, or launching, boards about 11 in. in width, which themselves rest upon rollers inserted in the ways. After slab manufacture and upon sufficient air hardening, the intermediate sections are dropped, the concrete structure thus resting entirely upon the butter boards referred to. To launch a slab it is therefore necessary only to overcome the axle friction of the rollers, butter boards moving with the slab and being recoverable under proper provision for that purpose. The ways are steel shod to receive the wheel bearings of overhead trusses.

Mechanical and structural equipment, mounted upon a wood barge 124x30x7 ft. consists of 35-hp. boiler and double 7x7-in. engine, rigged with drums, winches, etc., of five intermediate trusses from which to suspend the slabs; and of two end trusses carrying sheaves and lines whereby to effect mat-barge manipulation. All trusses are hinged near the downstream edge of the mooring barge and have wheel bearings upon the ways of the mat barge. These trusses may be raised or lowered in unison through rigging to engine on the mooring barge, which as well



FIGS. 5 AND 6 DETAIL VIEWS OF PARTS OF THE REVETMENT MACHINE

Fig. 5 Lower end of slab, showing detail of supporting chain. Fig. 6 Near view of barge deck, showing rollers of truss supports and at right concrete slab disappearing into water

provides power through suitable lines for the maneuver and control of the mat barge during its withdrawal.

Suspension trusses are of five-panel point Pratt type, spaced on 25-ft. centers, the interval being subdivided by side stirrups from each main truss. All trusses are cross-braced and interconnected by rods and shapes. Suspension is assumed from each panel point of both main trusses and stirrups, and is accordingly on square 8 ft. 4 in. by 10 ft. Five supporting lines across the mat are thus available, each involving 15 suspension points. The supporting lines consist of $\frac{3}{8}$-in. cable, end-wedged on outside trusses, passing thence through two fixed and one movable sheave above each suspension point to drums of a shaft located on the center truss. Lines from one side pass under and those from the opposite side over the said drums. Prior to launching, the lengths of these lines are fixed for support of the mat at desired submergence, the end brake of shaft thereupon set. As the mat relatively lowers during the withdrawal of the barge upon which formed, the supporting lines come successively into play, and the total weight to be carried is accurately and automatically distributed to the several suspension points, due to the character of the operation and to the fact that each suspension involves a movable sheave riding on a running line from center shaft to end trusses. No suspension, therefore, can assume more nor less weight than its due proportion. Under the arrangement described, the weight of a slab of 100 tons in air is necessarily so subdivided that the main trusses take each but slightly over 11½ tons, the suspension points somewhat less than 0.8 ton and the supporting lines but about 900 lb.

As a precaution against uncertainty or mishap involving the safety of the main plant, the strength of mat loops and of supporting lines is materially less than any element of the carrying structures. If, therefore, a trigger should fail to trip, or other untoward incident eventuate, the mat loop involved would part or pull or the suspension line break, before more serious result could develop.

The device employed at suspension points, suggested by the Bucyrus Co., of South Milwaukee, Wis., consists of a trigger attached to the housing of a movable sheave and carries a pin held by a spring in what may be termed a "locked" position. To "hook up" a mat for launching, this pin is withdrawn by hand sufficiently to pass the mat loop between the pin and the jaw. The trip device remains in the "locked" position during the operation of launching and while the mat is held in suspension. Connected to the tops of the several trigger pins are chains attached to the overhead trusses and of such length as to retain slack when the running suspension cables have taken weight, all chains being adjusted for as nearly the same amount of slack as practicable. To trip or release the mat from suspension it is therefore necessary only to throw the brake at the end of the shaft on the center truss, whereupon the weight of the mat itself overhauls all suspending cables, thus taking up the slack of all trip chains, whereupon the trigger pins are pulled practically simultaneously and the mat is thus freed from any connection to the overhead structures.

To withhold the mat from movement with the mat barge, during withdrawal of the latter, shackle attachments are made from its upstream edge to trolleys designed to travel vertically upon spuds of the mooring barge. The mat, upon being tripped, will therefore continue under control of its attachments to these spud trolleys, connection being severed at any predetermined depth by the withdrawal of shackle pins. Upon release from suspension, the mat may be controlled likewise by upstream and shore lines of appropriate number and anchorage.

To prevent the slab during barge withdrawal from tending to race off the latter, back hold lines are provided from attachments at its downstream edge to connections with overhead trusses near their wheel bearings.

PROGRESS OF EXPERIMENTAL WORK

Eight concrete sheets or mats have thus far been constructed and launched. They were reinforced by ½-in. strand around the edges and on the lines of suspension and normal thereto; by $\frac{5}{16}$-in. strand running diagonally through suspension points, and by triangular mesh over the whole area. Both strand and mesh were variously clipped and wired together. Suspension loops were formed of ½-in. round iron in the shape of hooks of uniform height and were engaged about the lines of strand at their several intersections.

The first mat handled was 50x50 ft. by 3 in., weighing 62,500 lb.; the second was 122x47 ft. by 3 in. and weighed 215,000 lb.; the last six have been each 122x42 ft. by 3 in., weighing 192,000 lb. Width was reduced from 50 ft. to 47 ft., in order to provide a somewhat longer bridle from spud trolleys to upstream edge of slabs. It was again cut to 42 ft. in order to reduce overhang above the first line of suspension, which theretofore had caused objectionable droop of the upstream portion of the mat.

The transfer of slabs from the mat barge to suspension was accomplished without incident involving difficulty or trouble of any character. The general scheme, in this regard, would appear to be unexceptionable. Under proper lubrication of launching rollers, the mat barge may be withdrawn with an insignificant amount of power, moving in fact entirely under the influence of current and of the weight of the mat, once the latter is started.

The several slabs were launched over a shelving bank in inshore depths of from 8 to 18 ft. and outer depths of from 20 to 50 ft. All mats arrived at the desired position within reasonable limits of error, as indicated by corner lines.

Three slabs launched during a high river have been partly exposed to view at lower stages. They are to all intents and purposes intact, being cracked only to the extent necessary for their accommodation to bank inequalities, which are closely and satisfactorily followed.

It is conservatively estimated that with reasonably resourceful management, one handling plant should dispose of five slabs or more per day of 10 hr. Expenditures upon the experimental work outlined have been such as to suggest for comprehensive work a probable field cost of about 60c. per sq.yd. A comparable figure for willow fascine construction is from 70c. to 80c.

POSSIBILITIES OF THE METHOD

It will be noted that the plant on hand was designed to handle continuous concrete sheets 125x50 ft., but that slightly lesser sizes were employed. The only case known to the writer where bank revetment requires an outshore dimension in excess of 125 ft. is on the lower Mississippi River, where, as stated, willow fascine mattresses are installed of a width of at least 250 ft. Concrete revetment in single sheets of this latter width is believed to be entirely feasible along the lines described, since the additional size involves no essential complication beyond the requirement of floating and other plant to scale, still within the limits of practicable construction and maneuver.

The launching, suspension and release of such slabs would not increase unit stresses in any element of the operation. Additional outshore dimension would simply be met by additional supporting trusses and suspension points, each carrying no more nor less than its due proportion. Similarly, no physical nor mechanical consideration militates against the handling of a slab exceeding the 50-ft. dimension, though a limit in this direction would soon be reached by reason of excessive mat-barge width, as well as the rapid increase of truss weights and stresses, due to additional spans. However, a slab of 50 ft. or thereabouts should be suitable and economical for the class of revetment involved.

The use of heavily reinforced concrete sheets after the manner described is not necessarily confined to bank revetment. They may be employed in any situation around or about the base of a structure to resist undercutting or erosion. Special arrangements for handling sheets in such situations would be required, the bulk of which, however, would doubtless be well within the field of reasonable resourcefulness and ingenuity.

Civil-Service Examination for Junior Engineer

On Oct. 11 and 12, civil-service examinations of candidates for appointment as Junior Enginer, Civil Engineer Department at large, were held by the United States Civil Service Commission at different places throughout the country. As stated in the letter of General Black, Chief of Engineers, published in *Engineering News* of Sept. 28, those passing this examination are eligible to take the examination for appointment as Second Lieutenant in the Corps of Engineers to be held about the end of January.

The candidates for the examination on Oct. 11 were required to be over 20 years of age, graduates in civil engineering from a technical school of recognized standing or a senior student in such a school within six months of graduation, or else to have had at least four years' responsible experience in civil engineering.

The questions used in the examination, as reported to *Engineering News* by one of the candidates, were as follows:

Time allowed, two days of six and three hours respectively. The first two subjects will be given on the first day and the third subject on the second day. Candidates are allowed to use a slide-rule.

Subjects of examination and relative weights of subjects on a scale of 100: Pure and applied mathematics, 20; use and construction of instruments and surveying, 30; design and construction, 25; training and experience, 25.

MATHEMATICS

Answer five questions.

1. A man stands on a platform which ascends with uniform acceleration 6 ft. per sec. per sec., and at the end of 4 sec. after the platform began to move he drops a stone. Find the velocity of the stone after 3 sec.

2. The pressure of the water in a hydraulic company's main is 750 lb. per sq.in. and the average flow is 25 cu ft. per min. What horsepower does this represent?

3. Find the length of a steel bar of a specific gravity of 7.8, supported vertically, which will break of its own weight. Ultimate strength of steel, 60,000 lb. per sq.in.

4. A uniform beam of a weight W^1 crossing a given span can bear a uniformly distributed load W'. What load may be placed on the same beam if it crosses the span in n equal lengths supported by piers whose widths may be disregarded?

5. A 5-oz. ball moving at 1,000 ft. per sec. pierces a shield and moves on with a velocity of 400 ft. per sec. What energy was lost by piercing the shield?

6. Two plane mirrors A and B are placed vertically upon a horizontal table. A ray of light PB falls upon mirror B and is reflected to mirror A. Show that ray AQ reflected from the latter makes with PB an angle which is double the angl between the mirrors.

SURVEYING

Answer four questions.

1. Make a neat sketch of a Wye level mounted on a tripod. Make the sketch large enough to show all the outside details and name the parts.

2. (a) The following data cover a set of stadia survey notes and a table of horizontal distances and differences elevation. Fill in the blanks in the set of notes by using th table and allowing for the instrument constant. (b) What is the horizontal distance between A and C?

Sta.	Az.	Inter.	Vert. Ang.	Hor. Dist.	Diff. Elev.	Elev
Inst. at A						100.00
1	149° 20′	2.27	—3° 40′	......	......	....
2	201° 15′	2.58	+4° 20′	......	......	....
3	259° 45′	2.83	+7° 10′	......	......	....
4	291° 18′	1.69	—2° 50′	......	......	....
B	230° 10′	4.20	+5° 30′	......	......	....
Inst. at B						
A	50° 10′	4.20	—5° 30′	......	......	....
5	98° 38′	1.89	—1° 20′	......	......	....
6	171° 47′	2.02	—4° 30′	......	......	....
7	258° 18′	2.53	—8° 20′	......	......	....
8	352° 18′	1.38	+7° 40′	......	......	....
C	302° 23′	3.50	+2° 10′	......	......	....
Inst at C						
B	122° 23′	3.50	—2° 10′	......	......	....

Stadia constant = 100

(Then followed a stadia table from 1° to 10° and for 1 intervals, giving both horizontal and vertical distances.)

3. Describe in detail and illustrate three good methods o locating soundings.

4. Rods are sometimes graduated to correspond with th stadia interval of a particular instrument. Describe in detai how you would determine the graduation for a rod in a cas of this kind

5. Name three methods of determining the discharge of a stream and describe one of the methods in detail.

DESIGN AND CONSTRUCTION

Answer four questions.

1. Describe the construction of a first-class brick pavement. Make a neat sketch showing the cross-section of one-half o the roadway and the sidewalk adjacent to it.

2. (a) Make sketches showing three different methods o splicing large structural timbers used as beams. (b) Show by a sketch how you would truss a 6-in by 8-in. by 20-ft. timber beam with iron.

3. Make a longitudinal section of a square concrete box culvert 1 ft thick all around to take care of a drainage area of 160 acres, showing a cross-section of a single-track railroad at that point. Top of rail to be 6 ft. about the top of the culvert, roadbed 18 ft. wide, slope 1½ to 1 and the ends of the culvert to be vertical and even with the intersection of the side slopes with the floor of the culvert. Show general dimensions. Given area of waterway = 0.8 acres.

4. (a) When it is necessary to lay concrete under water how can it be done with good results? (b) When would yo use the egg shaped section for a sewer?

5. State the important details of construction of a heav masonry dam.

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Cable Street Railways, which came into extensive use in American cities to replace horse cars in the '80's and earl '90's, but were superseded almost everywhere by the electri railway in the next decade, are still in extended use in San Francisco, Calif., and Edinburgh, Scotland. The cable lines that still remain in San Francisco are those which run on streets crossing the San Francisco hills with grades so steep that electric operation would not be possible. In Edinburgh, however, the entire city street-railway system is operated by cable. The Edinburgh system was built by the city in 189 and leased for 21 years to a private company at an annual rental of 7%. The lease expires on June 30, 1919. The cars used are of small size and are operated at very low speed. The city plans to take over the system on the expiration of the lease and operate it by electric traction. A commission has reported in favor of operation by the overhead-trolle system, and the work of reconstruction is likely to be undertaken shortly, so that electric cars can begin running as soon as the lease expires.

Heavy Grading on 50-Mile Southern Relocation

SYNOPSIS—Striking items in 9,000,000-yd. grading on the Southern Ry. Very heavy excavation in four classifications. This 50-mi. relocation is heaviest of second-tracking between Washington and Atlanta. How the contractors are proceeding.

More than 30 steam shovels are at work grading a double-track line for the Southern Ry. from Central, S. C., to Cornelia, Ga. The present (single-track) line is 56 mi. long and serves Central, Seneca, Richland, Westminster, Madison, all in South Carolina, and Deercourt, Toccoa, Ayersville, Mt. Airy and Cornelia in Georgia. The new line, while touching at the present depots of the towns named, will cut down the distance 5.76 mi.; the curvature, 3,287° 17′; the vertical lift, 368 ft.

The work, which is very heavy, has been going on since spring and now is approximately 50% complete. The heaviest cuts and fills are as given in Table 1, printed

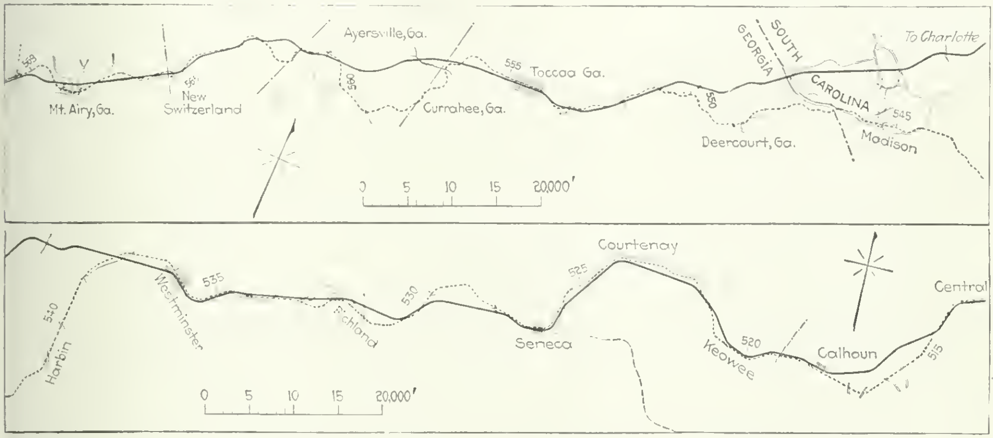

FIG. 1. RELOCATION OF SOUTHERN RY. FROM CORNELIA, GA., TO CENTRAL, S. C.
Old line shown dotted, new line full

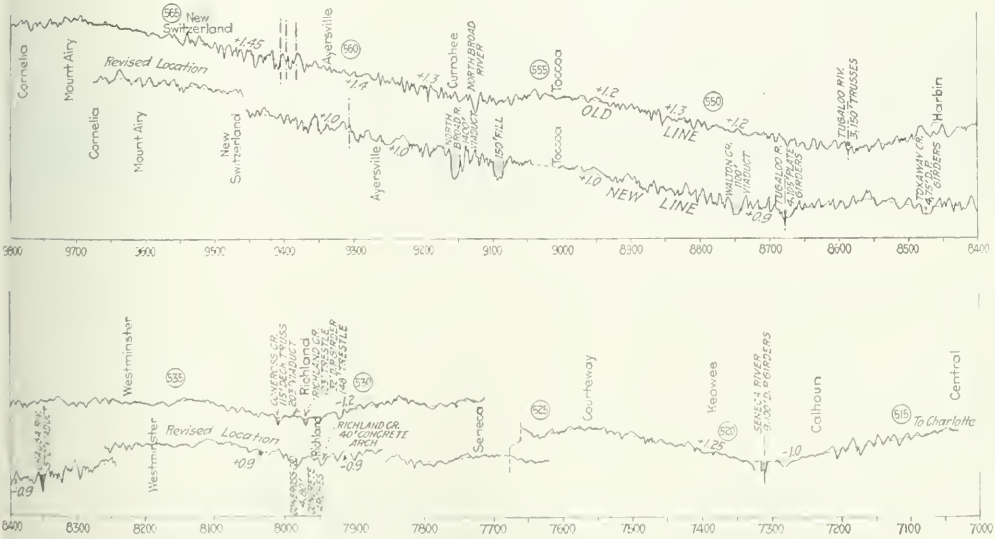

FIG. 2. OLD AND NEW PROFILE OF LINE WITH HEAVIEST GRADES

just below. The contract classification for material comprises earth, loose rock, soft rock and hard rock. The earth is a peculiarly light gritless material, easily handled whether wet or dry. The rock varies from disintegrated granite to blue granite and flint, with interspersing of mica. The grading was let in five sections to the contractors noted in Table 2.

TABLE 1

Station from Charlotte	Cu Yd.
In Georgia	
9647 28	219,000 cut
9365–45	209,460 cut
9373–61	208,730 fill
9100–9083	1,500,000 fill
In South Carolina	
7940–21	103,100 cut
7858–29	256,870 cut
7830–7781	146,100 fill

TABLE 2

Contractor	Length of Section, Mi.	Cu.Yd	Shovels at Work	% Complete
C. J. McKinney......	12 5	774,000	5	63
Robert Russell	9 7	859,000	5	74
Winston & Co	9 3	1,877,000	7	25
Rinehart & Dennis..	6 2	1,667,000	5	40
C. W. Lane & Co	5 5	2,750,000	8	21
H. S Dunavant & Co	7 2	1,011,000	3	32
Total..	50 4	8,938,000	33	49

Where New Line Crosses Old

On the Rinehart & Dennis section, between Toccoa and Deercourt, Ga., the new line crosses the old at two points. Work is going on at one of these at the present time, and not a little annoyance was caused at first by hold-ups due to traffic on the main line. In one day there were ten stoppages aggregating 2 hr. 32 min., the longest being 50 min. One day 40 cars were blocked; on two other days 80 cars were held up per day. The narrow-gage tracks cross the main line on rails fastened to a turntable. To clear the main line all that is required is the removal of four pins, and a 10-ft. walk by a man to swing the turntable rails out of the way. When the work at this point is finished, the turntable will be taken to the other intersection and work will be started there. Six scrapers are doing the final grading.

North of the first intersection the old and new lines run side by side, the new being about 15 ft. lower. At one point the old roadbed is supported by a cross-tie crib.

The yardage on this section totals 1,800,000, of which 730,000 is borrowed for a fill 105 ft. high by 1,100 ft. long. The average height of this fill is 95 ft., while the average width on top is 60 ft. It is made from three parallel trestles of increasing height. Material is obtained from the hillside at three points corresponding in elevation to the several trestles. The fill will be pierced by a 30-ft. arch concrete culvert 300 ft. long.

The contractor has three shovels at work, the first served by 4-yd. cars, the second by 5-yd. The trains vary from 8 to 16 cars and are hauled by three 16-ton dinkeys, two 14-ton and a 12-ton. Two of the shovels started work the middle of May and have dug as follows:

	June	July	August
Cubic yards. ..	30,000	28,000	35,000
Cubic yards	20,000	20,000	30,000

Of this, 25% was hard rock, 25% soft rock and the remainder earth.

One of these shovels is operated at night, because the material from it has to be hauled through a cut where another shovel works. It would be impracticable to haul the spoil from both shovels through this cut during the same working day. Carbide light is used.

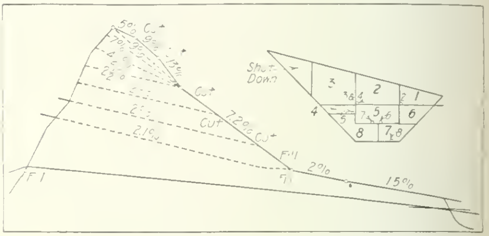

FIG. 4. OPENING ROCK CUTS ON SHEAHAN'S SUB-CONTRACT

Right-hand sketch is cross-section showing shovel trips through hard-rock cut. Left-hand sketch is a longitudinal elevation showing method of excavating another cut. In order to start shovel at top of this second cut a fill had to be made on hillside as shown.

One of the fills is being made by "washing." A No. 8 Cameron pump having a 3-in. discharge lifts water 200 ft. through a 2,000-ft. pipe line. A rough trench was dug down the hill, and the water is directed into this through a 2-in. hose attached to the 3-in. line. The earth is light and is washed down to the fill. A small earth dam on each side of the fill retains the water until the earth settles. Two feet of clay overlies the light material in the hill and must first be washed away.

Two weeks sufficed to wash a cut wide enough for a dinkey track. The maximum depth was 20 ft.; the length was 400 ft. "The long pipe line and high lift reduced the water pressure to such an extent that the No. 8 pump used was not adequate," says the superintendent; but he adds: "With the right pressure this is a good way to move material of this kind."

The contract calls for the completion of this section by July, 1917, E. R. Faulconer, Superintendent for Rine-

FIG. 3. TWO VIEWS SHOWING HOW 105-FT. FILL WAS MADE; CONCRETING 30-FT. CULVERT AT RIGHT

hart & Dennis, estimates that 8 mi. will be ready for the track gang by March. When the track is down and the old line relieved of traffic, two of the cuts will have to be made from 6 to 10 ft. wider. The rest of the section should be finished a few months later.

Hard Rock Chewed Up 17 Bits in Two Days

The Sheahan Construction Corporation, of Roanoke, Va. (sub-contractor for Rinehart & Dennis), has heavy bluff work midway between Toccoa, Ga., and the South Carolina-Georgia state line, a distance of about 1½ mi. and containing 650,000 cu.yd. of excavation.

Very little earth has been encountered, the material being loose, soft and hard rock. One of the first cuts started contained very hard blue granite underlain with flint and was exceedingly difficult to drill. No. 3 Keystone traction well drillers were used, and seven 5⅝-in. bits were required to drill through a stratum of flint 2 ft. 10 in. thick. Seventeen bits were badly damaged in drilling a single hole 22 ft. deep in 22 hr. Cyanide of potash was obtained in Atlanta for the purpose of case-hardening the bits, but there was little improvement. The drilling machines made the journey from railway to hill by their own power and went up the hill, assisted by two mule teams and block-and-tackle.

The holes were drilled about 20 ft. per lift in three lines 20 ft. apart, the holes in a line being on 15-ft. centers. After springing, the tamping was drilled out of the holes with the well drill, and three cases (300 sticks) of 60% dynamite were loaded into each hole. Much of the hard rock came out in large pieces, which were piled out of the way by a steam shovel (views 1 and 6 in Fig. 6) and later were drilled with "Jackhamers" and broken into sizes convenient for shovel handling.

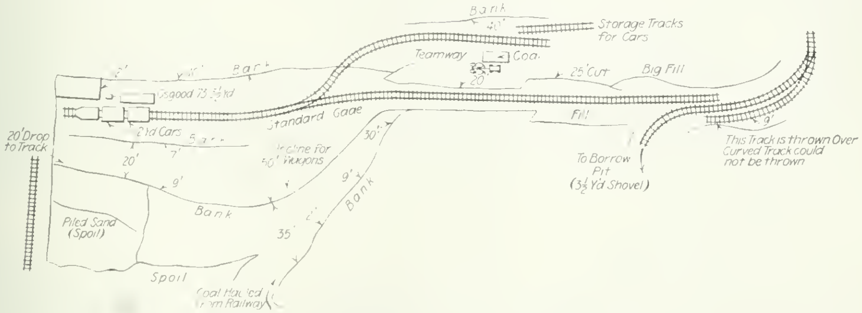

FIG. 5. PLAN OF BIG FILL AND BORROW PITS ON C. W. LANE & CO.'S SECTION, SOUTHERN RY. RELOCATION

The handling equipment on this work comprises two 2½-yd. shovels, six 18-ton Vulcan locomotives, sixty 1-yd. Western dump-cars, two Keystone drills and a steam-drill outfit.

In the beginning 12% grades were encountered, and two locomotives were required to haul two to four cars. As quickly as possible more cars were added to the trains. In the latter part of September the steepest grade was reduced to 7½%, and one locomotive could haul 10 cars. There was practically no light work, except drilling.

The first shovel started May 23, the second on June 1. The best record made by a single shovel was 10,000 yd. in August and 38,000 yd. in September, digging in earth, soft rock and boulders. The haul was about 2,000 ft. In August this shovel moved 12,000 cars, and 11,500 in September. In the rock cut the shovel averaged about 12,000 yd. of hard rock per month, working 11½ hr. per day.

Trestles up to 70 ft. in height are built to grade. For fills higher than 70 ft. the trestles are built 50 ft. high, filled in and the track jacked to grade.

Fill 150 Ft. High Instead of Viaduct

By far the biggest fill on the Southern Ry. is under way on C. W. Lane & Co.'s section, near Toccoa. This fill will be 150 ft. high, about 1,500 ft. long, 530 ft. wide at the base and will contain 1,500,000 yd. of material, a large part of which is borrow. The fill crosses the present location of the main line at an angle of 60°, and the top will be 82 ft. above the old grade.

When the line was laid out, it was proposed to erect a steel viaduct at this location; but the high cost of steel caused the railway company to decide in favor of a fill. An arch concrete culvert has been built under the fill, and the fill itself had been carried up about 60 ft. by Oct. 1.

In making the fill the first important operation was to build an 18-ft. dumping trestle. After this had been filled, the work was carried up by jacking the track and throwing it over, as required. Two 3½-yd. steam shovels supply 12-yd. air-dump Westerns drawn by standard-gage locomotives having six driving wheels, the middle driving wheel on each side having no flange. These locomotives are too long for the curves encountered and derailments have been common. It is the intention shortly to place flanges on the middle driving wheels. As an example of the difficulty, one morning four locomotive derailments occurred in as many trips from shovel to dump.

Observation of the work at this particular point leads to the conclusion that, while the heavy standard-gage engine with large wheelbase has undeniable advantages in main-line work, it cannot give its best service on the crooked and undulating construction tracks common to new work.

The heavy grade leading to one of the shovels necessitates a two-car train. Four-car trains run from the second shovel, one every 15 min. when all is well. Fig. 5 is a plan of the fill and adjacent borrow pits. The track running out on the fill from the borrow pit cannot be jacked and thrown over, on account of the curve in it. A switchback is therefore provided on the fill. A train from the second shovel runs the full length of the fill,

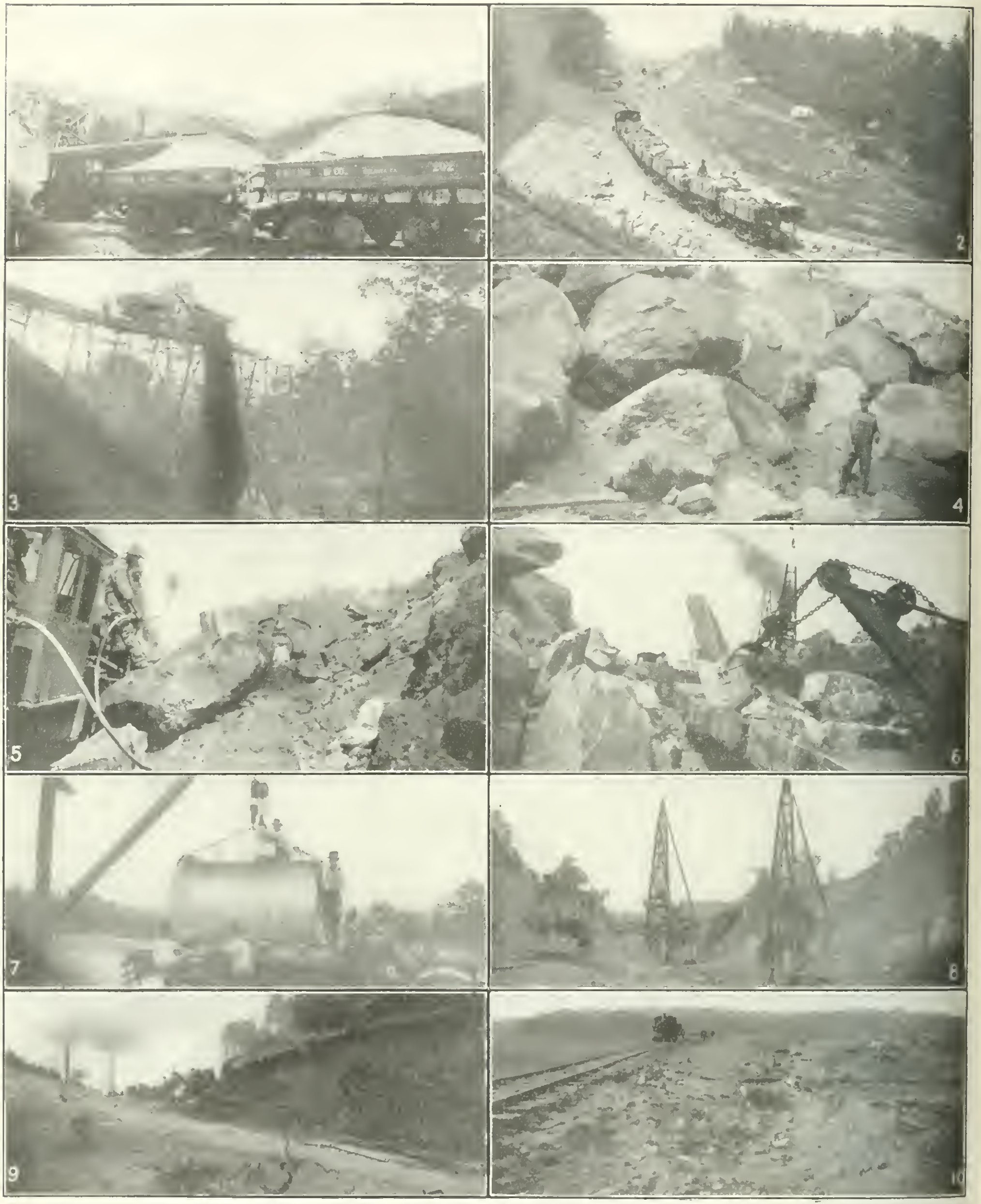

FIG. 6. HEAVY HANDLING IN GRADING 50-MILE SOUTHERN RY. RELOCATION

1—Shovel with 3½-yd. dipper loads 12-yd. air-dump cars on C. W. Lane's section. 2—One of Sheahan's trains of 4-yd. cars making a high fill. 3—Dumping 4-yd. cars from a 50-ft. trestle; cars sent out on trestle by thrust from dinkey, and are recovered by cable. 4—Large rocks piled temporarily by shovel. 5—Breaking up these rocks by drilling and shooting; drills take steam from dinkey boiler. 6—Shovel loading the broken rock into 4-yd. cars. 7—Few men required to load large concrete pipe on Sheahan's work. 8—Well drills working ahead of shovel in rock cut. 9—Old Vulcan shovel handling 17,000 yd. of rock per month. 10—Spoil from the Vulcan shovel is hauled to this 5-acre waste dump. Yardage wasted here exceeds 200,000.

backs down on the outside track and dumps. It then runs down the fill and backs to the shovel.

This procedure is not conducive to extremely fast progress, but it appears to be the only one practicable under the circumstances, these circumstances comprising th jacking and throwing of track. Another method would be to erect a trestle, dump from it and widen the top of the fill to permit the erection of another trestle, and repeat. The jacking method is slow. Its chief applications are to widen the top of a fill or to raise a fill a comparatively short distance.

Just over a hill adjoining the big fill, and on the new line, a 1-yd. shovel is digging its way through at the rate of about 14,000 yd. per month. The spoil is hauled by 12 Western three-mule wagons to a small fill 600 ft. north of the shovel. When the shovel started into this hill, the haulage was difficult and a mule snatch was necessary in order to pull the wagons to safety. The lift was 30 ft. in 100 ft. The wagons hold approximately 1¼ yd., and about 600 are moved in a 10-hr. day.

The digging was earth at first, but rock was soon encountered, making blasting necessary. As soon as the shovel digs through, a track will be laid for a long haul to the big fill. Some distance beyond the fill is a rock cut containing considerable blue granite, which is very difficult to get out. One of the slopes will be 200 ft. high. An Atlantic shovel is handling the material.

At Ayersville—6 mi. south of Toccoa—a 3½-yd. shovel is working in a long cut containing some rock. The spoil is transported in six-car trains of 12-yd. cars. About ¼ mi. south of Ayersville the new line parallels the old, the two meeting at a fill. Here a trestle has been built on the side of the old 70-ft. fill. Material is brought to this fill from the long cut, the cars being backed out on the trestle, which is not intended to carry a dinkey. The new fill will be about 10 ft. higher than the old. Below is a 4x4-ft. concrete culvert. The concrete materials are delivered on the old fill, by railway, and chuted to the bottom. The concrete is mixed by hand on a large board.

OLD STEAM SHOVEL WORKS WELL

At the extreme end of Lane's section, and in sight of the well drills of H. S. Dunavant & Co., a very old 3-yd. Vulcan 70-C shovel is working in a 100-ft. cut containing considerable blue granite with mica. A Cyclone well drill puts down 35- to 40-ft. holes. In the granite it is usual to make 35 ft. of 5-in. hole in a day. In the soft rock five holes, 100 ft., are put down in a day. The drill pulls itself along by cable.

The shovel handled 26,000 yd. (50% rock) in August, and 17,000 yd. (90% rock) in September. It is possible that 75,000 yd. from this cut will be used on a fill to the north; if so, a trestle will have to be constructed across the main line. Otherwise, all the material from this cut is wasted on a 5-acre tract purchased for the purpose by the railway (see views 9 and 10 in Fig. 6). The material is hauled to the dump in 6-yd. Kilbourne & Jacobs cars drawn by 20-ton standard-gage saddle-tank dinkeys.

When the shovel has almost completed a trip through the cut, a track is laid behind the shovel. By the time it has finished its trip, the track is ready for quick backing to position for starting the next trip. During this second trip the track on which the shovel backed is used as a loading track for the dinkey trains. The shovel has been moved back a distance of 600 ft. or so and started digging in a period of 6 or 7 hr. It was turned around, by throwing the track, in one day. The Vulcan shovel loads cars on a 5-ft. bank.

About a mile south of Seneca, S. C., Hickey Bros. (associated with Robert Russell) are making a long fill having a maximum depth of 42 ft.—the heaviest fill on the northern end of the line. The material—rock and earth, the latter being borrow—is hauled 1½ mi. by two 6-wheel (driving) switchers, having a short wheelbase. The train consists of ten to twelve 12-yd. cars. Between the 2½-yd. shovel and the dump there are three passing tracks. With this plant as many as 279 cars have been moved in a day. Although the cut contained 300,000 yd., this was not enough to make the fill; hence the borrowed earth, which is obtained from the south end of the cut. Later the haul will be 2 mi. The material in the cut was about 75% blue granite and 20% soft rock.

BIG LOCOMOTIVES HANDLE RECORD AMOUNT

Two lengths of trestle were still open in the fill on Oct. 1. One of these was several hundred feet long, the other less than one hundred. Suddenly it was decided to construct an underpass at the shorter trestle, which is located between the shovel and the long dumping trestle. In order to proceed with the filling of the latter the shorter trestle was greatly strengthened by the addition of bents, bracing and longitudinal stringers, so that the heavy loaded trains could pass over it without noticeable vibration.

The entire fill was made by dumping from trestle, being carried to grade by jacking the track. Ordinarily it would have been widened by throwing the track over, but a curve in the line made this impracticable. A Western spreader is used. It is pushed by a 50-ton four-wheel switcher, and this outfit passes over the reinforced trestle without danger.

At the Seneca depot the old and new lines converge, the new dropping about 5 ft. below the old several hundred feet south. Here, the cut has been made wide enough for one track. When this has been laid, it will be used for traffic, and the old track will be removed and the cut widened for the second track. At present the cut is so close to the existing track that a crosstie shows through here and there. The earth is firm, however, and no underpinning is used. The cut is from 10 to 20 ft. deep. Final grading on this strip was completed by three wheeled-scrapers, a plow and two snatch teams.

DOUBLE-TRACKING BETWEEN WASHINGTON AND ATLANTA

The entire line of the Southern Ry. between Washington, D. C., and Atlanta, Ga., will ultimately be double-tracked. This work is now going on at numerous points. The grading from Atlanta to Cornelia is completed. The work from Cornelia to Central, S. C., has been described in this article. From Central to Spartanburg, S. C., the grading is finished, while from Spartanburg to Charlotte, N. C., a distance of 75 mi., no work has been done; but it is probable that contracts for this grading will be let next season. From Charlotte north, about 210 mi. of line has been practically finished; from Arrowhead north, 121 mi. has been completed, and 16 more will be finished by the end of 1917.

All this double-tracking work is under the supervision of W. H. Wells, Construction Engineer of the Southern Ry.; R. F. Ezzell, Principal Assistant Engineer, Charlotte, N. C. J. O. Parsons, Assistant Engineer, is in charge of the work between Central and Cornelia, his office being at Toccoa.

Irrigation Field Laboratory at Denver, Colorado

By R. B. Sleight*

Coincident with the establishment, in July, 1915, of a district office of the United States Office of Public Roads and Rural Engineering at Denver, Colo., arrangements were begun for a field laboratory for irrigation research. This plant is maintained by the Division of Irrigation Investigations for the purpose of studying from an engineering standpoint such subjects as evaporation from water and soil surfaces, percolation and movement of water in soils, maximum duty of water for standard crops and similar problems. It is to be a field laboratory of such size and kind that natural phenomena can be observed under conditions somewhat less artificial than has been the practice.

A tract of land was selected in South Denver. A 12-in. main of the Denver Union Water Co., from which the water-supply is obtained, runs along one side of the lot. Electric power is available; sewer connection is possible; two car lines into the city are 300 ft. away; and the land is within the delivery limit of the Denver firms from which supplies are purchased.

Contrary to what might be supposed from noting the facilities mentioned, the tract has an exposure equal to that of a prairie homestead. To the north the adjoining territory is only partly built up with a few low houses. The east, south and west sides are open for from $\frac{1}{2}$ to 5 mi. The topography is such that one-half of the tract is practically level, while the other half slopes off rapidly to the south. A grade of 20% is possible on this slope.

Since the research work is nearly all carried on in the field, a small shop and record office is the only building that has been necessary. However, the experiments in progress during this first year have required the construction or purchase and installation of a considerable amount of apparatus. A standard instrument shelter of the Weather Bureau is in use at present for housing, in addition to the maximum and minimum registering thermometers, a Piche evaporimeter, a hygrograph and a thermograph for air.

Supplementary to the usual two readings a day, which is as far as the ordinary meteorological observations go, continuous records made by recording instruments are kept of relative humidity, temperature of the air, temperature of water in one of the evaporation tanks, rate of evaporation from this same tank, barometric pressure and wind movement as shown by one of the anemometers. Two anemometers are in use at the laboratory, one located near the ground and the other on a tower.

For this meteorological observation work standard instruments furnished by commercial instrument makers are in use with one exception. For recording rate of evaporation from the surface of one water tank the Hoff evaporimeter, designed and built by Edward J. Hoff, of the Division of Irrigation Investigations, is in use[1].

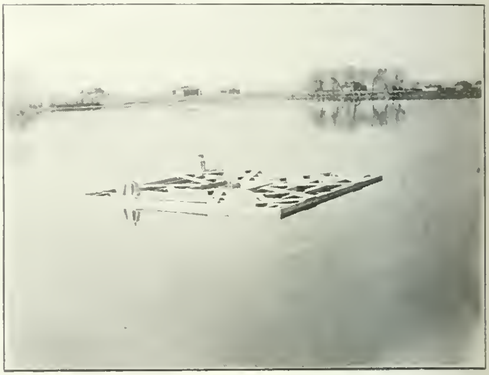

FIG. 2 FLOATING TANK FOR EVAPORATION EXPERIMENTS, WASHINGTON PARK

The equipment includes one mountain barometer, one barograph, one thermograph for air, one thermograph for water, one hygrograph, one anemometer register, three anemometers, five rain gages, one sling psychrometer, one reservoir psychrometer, eight registering maximum thermometers, eight registering minimum thermometers, six soil thermometers, three test thermometers and one standard thermometer. The instruments enumerated, and in

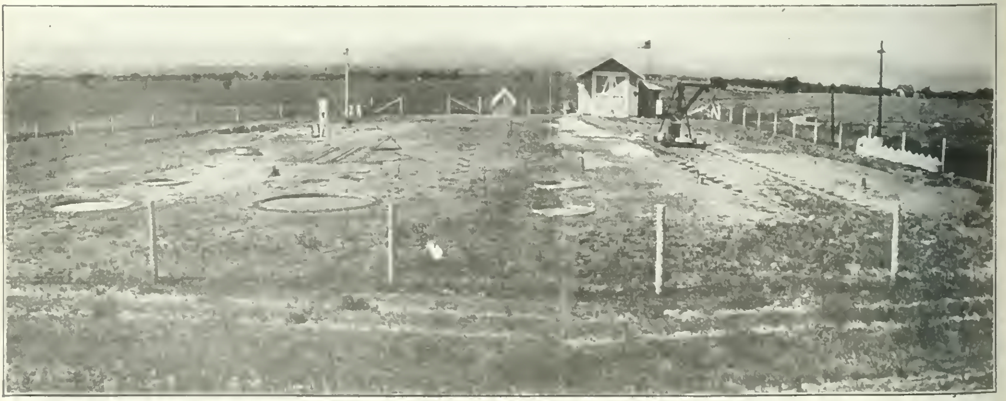

FIG. 1. GENERAL VIEW OF IRRIGATION FIELD LABORATORY AT DENVER, COLO.

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*Assistant Irrigation Engineer, Office of Public Roads and Rural Engineering, United States Department of Agriculture, Denver, Colo.

[1] Described in "Engineering News," Nov. 23, 1916, p. 974

addition one or two standard types of water surface evaporation tanks—the type to be selected at the close of the present season's work—will comprise the permanent meteorological equipment.

The permanent shop equipment consists of such tools as are necessary for building, repairing and installing apparatus for any investigation in progress. Electricity is used for power and in the drying oven. The water-supply is piped to all parts of the tract where needed, with outlet connections every 50 ft. along the pipe lines. Throughout, the laboratory has been arranged and the equipment selected and installed in a manner so that research work may be carried on exhaustively and thoroughly, and still efficiently and at a reasonable cost.

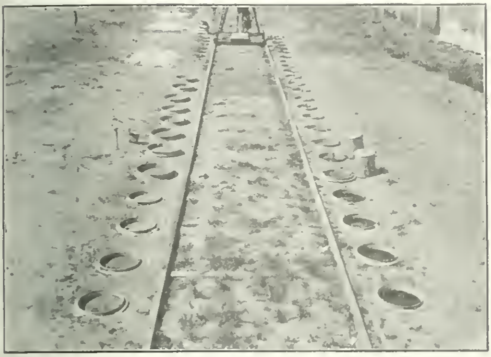


FIG. 3. SAND SURFACE EVAPORATION TANKS, FORTIER TYPE

Irrigation Experiments

During the season 1916 the experiments in progress are such as will form a basis for future research. They are: (1) An investigation of evaporation from water surfaces; (2) a study of evaporation from sand surfaces; (3) a study of evaporation from the surface of the laboratory soil; (4) flow of water in small furrows.

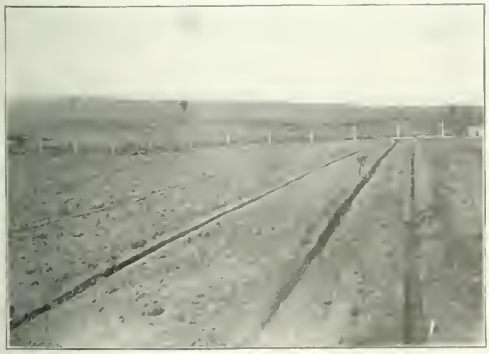


FIG 4 FURROWS FOR TESTING FLOW OF IRRIGATION WATER

Work on evaporation from water surfaces was begun as soon as possible after the establishment of the laboratory. The equipment in use consists of 26 water surface evaporation tanks and necessary gages for making measurements. These tanks range in diameter from 1 to 12 ft. and in depth from 3 in. to 6 ft. A floating tank station is maintained on one of the lakes in Washington Park, ¾ mi. from the laboratory. Provision is made for holding a set of tanks at different temperatures, and another set is equipped in a manner to allow a comparison between the evaporation from flowing water and a still body of the same shape and area. All tanks are of galvanized iron.

The equipment in use for the second experiment consists of a set of 28 double water-jacketed tanks of the type developed by Dr. Samuel Fortier for the study of losses of water from soil surfaces. These consist of an outer galvanized-iron tank inside of which is set a smaller inner tank containing the soil or other material to be used. The whole is set flush with the ground, and the annular space between the two is filled with water. The water jacket makes it possible to control temperature as well as facilitating the operation of weighing.

At the beginning of this investigation samples of river-bed material were secured from each of the principal Western streams. An analysis consisting of sieve separation and void determination was made of each of these samples. From the analysis certain type sands were selected for the purposes of the experiment. Tanks were filled with these type sands.

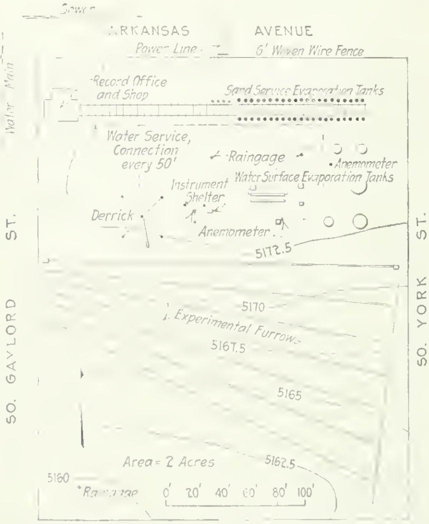


FIG 5 PLAN OF IRRIGATION FIELD LABORATORY

The water level in each tank is held at a certain fixed depth below the surface by adding water two or three times each day. The exact water loss under different conditions is arrived at by weight. A special swing hoist was designed and built for this weighing work. The lightest tank to be lifted and measured weights 370 lb. and the heaviest a little more than one ton.

It is hoped that the results from this experiment will present data from which to estimate the evaporation losses from the beds of such streams as the Rio Grande, the Platte and the Arkansas.

The investigation of evaporation losses from soils is being carried on in the same manner as the one on stream-bed material. It is the basis of more extended work on water losses from irrigated lands and the deposition of salts in waterlogged or wet lands.

The south slope is being used for the fourth experiment of the season. Furrows were prepared on different grades, built to duplicate furrows used in the irrigation of orchards and row crops. Different heads of water, all small, were run in each of these in a manner to correspond with furrow irrigation. Data on the rate of flow, cross-section and grade have been obtained. It is hoped that the results will show whether or not the accepted formulas for flow of water in open channels can be extended to the very small ditches, as well as the flow in furrows. A view of this part of the field is shown in Fig. 4.

During the coming winter season the first work to be carried on under shelter will be started in the shop building. This will relate to the passage of water under pressure through different types of soils.

The Irrigation Field Laboratory is located at 1400 South Gaylord St., Denver, and forms part of the equipment of the Division of Irrigation of the Office of Public Roads and Rural Engineering, of which L. W. Page is director. The experiments have been planned and directed by Dr. Samuel Fortier, chief of the Division of Irrigation, while the writer has had much to do with the design and construction of the plant and has been in direct charge of the experiments from the beginning.

* *

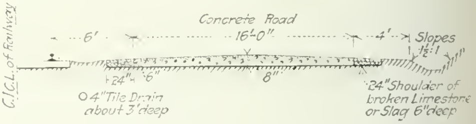
Concrete-Road Construction in Michigan

SYNOPSIS—This road was built alongside an interurban railway, which introduced drainage difficulties. Gravel concrete was used, and of special interest was the employment of machinery for floating the surface and placing the expansion joints. The plant and construction methods are described.

The concrete road between Royal Oak and Pontiac, Mich., has one side of the right-of-way occupied by the Pontiac double-track interurban line of the Detroit United Ry. This makes it impracticable to use the ordinary side ditches, so that special arrangements had to be made for carrying off surface water. The road has a heavy traffic of automobiles and motor trucks. The concrete road is 16 ft. wide and is built on an old gravel road. There is a 2-ft. shoulder of crushed stone on each side, and the inner edge of the concrete paving is in general about 6 ft. from the rail of the nearest track. The country is rolling, and in places there is a succession of grades of 3 to 6%, as shown in Fig. 1. Fig. 2 is a typical cross-section.

FIG. 1. REINFORCED-CONCRETE ROAD BESIDE INTERURBAN RAILWAY: ROYAL OAK TO PONTIAC, MICH

Drainage is provided for on the outer side of the road by an open ditch. On the inner side a drain of 4-in. vitrified tile is laid under the space between the road and the track, with iron-grated inlets at drainage points or sags.



C.L. of Railway
Concrete Road
6'
16'-0"
4'
Slopes 1½:1
24"
6"
8"
O 4" Tile Drain about 3' deep
24" Shoulder of broken Limestone or Slag 6" deep

FIG. 2. CROSS-SECTION OF ROAD FROM ROYAL OAK TO PONTIAC, MICH.

The joints in the tile drain are wrapped with tar paper to exclude the entrance of earth or other solid matter. Laterals of 12-in. vitrified tile are laid under the road and railway at drainage points.

The grading was heavy for 7 mi. and light for 4 mi. After the old road surface had been sacrificed and the necessary grading done by a Thew steam shovel, the 16-ft. subgrade was well rolled with a 10-ton roller. Grade stakes for the concrete were then set at intervals of 100 ft. by means of a level, and intermediate stakes at intervals of 25 ft. were set by sighting over targets on the main stakes. Steel side forms were next placed. These were of the Baker type, 6-in. pressed-steel channels in lengths of 12 ft. supported by steel stakes.

The concrete is 8 in. thick in the middle and 6 in. at the side, the bottom being flat and the top crowned ¼ in. per ft. It is reinforced with a strip of American woven-wire fabric, 10 ft. wide, placed about 2 in. below the top surface and laid to within 6 in. of each expansion joint. These joints are of the Baker armored type, at intervals of 30 ft. An interesting feature was the placing of these joints by machine, as noted below.

The concrete is a 1:1½:3 mix. The coarse aggregate consisted of washed and screened gravel, graded from ¼ to 1½ in., while the fine aggregate ranged from ¼ in. down. At times the gravel contained an excess of the larger sizes, in which case the sand was increased to make a 1:2:3 mix, to insure filling of the voids. An unusual feature is that the concrete was made in a relatively dry condition, the working given it in the finishing process being relied upon to flush sufficient water to the surface. It was considered that a better and stronger concrete could be made in this way than by using a wet mixture.

One of the most interesting features of the work was the use of a Baker finishing machine. It consists of a transverse frame of steel beams, having its ends carried by wheels that ride on the steel side forms. It hauls itself ahead by means of drums having cables anchored ahead. The machine carries a templet, a compressing pan and a finishing float, all adjustable to the desired cross-section of the road and having an oscillating motion in a horizontal plane. The mechanism operating these parts and the cable drums is driven from a 3-hp. gasoline engine mounted on the machine.

As the machine pulls itself forward (at a rate of about 100 ft. per hr.), the rough concrete is first struck to the proper cross-section by the strike templet and is then compressed by the pan, which is set at a slight incline so as to press against the concrete, squeezing out air bubbles and excess water and filling all voids so as to make a dense surface. At the rear of the machine is the finishing float, which gives the final dressing and leaves a smooth surface. This machine weighs about 3,600 lb., and its surfacing parts exert a pressure of approximately 80 lb. per sq.ft. on the concrete. It is built by the R. D. Baker Co., of Detroit, Mich., which company uses it on its own work and also sells it to other contractors.

Behind the finishing machine was drawn a new joint-installing device that is being perfected by the same company. This consists of a frame carried on two truck wheels. It has a plate curved to the crown of the road and holding the Baker expansion joint. When it comes to the place for a joint, the plate is inverted, and by means of a slight sawing motion and vibration the joint is forced down through the green concrete.

CONCRETE MIXING AND PLACING

For the concrete road built in 1915 the gravel was delivered in drop-bottom cars on a siding of the interurban line and dumped into a track hopper from which a Weller conveyor carried it to a Stocker washing and screening plant. This plant had storage bins for 100 tons of sand and 100 tons of gravel. For the 1916 work, the gravel was obtained from a pit at Pontiac, where a Dull screening and washing plant was installed. The product was delivered to the storage bins by motor trucks, which ascended an incline of 6% grade, ran over the top of the bins to dump the material and then backed down.

From the bins the materials were delivered by chutes to the 1½-yd. steel dump-cars of a Koppel industrial railway of 24-in. gage. The railway was laid along the subgrade and was built with 16-ft. sections of track having light rails riveted to flat corrugated-steel ties. As the profile was very irregular, with grades of 3 to 6%, the trains of 10 cars were operated by a 13-ton Shay-geared locomotive. The materials were delivered in continuous stock piles along the work and were carried to the mixer by wheelbarrows.

The 16-cu.ft. Koehring mixer was equipped with a batch meter adjusted to retain each charge for 12 revolutions, or a period of about 45 sec. The machine traveled on the center line of the road and distributed the concrete by means of a drop-bottom bucket on a swinging boom that covered the full width between side forms.

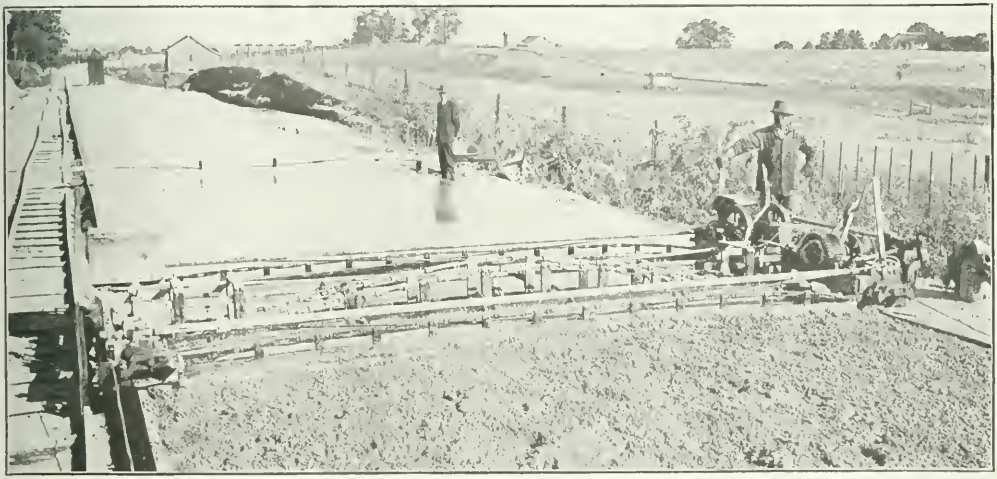


FIG. 3. THE BAKER MACHINE FOR FINISHING CONCRETE ROADS WITHOUT HAND FLOATING

The rough concrete in the foreground shows the comparatively dry mix used, the machine working the water to the surface as shown by the finished concrete in the rear. The bridge beyond the machine is for the hand floating at expansion joints. At the left is the industrial railway for distributing concrete material. This occupies the space for the stone shoulder of the road

With a gang averaging 30 to 35 men the work progressed at the rate of 450 to 600 ft. of road per day. The main part of the gang was distributed as follows: 1 on the steam roller, 3 with the material train, 2 trackmen, 12 wheeling material to mixer, 2 on the mixer, 3 spreading concrete, 1 operating the finishing machine.

The cost was about $13,500 to $15,500 per mi. of road. On half the work the grading cost $11.22 per 100 ft., and concrete cost $1.27 per sq.yd. On the remainder of the work these costs were $20 and $1.10 respectively. About 5½ mi. were built in 1915 and 1½ mi. in 1916. The R. D. Baker Co., of Detroit, Mich., had the contract for the entire work. The road was planned and surveyed under the direction and requirements of the State Highway Commission. M. De Glopper, County Engineer, Pontiac, Mich., represented the county during the construction of the work.

A City River-Control Reservoir and Plans for Operation

By completing its Milton reservoir on the Mahoning River, the City of Youngstown, Ohio, has acquired the distinction of possessing one of the few low-water river-control reservoirs in the United States—probably the only municipal reservoir of the kind on this side of the Atlantic. Frank M. Lillie, city engineer of Youngstown, has been in charge of the project from start to finish and will have the responsibility of planning the system of operation.

The reservoir is formed by a rolled earth embankment about 40 ft. maximum height and a concrete spillway of typical overfall dam section, 638 ft. long. Plans were shown and the construction described in *Engineering News* of Mar. 11, 1915, pp. 468-471. From the construction standpoint the distinguishing element of the dam is the upstream cutoff, a composite concrete and steel-sheetpile wall going 25 to 30 ft. down to rock, and the joining of this wall to the concrete paving of the upstream slope. The upper half of the upstream slope is paved with 18 in. of "riprap," which really is block-stone pavement, laid dry and then grouted solid with 1:3 cement mortar. The downstream face may be paved or sodded; the decision has not yet been made, but to simplify the maintenance work it is likely to be paved, either dry or grouted.

A new safety element has been added to the dam by detailing the concrete walkway on the top of the dam with a 24-in. concrete wall, 2 ft. high, along its upstream edge. The concrete of wall and walk is carried over 18 in. deep to join the upstream pavement. The embankment now has the safety margin of spillway overflow depth of 11½ ft. (in place of 9½ ft. without the wall) and in addition the margin afforded by flow around the ends: the adjoining ground surface at both east and west ends is level with the embankment crest and therefore will spill water over a width of several hundred feet before the crest wall is overtopped.

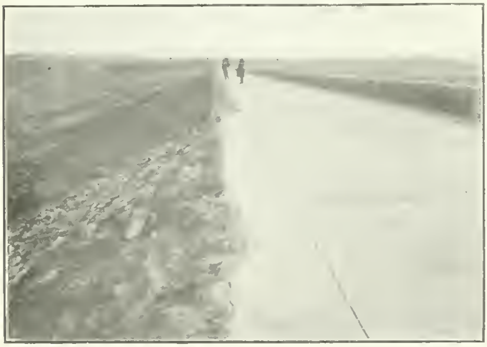


FIG. 1. DOWNSTREAM SLOPE, A SHORT SECTION PAVED

No water has been impounded as yet. The four 60-in. conduits through the west spillway abutment are kept open, as the small present flow is needed in the river. The conduits have gate valves whose stems go up vertically to the top of the abutment and there have manual winch-and-gear mechanism for operation. The four individual gate chases are closed off toward the reservoir by bar screens extending from bottom to top of the abutment.

Two inches of runoff from the 300-sq.mi. drainage area of the reservoir will fill the basin. The spillway can discharge in 24 hr., at 5-ft. depth on the crest, an amount equal to 3 in. of runoff, and at 10-ft. depth nearly 9 in. of runoff. The spillway therefore is amply proportioned.

The volume of the spillway discharge is very great. At 5-ft. depth of overflow the discharge will be nearly 25,000 cu.ft. per sec., or 40 cu.ft. per sec. for each foot of length; at 10-ft. depth these quantities become 130,000 cu.ft. per sec. and 200 cu.ft. per sec. per lin.ft. Up to the present no artificial provision has been made to take care of this flow below the spillway; the concrete ogee ends at the structural toe of the dam, and the dam has been so stepped off that the horizontal discharging surface is practically flush with the natural surface of rock.

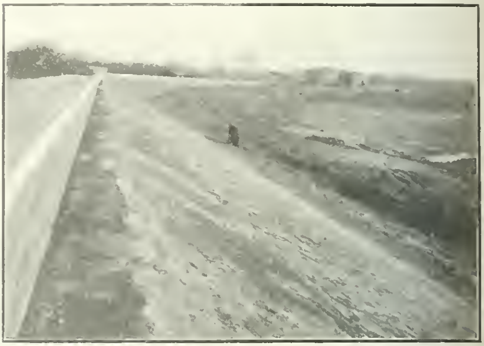


FIG. 2. GROUTED PAVEMENT OF UPSTREAM SLOPE

The main use of the reservoir will be to increase the river flow at Youngstown, 35 mi. below, in order to make more water available to the steel mills for cooling purposes and in consequence obtain cooler and less polluted water at the city water intake, which is near the center of the city. As the consumption by the city had approached dangerously near the extreme dry-weather flow of the river, an increased supply was a necessity.

As matters stand now, in the summer months the river water is used five or six times over by the mills for cooling purposes before it reaches the city intake. The hope is that with the reservoir the low-water flow will be increased four or five times.

The reservoir is capable of supplying half the annual mean flow for a period of two months. Since the drainage area at Youngstown is about three times the drainage area at the dam, the amount of increase at Youngstown is considerably less.

Over how long a period the reservoir storage must be spread will have to be determined by judgment each season. To furnish a guide, equipment will be installed for routine measurement of river flow above the reservoir, discharge below the reservoir, and rainfall. Rainfall observations near the dam site were started a year ago. They will be continued at the operator's house, close to the east end of the dam.

It is expected that the routine records and the record of accumulated runoff will enable the city engineer's office to direct the gate operation prudently enough to utilize the stored water with satisfactory efficiency. Some useful effect of the reservoir in reducing floods is, however, also looked for, as the high floods are nearly always springtime occurrences.

The reservoir is likely to be of scenic and recreational value. Real-estate development for summer cottages is already in progress. With regard to this and to boating, as well as the preservation of fish in the reservoir and avoidance of nuisance from exposed bottom areas, it is intended to fix a normal low-water limit for the reservoir, beyond which it would not be drawn down except in the extreme seasons. Such a limit must be decided upon before a storage and control schedule can be established.

The reservoir is under the jurisdiction of the Department of Public Service of Youngstown, under Harry Parroch, Director, and Frank M. Lillie, City Engineer. Its total cost has been about $1,200,000 to date, which will be increased slightly by cleanup work. Of this total, $243,000 represents the cost of real estate, and the rest is construction cost.

⁂

Combined Steam and Gas Power Station at Ford Plant

The plant of the Ford Motor Co. in Detroit, furnishing power for its shops, is one of the most novel and economical factory power stations to be found. It is described at length by Thomas Wilson in *Power* for Nov. 21, 1916, and from this article the following brief description is abstracted:

The combined gas- and steam-driven units were dictated by local conditions. The water-supply was insufficient for the condensers required with a steam-turbine installation; direct-current generators were advantageous for the shop drive; the combination units had gas engines on one side of the generators for economy and steam engines on the other side for reliability and regulation.

The engine units are arranged as cross-compound sets; there is a tandem compound gas engine on one end of the generator shaft and a tandem compound steam engine on the other end. There are at present four 6,000-hp. and one 5,000-hp. units; four more of the 6,000-hp. sizes are to be added. The generators are 250-volt two-wire direct-current machines. For the larger units the generators are rated at 4,000 kw.; for the smaller units, at 3,000 kw. The gas engines are of a four-cycle double-acting type with 42x72-in. water-cooled cylinders. The steam engines have 36 and 68x72-in. cylinders. The engines were made after the Ford company's design by the Hooven, Owens & Rentschler Co., of Hamilton, Ohio. The generators were made by the Crocker-Wheeler Co., of Ampere, N. J.

Ordinarily the load is carried as much as possible on the gas-engine side. At maximum load it is equally divided. The gas engine is connected to the governor of the unit, but it exerts no influence up to normal speed; above this it throttles both gas and air. The steam engine does the regulating and meets the load fluctuations. When the main circuit-breaker opens, the ignition circuit of the gas engine is opened and the gas throttle-control magnet closes—in addition to the regular action of the governor on the steam engine.

The various gas, water and steam circuits arranged for securing maximum utilization of heat are briefly as follows: Producer gas averaging 140 B.t.u. per cu.ft. is supplied to the gas engine; the exhaust passes through a water-cooled discharge line to superheating receivers between the high-pressure and low-pressure steam cylinders. Part of the gas from here is shunted through the high-pressure steam-cylinder jacket to maintain a temperature of 500° in the jacket. All the exhaust finally goes to the feed-water heater and is ultimately exhausted up through ejectors in the 207-ft. boiler stacks, increasing the draft for the boiler flue gases.

Cooling water for the gas engines comes in at 65° and leaves at 195°, going to an air-separating tank first and from there (as much as required) to feed-water heaters, pumps and the boilers. The excess, together with the condensate from the surface condenser, goes to the water-supply for sprinklers, cooling, etc.

Steam comes from the boilers (which are the largest yet built) at 175-lb. gage and 600° to the high-pressure cylinders (gas jacketed). From these it passes to the intermediate receivers (gas superheated) and thence to the low-pressure cylinders and the surface condenser. The condensate, as already noted, goes back to the water-supply. Eventually, if needed, the condensate may be used for boiler feed. The cooling water for the condenser comes from the general supply pressure tank. In summer the cooling water is led from three ponds on an adjoining roof by gravity through the condensers to suctions of circulating pumps that force the water through the spray nozzles over the cooling pond. In hot weather one-half the water circulated is bypassed around the condensers and re-sprayed to increase the cooling effect. In cold weather the cooling water is circulated through a hot-blast heating system instead of the cooling pond. This heating system cools the water enough to give a possible 26-in. vacuum in the condenser, although a 20-in. vacuum is designed for ordinary operation. The power and heating requirements will ordinarily balance; but if the amount of steam should prove inadequate for the shop heating, small boilers can be used as boosters for the circulating water to increase its temperature before it goes to the blast coils.

Tests have not been completed, so that only estimates of the efficiency of the plant are possible. Taking the guaranteed and expected performances of the different parts of the system, it is estimated that 57% of the heat in the coal is utilized—20% in switchboard power and 37% in plant service.

⁂

Subsidence of Buildings in Cheshire, England, as a result of salt-mining operations, is described in a recently published book entitled "Salt in Cheshire," by Albert F. Calvert (Spon & Chamberlain, New York). According to the accounts in this book, Northwich, England, has suffered much more severely from subsidence due to salt-mining operations than is Scranton, Penn., from the coal mining carried on beneath it. Enormous deposits of rock salt underlie Northwich. At one suburb called Marston the salt is in places 182 ft. thick. In the early days of the salt industry in Cheshire, in the beginning of the last century, the salt was extracted by mining. To support the roof above, which was about 130 ft. in thickness, pillars were left 24 ft. to 30 ft. square at intervals of about 75 ft. Later on the mines became flooded, and the bottom of the salt pillars was dissolved, removing the support of the roof. With the flooding of the mines, brine pumping replaced the salt mining. The subsidence that has taken place in recent years is due to the gradual washing away of the underground strata of salt. The companies pumping the brine are now compelled to pay a tax of about 5c. per thousand gallons, to provide compensation for property owners whose buildings are injured by subsidence as well as for those whose lands are submerged.

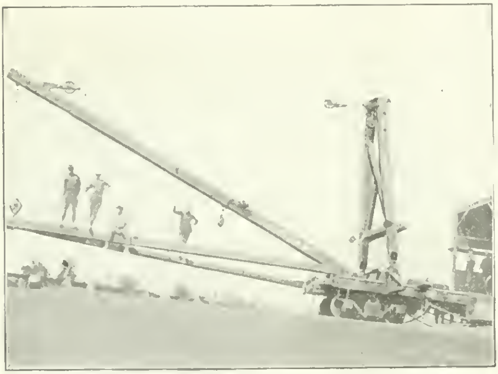
Notes from Field and Office

Machine rapidly shifts construction track—Surveying methods used in driving Strawberry tunnel—When jacks failed under a 400-ft. 700-ton bridge span; levers substituted—Charts for eccentric loading on rectangular areas

Machine Shifts 3,000 Ft. of Track in Half Day

At the Hill Annex iron mine at Gilbert, Minn., the dumps extend three or four miles, and there is a vast amount of stripped material to be handled, necessitating a constant shifting of track to the edge of the dump. The latter work was formerly done by hand, but a machine is now doing the work for A. Guthrie & Co., according to L. A. Rossman, of Grand Rapids, in *Engineering and Mining Journal*.

This machine is the result of several years of experimentation, as the contractors started to work on it several years ago when engaged in railroad operations in the West. A number of types were evolved, but the present one has given the best satisfaction. The contrivance resembles a wrecker in its general appearance. There is a boom about 40 ft. in length, and a wire rope, through pulleys, is fastened to the track for the purpose of lifting it up. On a level with the base of the machine is a side boom by which the track may be pulled sideways if desired. The operation is to attach the rope from both booms. The regular boom lifts to the required height, while the side boom is used to swing the track over to the desired place. There is one hoist of regular type and a horizontal boiler which furnishes the steam. The machine is self-propelled in the same manner as a steam shovel.



TRACK SHIFTER FOR STRIPPING OPERATIONS

This device can throw a track over 6 ft. at a time, though the work must be done gradually to avoid either bending or twisting the rails. The method followed is to shift a track over 4 or 6 ft. and then move back 30 ft. and make a like move. The shifter has moved as much as 3,000 ft. of track a distance of 10 ft. in half a day, or more than 40 men could do in a whole shift. While the machine requires but few men to operate, it will do as much work as 40 or 50 men and was a great labor saver during the last summer, when common labor was very hard to obtain.

⁂

Tunnel Survey Methods Used in Driving Strawberry Tunnel

By L. M. Hammond*

The Strawberry tunnel, constructed by the United States Reclamation Service in connection with the storage works of the Strawberry Valley Irrigation Project, is located under the rim of the Great Basin, in Utah and Wasatch Counties, near Provo, Utah. The tunnel is about 3½ mi. long and is straight for its entire length. The finished section is 7 ft. wide by 8 ft. 6 in. high, with an arched top. About 3 mi. of the tunnel was driven from the lower or west portal, and ½ mi. from the upper or east portal. As Project Engineer, J. L. Lytel was in charge of the construction of the tunnel, while the engineering work was in direct charge of F. W. Cater, Assistant Engineer. Several other engineers, of whom the writer was one, were employed from time to time on the routine engineering work.

The profile of the ground surface along the tunnel line was such that only two intermediate set-ups were necessary between the two portals. Four large concrete monuments were therefore placed along the tunnel line, one just beyond each portal and one at each of the two intermediate points. The exact location of the line on these monuments was checked from time to time and was finally decided upon some time before the work was started at the east portal. Two independent "double rodded" level lines were run along the wagon road between the two portals, a distance of about 7 mi.; and as these checked by less than 0.10 ft., which was close enough for construction purposes, no further work was deemed necessary. The distance along the line (about 3½ mi.) was determined with a slope board. Two independent measurements gave results differing by less than a foot, and so it was not thought necessary to determine the length by triangulation. This work was done by the resident or assistant engineer in charge and one or two rodmen, as necessary.

CONSTRUCTION LINE IN TUNNEL

The construction line in the tunnel was carried on screw hooks placed on the center line of the tunnel, either on wooden plugs driven into holes drilled in the roof, or on timber sets where convenient. These screw hooks were placed 50 ft. apart throughout the tunnel, and a new one was placed whenever the last one became 125 ft. from the heading. In order to facilitate the handling of muck-cars in the heading a section of double track, about 200 ft. long and with a switch at either end, was kept as close to the heading as possible. Hooks to be used as set-up points were set with special care at a point approximately in the center of this section. By setting the transit up in this particular spot it was possible to move empty muck-cars from a point ahead of the transit to the heading and back, leaving them (when loaded) on the other track, but still ahead of the transit. In this manner, construction work was not in any way interfered with, which is perhaps the most important feature of tunnel surveying.

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*Assistant Engineer, United States Reclamation Service Provo, Utah

A plumb-bob suspended from the previous set-up point and illuminated by electric lights if convenient, and by candles if not, served as a backsight, so that only two men were required for this work, one at the instrument and the other at the foresight. When the screw hooks were placed in plugs in the roof, there was practically no danger of their shifting; but when placed on timber sets, they had to be checked constantly, and it was customary after taking a backsight to check on one or two intermediate hooks before setting the new point ahead.

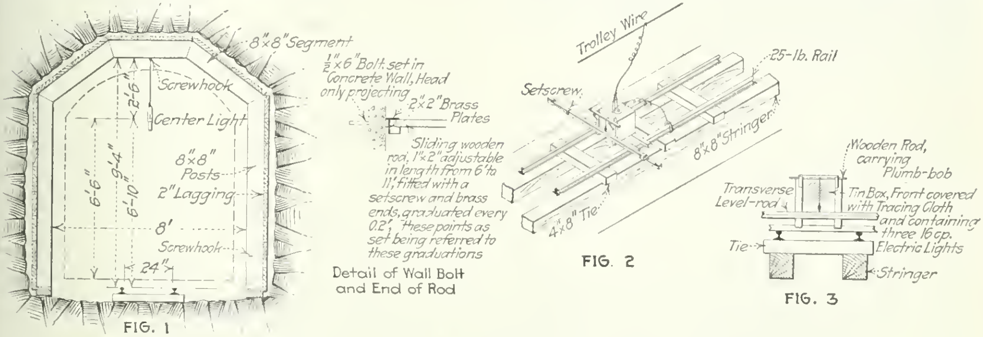
8"×8" Segment
Screwhook
Center Light
2'-6"
9'-4"
6'-6"
6'-10"
8"×8" Posts
2" Lagging
8'
Screwhook
24"
½"×6" Bolt set in Concrete Wall, Head only projecting
2"×2" Brass Plates
Sliding wooden rod, 1"×2" adjustable in length from 6' to 11', fitted with a setscrew and brass ends, graduated every 0.2', these points as set being referred to these graduations
Detail of Wall Bolt and End of Rod
Trolley Wire
25-lb. Rail
Setscrew
8"×8" Stringer
4"×8" Tie
Wooden Rod, carrying Plumb-bob
Transverse Level-rod
Tin Box, Front covered with Tracing Cloth and containing three 16 cp. Electric Lights
Tie
Stringer

FIG. 1

FIG. 2

FIG. 3

FIGS. 1 TO 3. SPECIAL SCHEMES IN STRAWBERRY TUNNEL SURVEY

Fig. 1—Sketch of location of construction-line points. Fig. 2—Arrangement for reading exact alignment on transverse level-rod. Fig. 3—Light-box

After the center screw hook had been set, levels were run, the elevation of the bottom of the hook determined and a grade hook set opposite the center hook and 1 ft. above true grade. This latter was to assist in laying track and placing timber sets. For the leveling, any convenient hook was used as a backsight, and for reasons explained above a sight was always taken on at least one other hook. In using overhead benchmarks it was of course necessary to use the level-rod inverted and to subtract backsights and add foresights.

The location of the center lights and their relation to the screw hooks and the neat lines of the tunnel, are shown in Fig. 1. The elevation of the screw hook once determined, it was an easy matter to adjust the length of the wire holding the center light (a candle stuck in a bushing) so as to bring the flame of the candle to the springing line of the arch. There were two of these center lights, one for each of the last two center hooks set. To avoid confusion a metal tag was kept fastened to the head light. This system of center lights was devised to give the shift boss or superintendent line and grade without the necessity of calling on the engineer at any time of day or night that he saw fit; and it made it necessary for the engineers to go into the tunnel only whenever a new center hook was necessary—at every 50-ft. progress of the tunnel, or approximately every third day. By hanging the two lights on their respective hooks the shift boss had a "line of sight" that would give both line and grade, sufficiently accurate for his purposes, at the face of the tunnel (or any other point) at any time. Having one fixed point, it was easy for him to "spot" the locations of the various holes to be drilled.

Control Line and Grade in Tunnel

Permanent benchmarks (for levels) were placed at various points in the tunnel, and the elevations of the construction points in the heading were checked up from one of these benchmarks at least once a month (from 300 to 500 lin.ft.). The elevations of the benchmarks were checked up occasionally from the portal benchmark. A 22-in. Gurley Y-level was used for all work, and sights were limited to 200 ft. and kept equal. While this instrument was somewhat heavy and cumbersome for tunnel work, the increased accuracy and its ability to hold its adjustments under somewhat trying conditions compensated for the inconveniences.

The apparatus used in checking the line is shown in detail in Fig. 2. For the first 2 mi. of tunnel, concrete monuments were placed at 1,000 ft. intervals along the floor of the tunnel and the line carried on them. At that point, however, a 7-sec.-ft. flow of water was encountered in the heading, which covered the floor of the tunnel with a foot or more of water and rendered useless all the carefully determined and preserved monuments up to that point. An entirely new system of marks was then determined upon and the line rerun several times.

Bolts were set in the concrete wall of the tunnel (or in the rock wall, if the tunnel had not yet been lined) about 1 ft. above the level of the water, with only their heads projecting. Three adjustable wooden rods were then made. The ends were capped with brass and had a small projecting brass lip (as shown), so that the ends of the rods could be made to rest upon and butt against the bolts on either side of the tunnel. The point was then determined on the rod. The rods were graduated to the nearest 0.2 ft., and the points as set were recorded as being so far to the north or south of any one graduation. It was thus an easy matter to take a numerical average of the location of the various shots. The rods were numbered, and the same rod was always used at any particular station. The point as finally determined was marked on the rod, and its location was carefully noted, so that it could be restored if obliterated. As temperature and humidity were practically constant, expansion and contraction was negligible; and it was possible for a point, once determined, to be relocated in practically exactly the same place at any future time.

These "benchmarks" were located at 1,000-ft. intervals (there were 16 between the west portal and the point where the headings met). The foresight was always kept at 1,000 ft., and the backsight was varied between 1,000 ft. and 5,000 ft. according to conditions.

The greatest difficulty, of course, was in getting the line started into the tunnel. In order to avoid heat waves and condensation of moisture, it was necessary to select a time when the temperature inside and outside the tunnel was about the same, but even with the best of conditions it was necessary to take more than 100 shots on each of the first two points in the tunnel before results satisfactory to the observers were obtained. Once inside the tunnel the work was much easier, and from 8 to 24 shots were usually sufficient to determine a point with a fair degree of accuracy.

One of the hardest tasks connected with the engineering on any construction feature, and particularly on tunnel construction, where all the work is being carried on in a very narrow space, is to do the engineering in such a manner and at such times as to cause the least delay and inconvenience to the construction. The superintendent is almost always intolerant of delays, and it is hard to convince him that the engineers have difficulties as well as he. In this case the engineering work was done with practically no delay whatever to the construction work.

Inasmuch as the driving of the tunnel was carried on with three shifts, a great deal of time was lost in disturbing and readjusting the instrument and sights to allow the muck trains to pass. The concreting gang worked only in the daytime; and so this engineering work was done at night, as it would have been absolutely impossible to dodge both muck and concrete trains and still do any work.

Light-Box and Instrument

The method of supporting and illuminating the plumb-bob is shown in Fig. 3. It will be noticed that the plumb-bob, its support and light are entirely independent of the rod on which is the "monument," being supported on the tramway tracks.

Six men were always used on this work, two each at backsight, instrument and foresight. The men at the instrument and foresight took turns with their work, while the extra man at the backsight acted as messenger whenever necessary. Owing to the fact that the work was done at night, in long shifts, in a very wet and comparatively cold place and in a tedious and painstaking manner, it was exceedingly fatiguing to all the party.

The instrument used was a large Berger transit-theodolite. It gave excellent results and held its adjustments well. The instrument used in the construction work at the heading was a small Buff & Berger transit, which did very satisfactory work.

When the two headings met, it was found that there was an error in alignment of 0.18 ft., in grade of 0.13 ft., and in chaining of 2.5 ft. Considering the difficulties encountered and the fact that at no time was construction work interfered with, these results were considered satisfactory.

The methods and apparatus described are not exactly original with this tunnel, they being in some respects patterned after the methods used in the Gunnison tunnel, Colorado; neither can the changes and improvements be ascribed to any one man. They are an evolution rather than an invention.

Raising a Bridge by Levers When Jacks Failed

By W. T. Penney*

The ingenious plan adopted for raising the 640-ft. central span of the Quebec bridge from the scows to the final position reminds me of an emergency caused by the failure of the jacks used in jacking up a 400-ft. span weighing 700 tons.

In December, 1908, after unusually heavy rains, several bridges on the Costa Rica Ry. were washed out. The president of the road, Minor C. Keith (now president of the International Railways of Central America, which operates nearly all the lines in Central America), employed A. W. Buel, Consulting Engineer, of New York, to inspect the washed-out structures and make a report on their reconstruction. One of them crossed the Reventazon, one of the principal rivers in Costa Rica. As this river has a very rapid fall and often becomes a veritable torrent, it was considered unsafe to construct falsework for the erection of the new bridge. It was decided to design a 400-ft. span to be erected on shore and launched into position over a temporary cylinder pier erected in midstream. The span was designed to provide for the unusual strains occasioned by the manner of launching into position, as well as the strains due to the cantilever projection of half the span during launching. The end floor-beams were designed unusually heavy, as all the jacking in raising and lowering the span was to be done under them.

The span weighed 700 tons when erected and ready for launching. The permanent abutments consisted each of a pair of 12-ft. cylinders suitably braced together and filled with concrete. The temporary center pier was a pair of 10-ft. cylinders, braced transversely and guyed with steel cables to the launching abutments. In order to provide for the heavy bending moments in launching, double lines of plate-girder stringers 4 ft. deep were bolted to the bottom flanges of the lower chords, from end to end of the span, to fit roller tracks. The stringers used for this purpose were those permanently belonging to the span and 20 from another span still to be erected.

The available space for the erection of the span on the shore was limited. For this reason, when the erection—beginning at the outer end of the span, which rested on an inshore set of rollers—had passed the central panel of the span, the erection gantry remained stationary and the bridge was launched panel by panel from under it. The last-erected entire panel rested on the rear pair of rollers and the outer end on those placed on the first abutment. After the camber blocks were removed and the span swung, it had already been launched about a third of the way.

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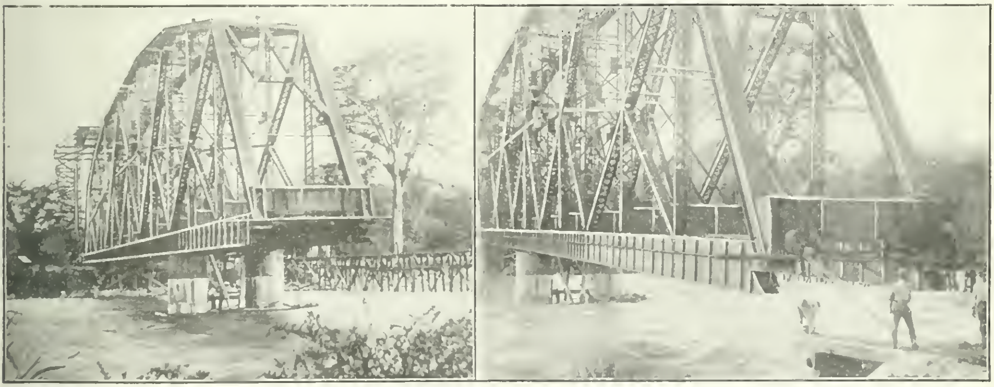
*Guatemala City, Guatemala, C. A.

Each truss was pulled forward by two luff tackles, operated by an estimated initial force of between 65,000 and 75,000 lb. Each tackle consisted of a pair of 20-in. triple blocks rove with $\frac{5}{8}$-in. steel cable lines with a luff composed of a pair of 14-in. blocks rove with a 1½-in. manila line. The latter led to the winch heads of the erecting engines on the traveler; this made a steady, uniform haul.

The steel-cable tackles were secured at one end to loops of wire cable previously embedded in the concrete of the cylinder abutments for this purpose and for use in raising the traveler. The other end of the tackles was chain-hooked to the lower edge of the track stringers and moved back as the span advanced; thus all the work of overhauling the tackles was on the shore. A skidding track of 12x12-in. timbers was placed horizontally in the plane of each truss, between the launching abutments and the temporary rear roller pier. A transverse rail was bolted across the lower flanges of the rolling stringers, just before the latter left the rear roller temporary pier, so that it engaged the longitudinal rails and prevented any possible drop. A precautionary 4-ton counterweight of rails was placed on the rear end of the span, and it passed smoothly from the rollers to the skid rails. The writer suggested that a temporary pilot projection, about 10 ft. long, be built and bolted to the front end of the rolling stringers, so that when the center of gravity of the span approached the launching abutment the ends of the pilot engaged the fixed rollers on the temporary cylinder pier.

As there was a downgrade between the initial and final positions of the bridge, a heavy preventer tackle was provided to control the launching, but this was found unnecessary, as there was no tendency developed to move, except as the bridge was hauled by the luff tackles. The last 100 ft. of launching was assisted by a hoisting engine placed on the opposite side of the river beyond the abutment.



FIGS. 1 AND 2 LAUNCHING A 400-FT SPAN OVER A TORRENTIAL STREAM

There being no anchorages available from which to guy the span transversely during launching, and some precaution against wind pressure being necessary, I moved the heavy erecting traveler to the best position for the purpose and blocked between the roller stringers and the traveler sills, spiking iron plates on the blocking and leaving a space of 1 in. With this arrangement, before the span could get out of line the traveler would have to move sidewise. When the launching was completed, I examined these plates and found them deeply marked from being in contact with the span, showing that the span had been forced back to position by its resistance.

When the span was launched, the end was jacked up to remove the roller bearings on the temporary center pier. It was supported on 7 ft. of blocking above the top of the cylinder abutment. The superintendent decided to raise the masonry 3 ft., to effect a reduction of the grade; even with this modification the bridge had to be lowered 3½ ft. The work was commenced with a number of 50-ton Norton jacks. Every precaution was taken to load these jacks uniformly, but three of them failed completely, and the remaining jacks were not sufficient to raise the load.

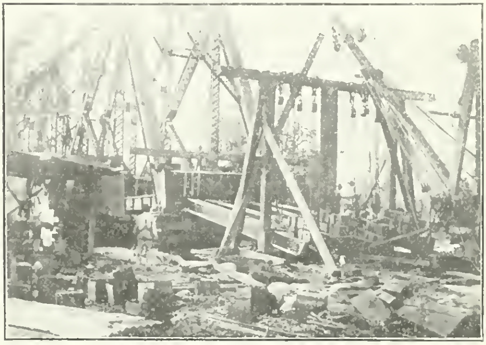


FIG. 3. LEVER RIG RAISING THE END OF REVENTAZON RIVER BRIDGE

To avoid delay an improvised method of lowering the bridge was devised by the writer and by the superintendent of bridges, R. Schutt, and was used successfully.

Four end posts of another bridge on the line, which happened to be available, were borrowed and used as levers. As these posts were 50 ft. long and weighed 6 tons each, they made serviceable levers. The short ends of the levers engaged the lower side of the end floorbeams. These beams had been reinforced for jacking, making them amply strong for the lever strains. In order that these posts could be easily and quickly handled and in view of the short ends requiring little movement, they were supported by a steamboat ratchet, one end hooked to a timber placed across the span, the other ends to the levers. As the opposite ends of the levers had to be raised about 18 ft., they were operated by tackles from a bent placed for this purpose. This bent, built of 12x12 timbers, had a leg on each side of all the levers, thus virtually forming a slot for them to work in and preventing any side kick when carrying the load. As a further precaution against this danger the end of the span was cross-guyed with chains and steamboat ratchets. The heels for the levers were of sawn oak 6x12 in. by 12 ft. cross-piled, with fulcrums consisting of car axles laid on steel plates placed on top of the cribs.

The fall lines of the lever tackles ran to the winch heads of a hoisting engine. The ends of the levers were 18 ft. above level when finally placed. When all was ready, the levers were lowered and their supporting tackles overhauled. It was supposed that the weight of these immense levers would raise the span, but it never moved. There being a pile of boxes of rivets near-by, one box was placed on the end of each lever—it took eight boxes on each lever to raise the span, or 32 boxes in all; they must have weighed some 200 lb. each.

When the span did rise, it came up as easily as a pair of scales, the levers coming down on blocking already prepared for them. When the cribbing under the spans, consisting of rail ends 4 ft. long—afterward incased with concrete—was properly adjusted, the boxes of rivets were removed, one at a time. This operation was repeated for each 6 in. height of blocking to be removed. A total of 3½ ft. lowering was accomplished in 20 hr. The launching of the span occupied 10 hr., one-half of which time was consumed in overhauling and adjusting the tackles.

The scheme of erection was that of A. W. Buel in consultation with Minor C. Keith. Mr. Buel also designed the erecting traveler. The bridge was designed and fabricated by the Baltimore Bridge Co., H. D. Bush, Vice-President and Chief Engineer, H. W. Shaw and George F. Dilly, Assistant Engineers. The erection was done under contract by the writer. R. Schutt was Superintendent of Bridges and Buildings for the railway.

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Charts for Eccentric Loading on Rectangular Areas

By S. M. Cotten*

The charts presented herewith give a graphical solution of the foundation-pressure formula $s = \frac{P}{L}\left(1 \pm \frac{6e}{L}\right)$. As usual, s is the pressure per square unit, P the vertica load on the foundation per unit of width, L the length of foundation, and e the eccentricity of P about the center of the foundation. The same units should be employed for L and e, either inches or feet, so that, if P be expressed in pounds, s is given in pounds per square inch or per square foot respectively.

The charts will cover any probable requirements of practice, but their scope may be infinitely broadened by remembering that it is entirely immaterial what units are used to express e, L, s and P, provided only that these are expressed in corresponding terms. For instance, if, when using the inch as the unit, a value of L greater than 60 is required, transform the given quantities into feet and

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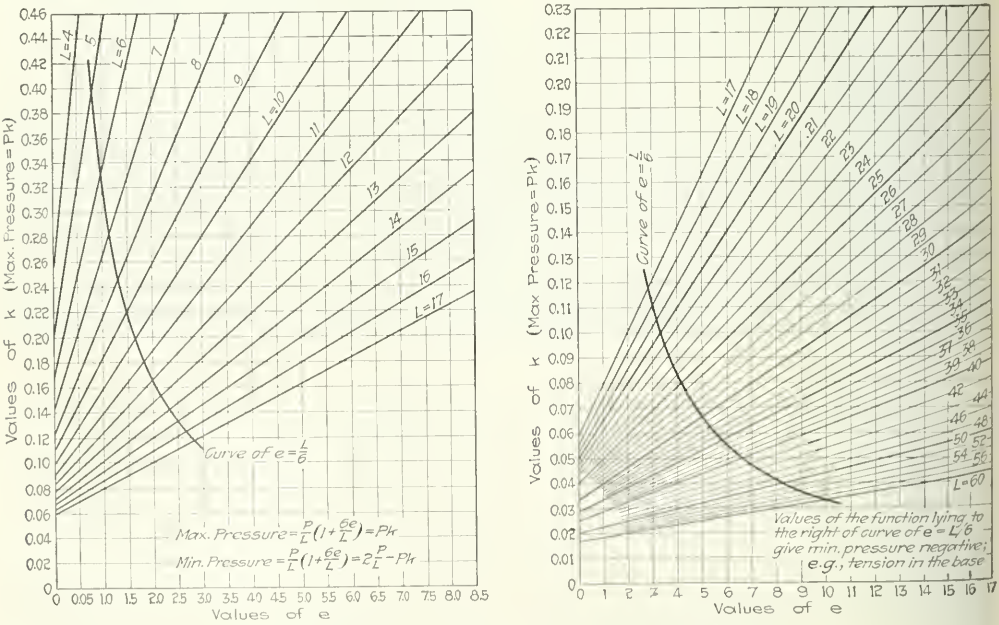
*Bridge Engineering Department, Kansas City Terminal Ry., Kansas City, Mo.



DIAGRAMS FOR PRESSURES ON ECCENTRIC FOOTINGS pounds per square foot, which will give a value of L covered by the charts.

Since the function k given by the charts is the value of the maximum pressure, s_1, when $P = 1$, Pk will give the value of s_1 for any other value of P.

Use of the Charts

Given P, L and e, to determine the maximum and minimum pressures, s_1 and s_2. From the value of e shown at the bottom of the chart trace vertically up to an intersection with the line representing the given L; thence horizontally to the left, and read the value of k. Then, $s_1 = Pk$, $s_2 = 2\frac{P}{L} - Pk$. The value $2\frac{P}{L}$ can be read off at once, as it is $2\ Pk$ for $e = 0$.

Given P, e and desired value of s_1, to find the required length. Since $Pk = s_1$, $k = \frac{s_1}{P}$. Compute the value of k; enter the chart with this and trace horizontally to an intersection with the vertical representing the value of e; the required length lies on this intersection.

Given L, e, s_1, to find the maximum permissible load, P. Enter the chart with the value of e; trace vertically upward to an intersection with L; thence horizontally and read the value of k. Since $s_1 = Pk$, $P = \frac{s_1}{k}$.

The accuracy of the charts, to the extent indicated by the scales chosen, is assured by the fact that three values were computed and plotted for each value of L, the straight line representing this passing through all three points.

A few auxiliary facts that most texts appear to neglect may be worthy of mention.

To interpret properly the equation $s = \frac{P}{L}\left(1 \pm \frac{6e}{L}\right)$, it must be understood that this is merely a special form of the equation $s = \frac{P}{A} \pm \frac{Mc}{I}$, in which P is the normal load; A, the area to which P is applied; M the moment of P about the center of gravity of A; c the distance from the center of gravity to an edge of A; and I the moment of inertia of A about its center of gravity. When A is a rectangle, the latter equation reduces to the former.

If the distance d of the load from one end of the foundation is fixed, an investigation of the charts will show that s_1 is a minimum (and hence P, the supporting power of the foundation, is a maximum) when $L = 2d$. The variations in s_1 and P for $d = 6$ and various values of L are shown in Table 1. It will be observed that the values of s_1 and P increase and decrease respectively as L increases from $12 (= 2d)$ to 18, at which point the order is reversed. For $L = 18$, $e = L/6$ and $s_2 = 0$; hence for values of L greater than 18, s_2 is negative, giving tension in the heel. The formula assumes that this tension is an actual force or stress, as the tension area of a section of a loaded beam. Consequently, in the case of foundations, unless an equivalent tensile force is provided, as by means of anchor bolts, the values given by the formula, or the charts, for values of e greater than $L/6$ are not true. If the conditions are such that tensile stresses are not provided for, the maximum length, L', over which P may be distributed, is $3d$. Hence, when d is less than $\frac{1}{3}L$ (e greater than $\frac{1}{6}L$), $s_1 = 2P/L'$, and $s_2 = 0$. Of course, this consideration does not ordinarily enter into foundation design, it being an established principle that the resultant shall not cut the base outside the outer edge of the middle third.

A case that sometimes arises is: Given the vertical load and its eccentricity, to determine the most economical dimensions of the footing. The charts will show that the area required decreases as L increases. Table 2 shows a special case of the relative bearing power of the same area, for a fixed value of e, as L varies. Though a specific case, the conclusions therefrom are general: namely, that the minimum area to carry a given eccentric load will be given by making the length of footing as large as possible.

TABLE 1. FIXED EDGE DISTANCE OF LOAD

Showing variations in s_1 and P as L varies, the distance of the load from one end of the foundation being constant and equal to 6.

Values of L	Values of s_1 when P = 1	Values of P when s_1 = 1
7	0.448	2.2
8	0.312	3.2
9	0.220	4.6
10	0.160	6.2
11	0.115	8.7
12	0.083	12.0
13	0.094	10.6
14	0.102	9.8
15	0.107	9.3
16	0.110	9.1
17	0.111	9.0
18	0.111	9.0
20	0.110	9.1
22	0.107	9.3
24	0.104	9.6
26	0.101	9.9
28	0.097	10.3
30	0.093	10.7

TABLE 2. VARIATION OF PROPORTIONS OF THE FOOTING

Showing proportional carrying power of an area of 24, eccentricity of load of 3, as L and the width b vary.

Values of L	Values of k	Values of P when s_1 = 1	Values of b	Values of Pb
24	0.073	13.70	1.0	13.7
20	0.095	10.54	1.2	12.6
16	0.134	7.47	1.5	11.2
12	0.208	4.81	2.0	9.6
8	0.406	2.46	3.0	7.4

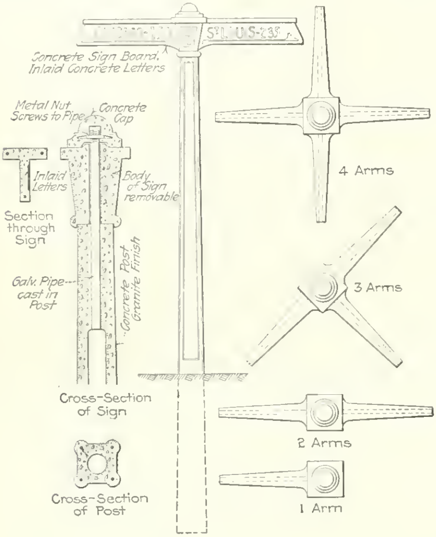
FINE AGGREGATE

Steel Must Be Inspected Before Shop Coat Is Applied—Clifford Older, Bridge Engineer, Illinois State Highway Department, Springfield, Ill., has just sent fabricators of bridge steel the following communication: "We believe it to be desirable that shop inspection of structural steel be made before the shop coat of paint has been applied. In the future, therefore, you will kindly notify us a sufficient length of time in advance of the painting of the fabricated steel, in order that our inspector may reach your shop previous to the application of the shop coat. In this connection I desire to call your attention to clause 359 of our 'General Specifications for Bridgework,' edition of July, 1915, which states in part that all parts which come in contact shall be painted with two coats before they are riveted together. In the future, failure to comply with this provision will be considered sufficient cause for rejection of the fabricated steel."

An Inverted Siphon on a Suction Pipe from a group of driven wells crosses the Des Moines River at Boone, Iowa, and is a part of the city's water-works system. The wells are on an island in the river, separated from the shore by a channel 200 ft. wide and about 12 ft. deep. The suction main is 800 ft. long from the wells to the channel, rising from 1.60 ft. above low water at the wells to 2.40 ft. at the edge of the island. Here an air chamber was provided by capping a cast-iron T 18x18x18 in. and dropping the main vertically to an elbow connection with the submerged pipe across the channel. The mainland end of the siphon terminates in a header about 4 ft. above low water, this header being located in a concrete pit 350 ft. from the pumping station. A 2-in. galvanized-iron pipe attached to the top of the air chamber is led down and along the siphon pipe to the pit, where it is connected to a wet vacuum pump. At low-water stages the siphon operates sometimes at 16 to 18 in. vacuum, corresponding to about 20 ft. hydraulic suction. The system has been in operation successfully since 1911. It was described by K. C. Kastberg, City Engineer of Des Moines (and formerly of Boone, Iowa), at the recent joint meeting of the Illinois and Iowa sections of the American Water-Works Association at Davenport, Iowa.

Curve for Design of Semicircular Flumes—The computation of the area and hydraulic radius for any given depth of water in a semicircular flume requires the use of somewhat long and complicated formulas. The accompanying curve gives the percentage of total area, hydraulic radius, or wetted perimeter for any percentage of total depth. The total area and the full-depth hydraulic radius for various diameters are generally given in the catalogs of the various flume companies or can be obtained from the "functions of numbers" tables in any handbook. The computation of A and r for fractional depths then becomes, by means of this curve and a slide rule, a very simple matter.—Lewis M. Hammond, Assistant Engineer, United States Reclamation Service, Provo, Utah.

A Road-Direction Sign that won the prize offered by the Illinois State Highway Commission last May (see "Engineering News," May 4, 1916) is shown herewith. The award was made to Walter H. Lienesch, chief engineer of the Universal Concrete Products Co., Chicago, Ill., for a concrete sign post and sign boards, in four units, all concrete except the galvanized pipe that holds the post, sign boards and cap in place.



PRIZE ROAD-DIRECTION SIGN

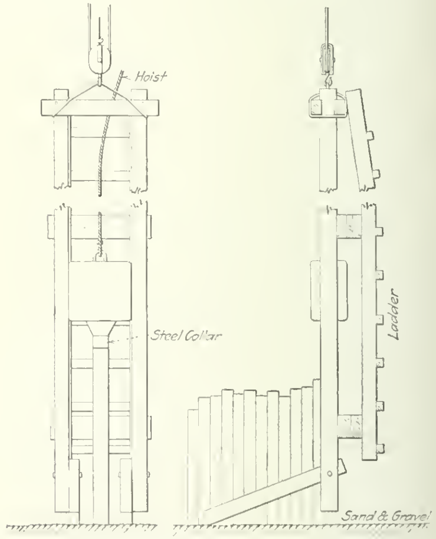
Rules To Govern Water-Main Extensions are recommended by J. A. Hiller, General Superintendent of the Water-Works Department of Cincinnati, Ohio, as follows: Property owners or others upon streets wherein no water mains have been laid and desiring the extension of water mains into such streets can have the mains extended upon the payment of 50c. for each lineal foot of main to be extended. This amount is to be considered as part payment for the main and is not to be refunded under any condition. The Water-Works Department is to pay the remainder of the cost of such extension. All parties tapping such mains and using water will be required to pay the regular water rates. The size of mains shall be determined by the general superintendent of the water-works. No mains are to be extended for a distance less than 48 lin.ft. No water mains will be extended in newly paved streets for a period of three years after the paving is completed. No water mains will be laid in streets unless the grade has been established and the surface is such as to make the work practicable.

Surface Finishing of Concrete Pavements—Very good results were obtained in finishing the concrete pavement constructed this past season on the Quogue-Southampton road, Long Island, N. Y., by the use of ⊥-shaped board floats about 6 ft. long and 12 in. wide. These floats were drawn back and forth crosswise of the pavement by workmen on bridges, as soon as the screeding had been completed. When not in use these floats were buried in order to prevent their warping. The width of the pavement finished with these floats was 20 ft.—H. T. Tuthill, Sayreville, N. Y.

A "Rag Method" of Finishing Concrete Pavement is described by S. P. Baird, engineer and contractor, of Columbus, Ohio, as follows: "I take a piece of ⅝-in. rope, preferably a piece that is worn and pliable. The length of the rope is about 10 ft. more than the width of the pavement. To the rope are fastened pieces of cement sacks—that is, cement sacks slit into two pieces with the seams and hems removed, leaving a raw edge all the way around. These pieces of cloth are sewed to the rope along the narrow edge of the piece, the adjoining pieces overlapping half their widths. The rope with it attached rags is drawn over the newly placed concrete. To keep the apparatus in condition it should be cleaned once a day. The advantage I claim for this method over the garden-hose method, described in "Engineering News," Oct. 26, p. 803, and the canvas-belt method, described in "Engineering News,' Oct. 5, p. 654, is that the finishing surface is wider than in the first case, and there is no puckering of the forward edge, as in the second case.

An Adjustable Grade Templet, designed to aid in laying mining and industrial tracks, is described by F. T. Teddy in "Engineering and Mining Journal." The templet is a yellow-pine plank 1¼x5 in. and 8 ft. 4 in. long, with the ends protected from wear by scrap-iron shoes, secured by countersunk screws, and having a vertical adjusting screw extended through one end. One of the straps is bent around the end of the templet and holds the nut of the adjusting screw. An inexpensive level bubble is fastened in a recess in the top of the plank by means of plaster of paris. In use, all that is necessary in order to establish any desired grade is to extend the adjusting screw through the necessary amount below the base of the plank. Thus, for 1% grade the screw is extended 1 in.; for a 2% grade, 2 in., etc. A screw that can be extended 3 in. is sufficient. Mr. Teddy says that he believes this method is sufficiently close for practical purposes.

Driving Sheetpiling with a Heavy Drop-Hammer—In constructing a 40-ft. concrete-arch culvert at Richland Creek, on the new Southern Ry. double-track line in South Carolina, wooden sheetpiling is being driven by an unusually heavy drop-hammer working in swinging leads. The hammer weighs 2,000 lb. and falls about 17 times a minute, the drop being 6 ft. A wood cap with steel collar is placed on the pile to be driven, to take the shock. The penetration of the piling is 20 ft. The swinging leads were made on the job, and the sketch shows them in position over the line of piling.



DRIVING 24-FT. SHEETING WITH A 2,000-LB. DROP HAMMER IN SWINGING LEADS

Alloys for High-Pressure Fittings were discussed by S. D. Sleeth at the September meeting of the Institute of Metals. As a suitable mixture for ordinary castings such as cocks, pistons, bushings, etc., he gives Cu. 72.50%; Sn, 1.75%, Zn, 19.25%; Pb, 6.50%. For high pressures he recommends Cu, 82.00%; Sn, 7.50%; Zn, 4.75%; Pb, 5.75%, and Cu, 83.00%; Sn, 11.50%; Zn, 4.00%; Pb, 1.50%. These alloys are hard to machine.

Editorials

A Sound Court Opinion on Flood Prevention

Those who have engineered the Miami flood-protection project and the residents of the Miami Valley are alike to be congratulated on the strong, clear verdict of the Conservancy Court, printed in our last issue. Thorough and conscientious engineering work won a brilliant victory. During a judicial inquiry continuing for two months the methods and results of the engineers' studies were set forth in fullest detail and were dissected by the opposing counsel's cross-examination with every bit of legal skill and technical advice at its command. In both the initial presentation and the defense against attack, the "official plan" justified itself most convincingly.

The residents of the Miami Valley are brought measurably nearer to complete protection against the flood hazard. A great enterprise of pioneer character is put in the way of realization. The cause of flood protection, or let us say of stream control, receives a strong and needed impetus.

With the Scioto River flood-prevention project about to have its day in court, it is especially fortunate for the engineers and the people interested in the protection of Columbus that the Miami case has furnished so admirable a precedent. The court at Dayton delivered a truly judicial opinion. It dealt with the question on its merits and declined to be swayed by clamor and local prejudice, although before the decision there was much apprehension that the judges might yield to local pressure. The outcome justifies the expectation that Franklin County's judges also will deal with the Scioto protection plan on its merits. In that event the keen and careful analysis of the problem by the engineers will receive a well-deserved approval.

Earth dams are safe. The judges in the Miami case carefully and deliberately state their conviction of this fact. They reject the searching and persistent criticism of such dams, which the opposition put forward. Their opinion, formed after hearing elaborate evidence on every possible phase of this subject, is a salutary lesson to many an engineer.

Bridges are safe, though some bridges have failed. Buildings are safe, though wretched design and bad work made many a wreck. Dams are safe, though quackery and incompetence and neglect have brought about many a washout.

The judges did not ask: May not a weak dam fail? They were willing to venture their own lives and the lives and property of their neighbors on the assumption that good dams would be built. And assuming good dams, they declared that the dams *would be safe and of sufficient strength to sustain at all times any burden that may be placed upon them* by impounded water. Many an engineer can study with profit this calm and deliberate statement made by laymen after weighing the merits of affirmative and negative in a lengthy battle of fact and opinion.

Not less important is the court's declaration that retarding dams combined with channel improvement furnish for the Miami Valley the only practicable and complete protection from floods. Again there is opportunity for reflection by engineers. Flood prevention by reservoirs has been under a cloud—and for that matter is today under a cloud, and with good reason. The proposal to provide empty space for flood water and yet keep that space full of water for other use has proved very difficult to defend. But temporary impounding of flood waters, applied with patiently calculated precision and properly adjusted to the other variables of the problem, can accomplish the best and cheapest flood control for the Miami Valley, for the Scioto Valley and perhaps for some other locations. This is a new fact.

That retarding basins are not a cure-all, that special physical conditions must exist in order to make them efficient and economical, will be recognized as soon as a study of their peculiarities is begun. Warnings against oversanguine expectations concerning retarding basins are therefore little needed. The fact of present importance is that retarding basins have been proved to be in certain cases a very important agency for flood protection.

United States the World's Reservoir of Capital

In a recent address before the Merchants' Association of New York, L. F. Loree, President of the Delaware & Hudson R.R., presented a summary of the international financial transactions of the United States since the beginning of the war. Mr. Loree is not only eminent as a railway president and a civil engineer, but he is a financier of international reputation. During the past two years he has collected statistics showing the extent to which American investors have repurchased American railway securities from foreign holders. These figures, in connection with the official statistics of the exports and imports from the United States and the floating here of foreign loans, enable a balance to be struck.

As everyone knows, the export trade of the United States has been increasing for the past two years by leaps and bounds, while the imports have remained about normal. In the last three fiscal years ended June 30 the United States has exported goods in excess of the value of the imports as follows:

1914	$470,653,000
1915	1,094,420,000
1916	2,135,775,000

This makes a total of over $3,700,000,000 as the value of the goods which the United States has sold to foreign countries in the past three years in excess of the value of its purchases from them. International trade balances are commonly settled by the export of gold, but it is impossible to settle any such vast trade balance by transfer of the precious metal. The entire stock of gold held by the four great government banks in Europe—those of Great Britain, Germany, France and Russia—was only $2,600,000,000 on Aug. 1, 1916, practically the same amount that they held two years earlier, at the outbreak of the war. Official figures for gold exports and imports show that whereas in 1914 the United States sent abroad $16,000,000 in gold, in 1915 $25,000,000 in gold came to this country, and in 1916, $404,000,000. The bulk of the payment for the vast exports from the United States has been made not in gold, but in securities. Mr. Loree finds that between Jan. 31, 1915, and July 31, 1916, American investors purchased from foreigners over $1,288,000,000 worth of American railway securities. The amount of other American securities—municipal bonds, industrial stocks and bonds, etc.—sold in this country by foreign investors can only be estimated, but Mr. Loree puts the total of all American securities sold back to people in the United States by foreign holders in the last year and a half as in excess of $1,500,000,000.

In addition to this, not only the belligerent nations but other nations have come to the United States during the past two years to borrow money on government bonds, and not only on government bonds but on bonds of cities, railways, industrial enterprises, etc. The National City Bank of New York has just published statistics showing the total foreign loans placed in the United States since the beginning of the war to be $1,981,000,000, in round numbers.

The international trade balance then stands about as follows:

American securities sold by foreign holders to Americans..	$1,500,000,000
Foreign bonds and stocks bought by Americans	1,981,000,000
Net gold sent to the United States from foreign countries...	383,000,000
	$3,864,000,000
Value of U. S. exports over imports for three years ended June 30, 1916..	$3,700,000,000

Of course these figures are only approximate, and further they do not show the entire transactions of international trade; the moneys paid for freight to foreign ship owners, money used by travelers, direct remittances between individuals, etc., are not included. These items are all small, however, compared with the vast sums above recorded.

These figures show that the United States, which for so many years was a debtor nation, relying largely on Europe for the capital to develop its resources, is suddenly and very rapidly becoming the great creditor nation of the world. If the further enormous increase in the value of exports over imports which was recorded during July and August continues throughout the present fiscal year, the rest of the world will have to pay the United States for its surplus of exports over imports in the year ending June 30 next, the enormous sum of $4,800,000,000. For obvious reasons gold can be used for only a trifling part of this payment; and there is reason to believe that most of the foreign holdings of American securities likely to be sold back to this country have already been transferred. If this is the case, then the only way by which this vast foreign trade can be maintained will be through the purchase of foreign securities by United States investors.

It may seem at first sight that so enormous an amount of capital invested abroad would make a scarcity for those who seek to raise money here for home enterprises. The indications are, however, that the amazing prosperity which the United States is enjoying will permit this diversion of capital and still leave sufficient for home demands. The figures above quoted show indeed that in the past two years United States investors have sent nearly 3½ billion dollars abroad, and during that time interest rates here on standard securities such as municipal bonds have dropped to a lower rate than prevailed before the war.

That higher interest rates are likely to prevail here, however, as they already prevail in all the rest of the world, is the general opinion of economists. Vast indeed are the accumulations of capital available for investment in times when a single great corporation can earn profits at the rate of $257,000,000 per annum, as did the United States Steel Corporation in the quarter ended Oct. 1. There is, however, a limit somewhere, and with all the rest of the world coming to the United States to borrow money and with the demand for money for great works of improvement from cities, railways and industrial and utility corporations at home, the law of supply and demand seems certain to raise the rate of interest; and it may even raise it to levels unknown to the present generation.

Must the Brush Mattress Go?

The brush mattress is a classic on the Mississippi. It has been the symbol, as it were, of the river-protection work there, the one necessity handed down to successive engineering generations. While varying in detail in different localities and experiencing at least one very decided change in design, it has been for a half century practically the only way the river engineer could hope to hold the unstable submerged banks from caving under the drive and cut of a flood-water current.

In spite of this evidently successful career, engineers are now casting about for some substitute for the willow mattress. This does not mean that the mattress has at last proved unsuccessful, although to be sure, it has not a 100% stability under adverse conditions, but that willows are getting scarcer in the Mississippi Valley, and therefore harder to procure and more expensive to place and that labor in the Mississippi Valley is becoming expensive. On the river as elsewhere in the South, negro laborers are not so plentiful as they once were, and those that are available cost more. It takes a seemingly disproportionate number of men to build one willow mattress, and where men are hard to get or when their wages are very high, the difficulties of weaving measurably increase.

The principal substitute thus far tried for the willow mattress has naturally been concrete, the modern cure-all for all structural ills. The possibility of carpeting a sloping under-water bank with a neat, flexible mat of permanent unbreakable material has appealed to a number of engineers. On the Mississippi it has been particularly appealing, because there is available a great quantity of river gravel which can be dredged right from the river and used in its natural gradation. So used it does not make a concrete of maximum strength, but it is one of sufficient strength for the purpose at hand.

The first application of the concrete idea was the use of small blocks, wired together both laterally and horizontally to form an entirely flexible mat. Such a design was most successfully used on the Ishikari River in Japan, and has been described a number of times in *Engineering News* by the chief engineer of the district there. It also has been experimentally tried on the Mississippi, and in a greatly improved form is about to be installed in the third district of the Mississippi River Commission's work.

The second method of using concrete for this work is to cast on a barge a solid reinforced-concrete mat, which, when set, is let over the side of the barge to pave the under-water bank. In this issue of *Engineering News* there is described a successful application of the concrete slab scheme, so successful at least in a full-sized experimental plant, that the Mississippi River Commission has appropriated $75,000 for actual work on the first and second districts of the river.

Few realize to what depth and what current the Mississippi River bends are subjected. To let down slowly a large plane, such as a concrete mat presents, in a current of 9 miles an hour and a depth of 100 ft., is to fly in the face of Providence. It would be practically impossible to hold either the slab or the barge from which it depends. To avoid the danger of such a contingency, Major Markham in his new scheme has suspended his entire slab only a few feet below water surface, where it will get the minimum effect of the force of the current. Once balanced there, the whole slab is let go at once, by an ingenious series of triggers controlled from one point. Held at its upper end to the bank and controlled by lines to the barges, this slab drops through the water very quickly and reaches its resting place before it can be warped or twisted.

The device has all the advantages of concrete for mattress work: that is, it uses the local material (except cement) and it can be operated by comparatively few men. The main expense is in its first cost, so that the total cost of laying the mattress should decrease in time, along with the amount of mats laid. At the same time, the heavy flexible mat which should easily accommodate itself to the movement of the bank would certainly seem to protect that bank much better than the brush mattress, which, while entirely flexible, is still subject to breaks due to large caves, and to the loss of its superimposed riprap.

Why It Is Economy To Study Foundation Conditions

In this issue there is described the extensive cracking and settlement which has occurred to the works just completed by the City of Cleveland for the filtration of its public water-supply. As described in that article, the movement has been so serious that it has been necessary to take down part of one of the main buildings to save it from falling down and wrecking the structures which it incloses. Elsewhere the cracks are so extensive that some of the tanks which have been built will not hold water. The most serious aspect of the situation is that the earth subsidence is still continuing and in some places apparently at an accelerated pace. Nobody knows at present whether this movement of the underlying earth will go on until the entire plant is destroyed or whether a condition of equilibrium will be reached soon enough so that the damaged structures may be repaired.

As to the cause of the earth movement, those responsible appear to be a good deal in the dark. There is, however, enough information to make it clear that in the earth strata, 100 ft. or more in depth, which lie between the filter-plant foundation and bed rock, there is a considerable amount of shifting and unstable material. This is in fact what might be expected in view of the general location on which the filter plant is built.

The occurrence is a new illustration of the wisdom of thorough preliminary investigation as to foundation conditions before building an important structure. Most engineers are only too well aware, however, that very often it is difficult or impossible to make those who hold the purse strings, especially public officials, realize the importance of such thorough engineering investigations prior to undertaking actual construction.

It may frankly be admitted, too, that there are cases in which it may be better to run a certain amount of risk than to spend a large amount of money on investigating foundation conditions when the result of the investigation may after all be inconclusive. Of course, where an engineer builds a structure which will produce concentrating loading, such as a bridge pier or a dam, he can and frequently does make thorough investigations as to what the underlying material is on which his structure is to rest. The cases are only too numerous, however, in which this is not done and in which failure occurs as a result.

Some of the older readers of *Engineering News* may recall, as a typical example, the case of the South St. bridge in Philadelphia, a stone arch structure built in the '70's with piers founded on piles that had been driven to what was apparently a solid foundation of boulders embedded in hardpan. Some time after the completion of the bridge, one of the piers began to settle, and the movement continued and increased until the pier broke through the stratum of boulder hardpan and sank into a layer of soft mud which underlay this stratum, causing the total collapse of the bridge.

It would have been a simple matter to have determined by borings the character of material under the pier foundation; but it is far from a simple matter to determine the character of the deep earth strata underlying an extensive area, such as that covered by the Cleveland filter works.

Some pertinent suggestions in this connection were made in the presidential address of Sir Maurice Fitzmaurice, President of the Institution of Civil Engineers, delivered on Nov. 7:

> I do not suppose there are any engineers in this room who have carried out undertakings to any extent who have not had at some time or other to lament failure or accident in connection with at least some part of their work. . . . Of the principal matters which cause trouble, the first one in my opinion is the small knowledge we are able to obtain of the conditions which exist below the surface of the earth on which everything has to be founded. It is commonplace to remark that the information obtained from borings is not always reliable, particularly when the ground is of a variable character. All we obtain from borings is a rough idea of the nature of the ground in the exact spot where the boring has been made.

Turning to the situation at Cleveland, it is quite possible that if a series of borings had been made over the site of the filter works, supplemented probably by the sinking of some test pits, enough might have been learned regarding the unstable strata underlying the site to put the engineers on their guard as regards the location or the design of the structures they were to build.

On the other hand it must be remembered that the foundation pressures involved in the Cleveland filter-works structures were extremely low. Even with complete knowledge of the underground conditions it is likely that no engineer would have been wise enough to predict with certainty that any troublesome movement would occur under these structures, spreading over such a large area and with such small concentrated loadings.

Letters to the Editor

Computing the Hydraulic Jump

Sir—Your issue of Sept. 21 contains a very interesting article by A. C. Norton on the "Hydraulic Principles of Flume Intakes and Outlets." In regard to intakes attention is wisely called to the common error of "making no allowance for velocity head"—that is, the error of neglecting to provide for the creation as well as for the maintenance of velocity. In regard to outlets the question of how much of the velocity head can be regained is a difficult one.

Two different and distinct conditions of flow are recognized. First, the ordinary case when the velocity in the flume is less than $\sqrt{g \times \text{depth}}$. This is always the case unless the flow has been throttled at the entrance or at some other point upstream. It is a sort of condition of stable equilibrium. The water is flowing at the "upper alternative stage." The article in question states that, though theoretically possible, it is practically impossible to regain any of this velocity head.

It may be unsafe to depend on regaining any, but it appears to be good practice to flare the exit of a flume or conduit slightly, thereby tending to slow up the velocity gradually and thus regain a portion of the difference in velocity heads before and after exit. This means the water level in the flume may be slightly lower than below the flume. There is such a thing as an "open venturi."[1]

The second condition of flow, entirely distinct from the previous one, is when the velocity is greater than $\sqrt{g \times \text{depth}}$. The water is flowing at the "lower alternative stage." It is in a runaway condition, which is stopped by the "hydraulic jump," the height of which represents velocity head regained. The principles involved in this jump have been thoroughly discussed in the *Proceedings* of the American Society of Civil Engineers, concluding with the writer's closure on p. 291 of the February, 1916, *Proceedings*.

Confining our attention to rectangular channels, if we let d and D = the depth before and after the jump respectively, and v = the velocity before the jump, then the two variables $J = \frac{D}{d}$ and $S = \frac{v}{\sqrt{gd}}$ will be found very convenient in practice and greatly simplify all the formulas involved in the case. The entire matter is summarized in the diagram of Fig. 35 on p. 292 of the February *Proceedings*. The formula for the jump given by Mr. Norton reduces to $J^2 = 2S^2$. To show that this is in error, it is only necessary to take a case when $\frac{v}{\sqrt{gd}} = 1$, the critical stage when no jump could occur. Substituting $S = 1$ in the formula $J^2 = 2S^2$, we find $J = \sqrt{2}$, corresponding to a jump of about four-tenths the depth of water in the flume.

It appears that the correct equation for the height of the hydraulic jump in a smooth rectangular flume, when simplified in terms of the above variables, is $J^2 + J = 2S^2$. This is the formula of Professor Unwin, deduced by equating moments before and after the jump. R. D. Johnson has shown that this formula is thoroughly consistent in its derivation with an energy equation between velocity and pressure heads before and after the jump. The writer's diagram in Fig. 35, referred to above, shows that this equation is verified by the recent noteworthy experiments of Prof. Arnold H. Gibson.

Mr. Norton states that it is better to count on only about half the theoretic height of jump. It would undoubtedly be a safe precaution to do so in practice. However, it is well to note that the diagram shows that the experiments which have been performed, under ideal smooth-flume conditions, give a jump just as high as that computed by the theoretical formula $J^2 + J = 2S^2$. This is apparently because this formula considers the internal friction losses and accounts for everything except such relatively insignificant friction as that of the sides and bottom of the flume.

The term "theoretic height" might better be applied to the equation $2J^2 - S^2J = S^2$, which gives a greater height of jump—in fact, gives the maximum height theoretically attainable if the jump could be assisted by a smooth obstruction in the bottom of the flume, which would prevent eddy losses. In this connection it might well be stated that there are of course certain problems, such as the prevention of scour, in which the factor of safety lies in using a higher instead of a lower height of jump than given by the Unwin formula.

Although the use of the above variables J and S greatly simplifies this formula for the jump, nevertheless it is a quadratic equation; and it so happens that a truly simple equation can be substituted for it without sacrificing any accuracy that is worth while in hydraulic computations of this sort. The equation is:

$$D = \frac{v\sqrt{d}}{4} - 0.45d$$

Apparently this gives the resulting depth D practically attainable by the hydraulic jump in a perfectly smooth channel of rectangular cross-section in which water is flowing with depth d and velocity v. The results agree, within about 1%, with those of the theoretic quadratic Unwin formula, throughout the entire range of practical use. Further reference may be had to p. 1110 of the August, 1916, *Proceedings* of the American Society of Civil Engineers. KARL R. KENNISON.

Providence, R. I., Sept. 25.

[A proof of the above letter was submitted to A. C. Norton and his reply follows.—Editor.]

Sir—There are several reasons for not recommending a general practice of using the head that can be gained at the outlet of flumes which carry water at higher velocities than the canal above and below. There is no question but that it is possible to regain part of the velocity head at the intake, even on velocities lower than the critical velocity required to produce the jump (which is greater than $\sqrt{g \times \text{depth}}$. However the amount of head that can be regained depends on several things.

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[1] See "Engineering News," Aug. 10, 1916, p. 270, for description of a venturi flume.

The amount of head that can be regained for velocities both below and above that required to produce jump depends to a certain extent on the shape of the outlet. In case the outlet is on a curve, or at an angle with the flume as is necessary in a majority of cases in order to connect the flume with the canal, the amount of head that can be regained is entirely an unknown quantity.

The freeboard in metal flumes is usually very small—but a few inches when the flume is carrying full capacity—and an additional factor of safety against overflowing is added by not using the head that may be regained. There is also the question of expense to be considered, as it is much more costly to install an outlet that may be used to regain head as it must be much longer than the ordinary in order to operate properly.

The type of outlet shown in the article on "Hydraulic Principles of Flume Intakes and Outlets" is designed to check the water as little as possible, hence the amount of head that could be regained would be small. If it is necessary to regain as much head as possible the outlet should be designed similar in shape to the intake. In case the velocity is high enough to produce jump the danger of the jump occurring too close to the end of the flume and overflowing may be prevented by making the concrete outlet the same size and shape as the flume for a few feet, with the walls raised, and then gradually flared out to the shape and size of the canal section, similar to the design shown for the intake.

The formula which Mr. Kennison shows reduced to $A^2 = 2 S^2$, and in which he points out the error, is the Merriman formula and at the time this article was written, which was before the publication of the discussions in the *Proceedings* of the American Society of Civil Engineers for January, and February, 1916, the Merriman formula derived from Bidone's experiments was practically the only source of information on this subject. As these formulas are derived from experiments in rectangular channels they must necessarily be used with caution when applied to semicircular flumes.

Denver, Colo., Oct. 7, 1916. A. C. Norton.

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Design of Flume Outlets

Sir—The design of flume outlets as outlined by A. C. Norton in the *Engineering News* for Sept. 21, under the title of "Hydraulic Principles of Flume Intakes and Outlets," appears to the writer not to be in accordance with the best practice. Equation (2) is equivalent to a statement that velocity head can be recovered at a flume outlet only where the hydraulic jump occurs. Abundant experimental data exist proving that this is not the fact, but that the percentage of head recoverable is much greater when the flume velocity is lower than that which will result in a jump, the necessary losses involved in the jump being avoided. Also, equations (2), (3) and (4) apply only to rectangular sections where the jump occurs *within the flume*, and are not applicable to semicircular sections, as evidently intended by the author, nor to cases where the hydraulic jump occurs in the transition, unless, of course, the transition has a rectangular cross-section. In the latter case v would refer to the velocity at the point where the jump occurs, and not to the velocity in the flume as stated. It is important to know whether the velocity at any point exceeds the minimum velocity at which the hydraulic jump may occur in order that the increased losses due to the jump may be allowed for and that precautions may be taken to prevent the jump from occurring in the flume just above the outlet structure. The simple formula given by Mr. Norton may be used in the case of a rectangular flume, but the corresponding formula for a circular or special section is complicated, and it is usually best to use the general formula *for the critical velocity head*,

$$hv = \frac{A}{2T}$$

where

hv = Velocity head for *critical* velocity;
A = Area of cross-section;
T = Width of section at top of water.

This equation, which applies to any form of section, provided only that A and T are *continuous* functions of the depth has not, so far as the writer knows, been published and a demonstration may be of interest. An extensive discussion of the hydraulic jump appeared in a series of articles in the *Proceedings* of the American Society of Civil Engineers, January and February, 1916. In these articles it is clearly brought out that a given quantity of water flowing under a given "total head" in a given channel may flow at either of two alternative depths, and that the hydraulic jump occurs when the depth changes from the lower to the higher stage. There is always one depth at which the two stages coincide, the total head being a minimum, and the jump cannot occur unless the depth is less than this critical depth. Let

D = Depth of water in any channel;
hv = Velocity head;
H = Total head = Dhv;
Q = Discharge;
V = Velocity;
g = Acceleration of gravity;
T = Width of section at top of water;
A = Area of section = some function, f(D), of the depth.

Then by definition,

$$\begin{aligned} H &= Dhv \\ &= D\frac{V^2}{2g} \\ &= D + \frac{1}{A^2} \times \frac{Q^2}{2g} \\ &= D + \frac{1}{f^2(D)} \quad \frac{Q^2}{2g} \end{aligned}$$

Differentiating,

$$\frac{dH}{dD} = 1 - \frac{f'(D)}{f^3(D)} \times \frac{Q^2}{g}$$

where $f^3(D) = A^3$ and $f'(D)$ = (the first derivative of A with respect to D) = the top width T; and H is a minimum when $\frac{dH}{dD}$ is zero, or when $\frac{A^3}{T} = \frac{Q^2}{g}$. Since $Q = AV$ this reduces to $\frac{A}{2T} = \frac{V^2}{2g} = hv$, the equation given above.

For a rectangular section, since $\frac{A}{2T} = \frac{bD}{2b} = \frac{D}{2}$, we may write $\frac{D}{2} = \frac{V^2}{2g}$ or $v = \sqrt{gD}$, which agrees with Mr. Norton's equation (2). It is also interesting to note that $\frac{D}{2}$ is equal to hv at the critical depth for a rectangular section. The situation is illustrated graphically herewith in Fig. 1. The curve is plotted for 150 sec.-ft. flowing in the section shown. If the flow is taking place under a total head of 5 ft., the depth may be either 1.4 or 4.9 ft., and if in the case of low stage flow, with depth equal to 1.4 ft., the flow in the lower part of the channel be retarded by a change of grade or otherwise, the water surface may be made to jump, theoretically, to a depth of 4.9 ft. The actual height of jump (for rectangular channels), which is less than the theoretical, is discussed in the *Proceedings* referred to above and will not be taken up here. If the depth is equal to or greater than the depth at *G*, no jump can occur, hence the critical depth is found where *H* is a minimum.

It should be noted that *e* in Mr. Norton's equation (3) is equivalent to *C* in the well-known formula $v = C\sqrt{rs}$, *r* being assumed $= D$; *e* should not be taken as a constant, but should be identical with the value of *C* used in determining the velocity in the flume. Unless the channel is very wide this formula should read $s > \frac{gD}{rC^2}$. Mr. Norton's equation (4) is equivalent to the Merriman formula for the height of jump in a rectangular section, and the relation of this formula to the Unwin formula and to the theoretical height of jump is illustrated graphically on page 292 of the *Proceedings* for February, 1916. So far as the writer is aware, no formula has been devised for the actual height of jump in other than rectangular sections.

The outlet structures shown in Mr. Norton's article are more suited to the destruction than to the conservation of the kinetic energy in the water and should not be used where the recovery of head is important. A better form of outlet would be Mr. Norton's intake reversed, though the outlet should be longer than the intake in a properly proportioned installation. Obviously, since eddies destroy energy, the outlet should be made as smooth and as gradual as possible, and the velocity should be reduced from the flume velocity to the velocity in the canal with a minimum of shock. In the structure shown by his "Type III," the depth, and consequently the critical velocity, in the outlet is greater than in the flume, while the actual velocity is higher in the flume; hence, if there is a jump it is likely to occur in the flume rather than in the transition as shown. If the flume velocity exceeds the critical velocity, there should be a hump in the floor of the outlet rather than a depression. It is claimed that by using the proper form of submerged weir the hydraulic jump may be made to take place with very little loss.

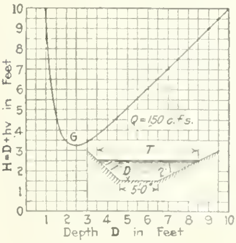

FIG. 1. DEPTH-HEAD RELATIONS

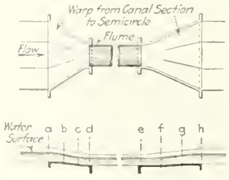

FIG. 2. INTAKE AND OUTLET FLUME

Where there is no hydraulic jump, or where the jump is made over a suitable weir, the writer suggests the following formula to be used for both intake and outlet:

$$h = K\frac{V_1^2 - V_2^2}{2g}$$

h = Change in elevation of water surface in feet;
V_1 = Velocity in flume;
V_2 = Velocity in canal;
g = Acceleration of gravity;
K = An experimental coefficient to be determined separately for intake and outlet.

The values of this coefficient vary with the design of structure, the range in practice probably being from about 1.6 to 1.1 for intakes and from zero to 0.7 for outlets. For careful design $K = 1.2$ at the intake and $K = 0.6$ or 0.7 at the outlet is believed to be conservative. This formula is identical with Mr. Norton's equation (1) except that $K = 1$.

In order to make the regain of head possible it is, of course, necessary for the water surface in the flume to be lower than in the canal. The type of intake and outlet shown herewith in Fig. 2 is believed to conform to good practice for ordinary purposes. Where it is important to keep losses down to a minimum any number of sections *a, b, c, d* and *e, f, g, h* may be taken and the formula $h = K\frac{V_1^2 - V_2^2}{2g}$ applied between each two sections, *h* being the change in water surface elevation between sections, V_1 and V_2 velocities at the sections and *K* the proper coefficient. The structures can then be adjusted to make the water surface follow a smooth reversed curve as shown. If the conservation of head is of little importance, the structures may be simplified. It should be remembered, however, that if a large part of the kinetic energy of the flowing water is converted into static head it will not create eddies and cause erosion in the canal below, and the amount of protection necessary to prevent erosion will be correspondingly reduced.

JULIAN HINDS,
Assistant Engineer, U. S. R. S.

Denver, Colo., Oct. 6, 1916.

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Lawyers Select the Juries

Sir—In the article by R. Fleming, *Engineering News*, Nov. 23, p. 967, on "The Engineer as a Juror," the inference is drawn that the low standard of jurors is due to the effort of intelligent men to be excused.

My brief experience on the petty jury in a civil court makes me believe that the low standard is due solely to the efforts of the lawyers, who promptly excuse the "electrical engineer," "telephone engineer," "civil engineer" and another man, "the most intelligent-looking in the box."

In my case I knew I would have to report to the court twice a day for two weeks, whether on the jury or not, so I always gave my business as "draftsman" and was accepted as being not too bright to please the lawyers.

I do not believe juries will be much improved until the judge is given more discretion and the lawyers given less in selecting them. ALLAN F. OWEN.

Chicago, Ill., Nov. 26, 1916.

Serious Settlement Destroys Part of New Filter Plant

SYNOPSIS—The water-filtration plant of Cleveland, which is just completed, has settled at some points 6 in. to 1 ft. A portion of the filter building has been so badly injured that it is being demolished. The subsidence started during the construction, in 1914. No explanation of the trouble has been found, and measures for safeguarding the plant have not been devised. The following descriptive account has been prepared in the absence of full data, withheld by the city officials.

The new Division St. plant for filtering the water-supply of Cleveland, Ohio, not yet put into service, has been seriously damaged by extensive cracking, caused by subsidence of the underlying earth. Conditions are growing worse. At the west end of the 125x730-ft. filter house the state of affairs is so bad that a 40-ft. length of the house is being taken down to forestall its collapse. While the subsidence is worst at this point, it extends through the whole length and width of the filter building and into the coagulation basins adjoining to the south.

Part of the trouble is two years old; part is very recent. The first difficulties developed at an early stage of construction. The substructure for the filter house was completed late in 1914, and about that time the footing slab under the building and the filters, a continuous reinforced slab 14 in. thick, was seen to be at least 5 or 6 in. low at its ends, though it had been laid level.

At the same time or even earlier the north filter boxes, resting on the side portions of the slab, cracked away from the central floor—the operating gallery. The longitudinal crack was carefully patched up at that time. As evidenced by small insert pieces placed at special points and still in place, the crack had opened up 1½ in. The trouble was diagnosed as settlement along the northerly edge of the filters, and to strengthen this edge a very large amount of grouting was done through pipes put down through the footing slab. Some 5,000 bbl. of cement was used in this work, which was paid for as an extra.

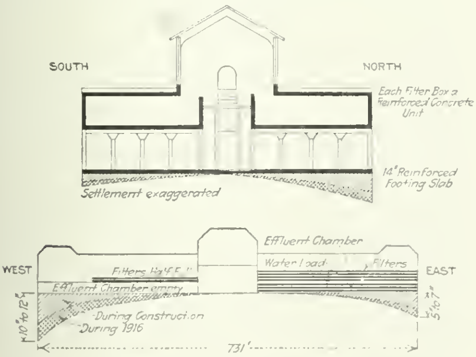


FIG. 1. DIAGRAM SHOWING SETTLEMENT UNDER THE FILTER HOUSE

At this period, also, the settlement of the west end was sufficient to pull some of the ceiling girders under the filter boxes away from their columns. Several heavy brick piers were built under these girders.

The superstructure of the filter house was completed (a separate contract) in 1915. The subsidence continued, or perhaps new movements developed, while the wall brickwork was being laid.

Because of prospective litigation over the failure and future rebuilding of the clearwater basin of the plant, 500 ft. to the west of the filter house, the city authorities refuse information bearing on the present and past movements. It is conceded, however, that the subsidence has been going on continuously during the entire season of 1916 and still continues.

A system of accurate leveling was instituted in April, 1916, to keep track of the movement. Shortly afterward, water was put into some of the filters, part of the effluent chambers underneath and some of the coagulation basins. This water load was applied gradually.

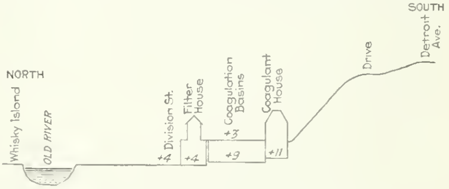


FIG. 2. CROSS-SECTION THROUGH FILTRATION PLANT

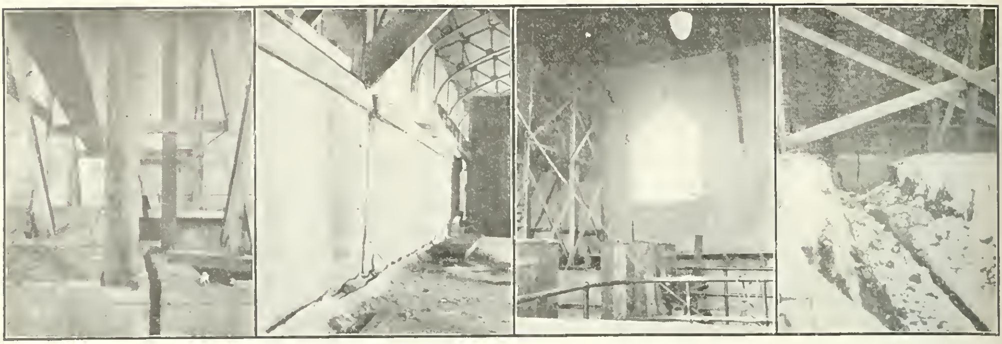
Indications are that the movement has been greater during the past two or three months than in the first half of the year. During the period from April to October the filter house went down 2 to 4 in. at its extreme ends, the greater amount at the west end.

Filter House Settles at Ends and Sides

The peculiar distribution of settlement in the filter house is possibly significant. Transversely, the north and south edges of the filters have gone down, leaving the bottom slab highest at the center. This is perhaps a natural occurrence in view of the excess load on the side portions, due to filter boxes and superstructure, and the continuity of the foundation slab. However, longitudinally the same concentration of settlement in the end portions appears in even more marked degree.

The sketch, Fig. 1, represents very roughly the distribution of the settlement of 1916, added to the earlier subsidence. The sketch is based on the best data obtainable outside of the city's records. The administration building, at midlength, is practically undisturbed. Thence east and west there is progressively increasing subsidence, going sharply to a maximum in the length of the last two filter bays.

The opening between the last two filter boxes at the west end is the most prominent gap, being 2½ in. wide in the north row and 1½ in. wide in the south row. This



FIGS. 3 TO 6. CRACKS SHOWING IN FILTER HOUSE AT CLEVELAND FILTRATION PLANT

crack has torn the walls of the house apart, and the settlement that causes the crack also is dropping the lower walls away from the brickwork.

There are plenty of other cracks throughout the filter house. The operating-gallery floor slab is pulled apart at numerous transverse cracks, and the passageway slab below it similarly. The columns under these slabs are split, in some cases, by the east-west pull. The admintration building (at midlength of the filter house) is also showing cracks. Its walls also show slight settlements independent of the movements of the filter-house.

Coagulation Basins Cracking Along Edges

Damage is by no means confined to the filter house, but extends into nearly all parts of the plant. The north side of the coagulation basins, where a narrow two-story operating gallery extends along the 850-ft. length, shows a general arching in east-west direction similar to that of the filter house. Many transverse cracks, running north-south in the middle part of the length and elsewhere usually northeast-southwest, prove this arching and its damaging effect. A direct measure of the movement is found in the fact that both ends of the gallery are about 6 in. below the middle, though originally they were about 1 in. higher than the middle.

The coagulation basins, though integral with the north operating gallery, do not show by cracks that they participated in the excessive subsidence of the east and west ends. Specific measurements are not available.

The west basin is badly cracked and will not hold water. The other five basins are full. The principal cracks in the west basin are two north-south roof cracks, one running the length of the barrel vault along the west, and the other along the crown of the second arch span east of here. At both the roof is open 1 to 2 in. The middle 150 ft. of the west wall is tipped outward slightly and has cracked away from the adjoining sections of wall. Other roof cracks occur.

Cracking of minor amount is found in the south operating gallery and in the mixing chambers. The coagulant house is apparently not disturbed.

Bad Soil Conditions; Little Definite Knowledge

The filter plant lies at the foot of the lakeside bluff near West 45th St. and occupies a flat stretching 600 ft. north of the Old River—the former mouth of the Cuyahoga—beyond which lies the ¼-mi. width of Whisky Island (Fig. 2). The site was 10 to 30 ft. above lake level; but as the excavation was in old fill and the bluff back of it has a fill face, the filter site was probably lower originally and may have been marshy.

Some of the original exploration borings showed peat, and the view has recently been entertained that a bed of peat underlies the site. This opinion is conceded to be largely presumptive.

While the boring record is not available, it is known that uncertain clay and sand strata were found. Rock is 100 to 130 ft. below lake level. Wet quicksand exists at an elevation equal to or above the river bottom.

Slips of the hillside were a frequent source of trouble during construction, in one case burying a steam shovel. Their nature was not that of a simple slide; vertical subsidence occurred, accompanied by squeezing out of unstable clay-sand masses at the foot of the bluff. To what extent these troubles involved old fill and to what extent original soil was not determined.

At the clearwater-basin site, 500 to 1,500 ft. west of the filter plant, the lateral movement was more pronounced. Here the footings for the southerly wall of the basin, which were poured in separate blocks, frequently shifted northward—that is, away from the hill—over night. Movements of these footing blocks exceeding 1 ft. occurred, and some heaving occasionally accompanied them. The hill slope was in all cases held well back of the footing excavations, and the movements were due to northward flow or squeezing of the underlying soil. The footing depth here was nearly 10 ft. below lake level—the clearwater basin has its floor well below datum and thus is like a dry-dock excavation.

As bearing further on the soil conditions, it is worth notice that the heavy pumping station, lying between the filter house and the clearwater basin, but resting on a substantial pile foundation, has shown little or no settlement. The piles here go down to depths of 40 to 45 ft. below lake level. Evidently, they pass through the unstable strata and are well seated in firmer ground.

Trenching Near Filter Caused Soil Movements

West and northwest of the filter house and 100 ft. or less distant, a 72-in. steel main was laid in 1915 with its bottom 12 to 15 ft. below ground, or at El. -9. The trench was unsheeted. Its bottom rose very decidedly before the pipe was laid. The pipe, resting directly on the soil, has settled or risen in places since completion of the main, indicating that the instability of the soil was not wholly neutralized when the trench was filled.

Two other sets of trenches were dug somewhat later, near the west end of the filter house. One of these was a pair of sheeted trenches leading out from the end of the filter building and 15 ft. below the level of its bottom slab. These trenches were for the cast-iron effluent pipes from the filters, connecting some distance out with a reinforced-concrete conduit to the clearwater basin. No disturbance was noticed that could be charged to their construction.

However, two deep supply-tunnel trenches put down 150 ft. to the north, a little later, made very considerable trouble. These trenches were inside of tight steel sheeting, well braced. When excavation was down nearly to their 30-ft. depth, the bottom rose somewhat, and the trenches moved bodily northward, sheeting, bracing and all, 12 to 18 in. This caused immediate settlement and opening of cracks at the west end of the filter house.

Plant Designed for Very Low Soil Loadings

It is said that the footing loads under the filter plant range from 1,500 lb. to 3,000 lb. per sq.ft. Under the filter house the dead-load averages 1,500 lb., and the total load 2,700 lb. The coagulation basins have a general floor load, from floor, water and roof, of between 1,800 and 2,300 lb. per sq.ft. The outer walls may have an extreme edge pressure of about 3,000 lb. per sq.ft.

These very low loadings are applied to a soil of miscellaneous fill. This soil was tested by loading-platforms in 1914, and the conclusion was reached that 3,000 lb. per sq.ft. would be safe. Some thought was given to driving concrete piles under all or part of the plant, but the idea was rejected.

The filter house, as already noted, was built on a continuous 14-in. concrete slab, reinforced in all directions. Above the slab, however, the building is cut apart by frequent expansion and construction joints and has no continuous reinforcement.

The coagulation basins rest on a plain-concrete groined-arch floor concreted in alternate diamonds, as is commonly done. As an afterthought, 10-ft. squares of reinforcement were put under the columns. The mixing chambers are reinforced work practically throughout.

The Situation in Brief

The filter plant presents the picture of a remarkably extensive foundation failure. The actions are most serious at the north and west edges, with maximum movement at the northwest corner of the filter house.

The filter house is arched up at the middle from subsidence of the ends that began two years ago, while the substructure was being built and the average footing load probably did not exceed 1,700 lb. per sq.ft. Later on, subsidences occurred in marked degree when lateral flow of the subsoil was induced by deep open trenches nearby. The movement was continued very actively during 1916 under the influence of the added water load. Distinct increase of subsidence at the west end was caused by placing about 20 ft. of fill along this end, during the past season. A maximum rate of subsidence, at the corner, of 1 in. per month was reached.

Peat is known to exist in places and is suspected under the whole area. Direct compression of this peat by the superimposed load is held to blame by some of those who have been consulted.

Compression (vertical squeezing) and flow (lateral squeezing) of the subsoil are the two chief possibilities.

Compression is indicated clearly at the west wall of the coagulation basin, which tipped outward slightly before the adjoining fill was placed. A few of the other occurrences also point to vertical compression.

Lateral flow is indicated by many of the other phenomena and most distinctly by the northward movement of the deep supply-tunnel trenches a year ago. It is probably the predominant element of the trouble, with vertical compression as an auxiliary and complicating factor.

The existence of springs in the bluff and the fact that much water flows through the underdrains under the plant may mean some complication of the conditions by moving groundwater.

Hillside pressure is probably not a factor now at the filter plant, but it is active at the nearby clearwater basin. This structure, which has not been included in the above descriptive statements, has developed in many of its 30-ft. columns cracks that represent a northward bending at the top. Cracks are seen on many of the columns, the south face near the base and on the north face near the top.

That the soil actions are of complex nature also at the clearwater basin is shown by recent outward tipping of the north wall of the basin, and (probably in consequence of this) the development of a few diagonal and longitudinal cracks in the roof.

In the case of the filter house the continuity of the bottom slab and the unequal transverse distribution of load upon it is possibly concerned in the transverse arching. It cannot be more than secondary to the subsoil movement, however.

Relation of the Filter Plant to the Water-Supply

The construction work on the filter plant was practically completed by the end of last February. The delay in putting it in operation is a serious matter for the city. According to a review of the Cleveland water system by C. F. Schulz before the Cleveland Society of Engineers the plan of development was to complete the Division St. filter plant and the new west side tunnel, put them in operation for the supply of the entire city, and then shut down the pumping plant on the east side of the city, unwater the lake tunnel which supplies it and make examination and necessary repairs, since the tunnel is believed to be in unsafe condition. Haste is imperative so that the work may be completed and the east side tunnel restored to service before the growth in water consumption reaches a point beyond the capacity of the west side tunnel and filter plant supply.

What the City Is Doing About It

As stated in a description of the new filter plant in *Engineering News* of Oct. 19, 1916, "the plant is being tuned up under the direction of J. W. Elms." The "tuning up" may be described as follows:

1. The westerly 50-ft. length of the filter-house superstructure is being taken down, for fear it may collapse. A low wooden shed will be built to protect the control boards, etc. The westerly filter boxes (one each along north and south edge) will remain out of use. The parts of the effluent chambers below them are also unserviceable; but as the downtakes to the effluent pipes are at the extreme west end, provision is being made to carry the water to them. This consists in building a new reinforced concrete end wall across the effluent chambers,

50 ft. from the west end, and constructing a closed timber flume from openings in this new wall to a connection with the downtakes. At the same time several brick piers are being built in the effluent chambers near the west end to hold up the ceiling girders where they are tearing away from their column seats. The westerly unit of the coagulation basin is empty and may be abandoned.

2. The other five coagulation basins have been filled with water, and most of the filters have been filled. This water load was applied gradually, beginning in the spring of 1916, with a view to bringing on the subsidence in easy stages and ultimately arriving at a condition of stability.

The clear water basin is to be rebuilt at once, as reported in *Engineering News* of Nov. 23, 1916. Its condition is largely or wholly due to defective concrete, which caused a section of roof to fall on July 10, 1916, as reported in *Engineering News* of July 20 and 27, 1916.

No active consideration has been given to methods of underpinning or otherwise supporting the filter-plant structures against continued subsidence. Such advice as has been obtained by the city officials is to the effect that probably the worst subsidence actions are now over and that keeping the plant loaded ought to develop final stability by next spring.

There is no evidence, however, that the movements have been decreasing recently. On the contrary, new cracks developing from time to time point toward continued movement.

What the Established Engineer Owes the Beginner*

By Isham Randolph†

What I wish to speak of more particularly is the helpfulness that should be extended by the older to the younger, the experienced to the inexperienced, the veteran to the recruit. The importance of this is borne in upon me by recollections spanning twoscore years of professional life.

I have attained to a standing in the engineering profession which is a source of satisfaction to me, and why have I attained it? Because of the helpfulness of my seniors. In 1868 I put my hand, not to the plow for I left that in the furrow, but to the ax in a railroad survey party. It was hard work, harder than similar work today, for in the old Valley of Virginia contending armies had burnt up all the fence rails and the axman had to cut down trees, cut them into proper lengths, split into stake sizes, smooth, sharpen and mark them; and this done, he had to make them into bundles and pack them on his back. Those green stakes were heavy, and each stake that was stuck was a welcome lightening of the axman's load. Such an idea as having stakes prepared at a sawmill and distributing them by wagon was in those days considered preposterous. At the close of each day I used to feel that I could not stick it out another day; but a night's rest, pride and the necessity of making a living sufficed to put me back on the job each succeeding day while it lasted.

I came within the helpful influence of James L. Randolph, Chief Engineer of the Baltimore & Ohio R.R. During the thirty years of his incumbency of that office he trained many young men. A young man in any of his engineer corps was a man in whom he felt a personal interest akin to that of a father for his son. We were of his official family in a real sense. He took an interest in our development. He knew us individually, and he used to find out how we were getting along, find out what our technical stumbling blocks were; and he would help us to surmount them by verbal instructions and by written elucidations of our problems. Most of the boys who were of his professional family have followed him into the great unknown, but the few of us who are left cherish a grateful memory of what he did for us.

I have said enough to let you see how much I owe to precept, example and sympathetic aid in those early days of my professional life, when the need was so great, and how that experience, as long as it is remembered, will incline me to doing for others what was done for me.

We must bear in mind that the young men who come to us—from the office boy to the college graduate—are not merely flesh-and-blood tools to be used in our work as so much mechanism, but men like ourselves, whose future we shall help to mold. Their destiny is to be worked out, and whatever we can do to make it a high destiny should be done generously and well.

I do not know whether the ethics of the profession are taught in the schools, but from occasional lapses from the code on the part of graduates of some of our technical colleges, which have come within my personal knowledge, I incline to the belief that little stress is laid upon the moral side of the engineer's training.

We must have those who come under our influence understand that no true success can wait upon departures from a high standard of justice and honor. The old chief whose influence upon my life I have before spoken of used to impress upon us that as engineers we held a judicial relation to employer and contractor and that fairness to each should govern all our decisions. The engineer should be sure he is right, then go ahead; his going ahead, however, should not be rough shod, but determined and effective.

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*From an address before the Cleveland Engineering Society, Nov. 21, 1916.

†Consulting Engineer, Chicago, Ill.

Extensograph Shows That Bridge Leans to Side

Extensograph measurements of stresses in an old highway bridge in Connecticut, made recently for the State Highway Commissioner by Rudolph Welcker, of Springfield, Mass., revealed the curious fact that the south truss in each span of the bridge carries very much greater stresses than the north truss. A survey of the bridge then showed that the trusses lean to the south, partly by distortion in the sway and top-lateral systems, and partly by bending of the truss posts on account of poor details. The following extract from Mr. Welcker's report on the bridge describes this condition:

> The size, fastening and construction of the lateral connections are inadequate for the height of the structure. Unusual stresses due to horizontal forces were observed in the struts which connect two trusses of the same span. The stresses therein become very high during wind storms and the following effect was observed: First, the channel irons of all the vertical posts are pressed together, thereby causing the lacing bars to buckle. Second, the whole superstructure of both fixed spans has been thrown out of plumb, which action should have been counterbalanced by stresses in sway rods and upper laterals. The upper lateral loop rod pins have been bent inward in several places, giving the rods considerable play.

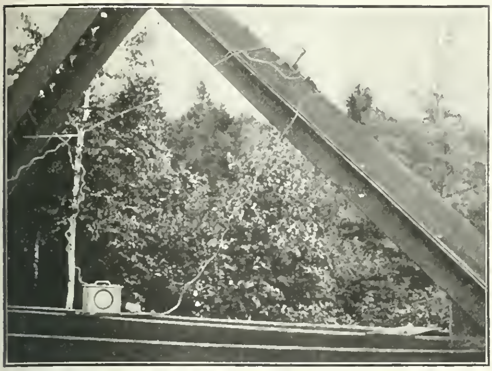


FIG. 1. WELCKER EXTENSOGRAPH ATTACHED

Clock shown drives the tape-winder of the extensograph and of similar instruments placed at other points on the bridge.

The permanent deformation was measured as follows:

East span: North center post 33 ft. high, 3¾ in. out of plumb toward the south, 1½ in. bend in the middle of the post. South center post: 2½ in. out of plumb, ¾ in. bent.

West fixed span: North center post 6½ in. out of plumb toward the south and ½ in. bent; south center post 4¾ in. out of plumb toward the south, 1¾ in. bent. It is evident that northwest winds have caused this permanent deformation.

The swing span: Southeast main post ¾ in. out of plumb and bent; northeast main post 1 in. out of plumb and bent; northwest main post 3¾ in. out of plumb and bent, southwest main post 1 in. out of plumb and bent.

Investigation was made as to how far the live-load on the bridge floor accounts for these conditions. Secondary stresses were measured in the horizontal struts connecting these posts during the passing of street cars.

The beginning of the failure mentioned above is aggravated by the fact that the vertical posts are entirely without diaphragms and that the sways and upper laterals do not take any stress under ordinary circumstances. The buckling of the lattice bars of the vertical posts has brought a greater strain to bear on the stiff diagonals of the trusses at the assembly of the panel-points, which also begin to show signs of buckling.

It is considered essential to ascertain from time to time by actual measurement whether any further movement of the trusses is noticeable, and if so, to proceed at once with strengthening of the sway bracing. All hanger rods should be tightened, also the rods forming part of the upper lateral system, and their pins strengthened if required. Stay-bolts should be inserted between the channels of the vertical posts in order to relieve the strain on the buckling lacing.

The bottom angle of the east portal of the east fixed span is rusted through, due to lack of rain holes. These portals should also be inspected from time to time, as they form at present the only means of preventing the failure of the high trusses under high wind pressure.

The bridge crosses the Housatonic River between Milford and Stratford, Conn., and is known as the Washington Bridge. It was built in 1893 and has the light and unsatisfactory construction and detailing of that period. It was reinforced in 1909 and 1913, at some points quite extensively (for example, the entire bottom chord of the swing span and its floor-beams were renewed), and probably by virtue of this work the direct stresses in the main members are not excessive. Bending of the members was found to occur in marked degree.

The two fixed spans of the bridge are each 232 ft. long, with 29 subpanels of 14½ ft., and center depth of 33 ft. The trusses are spaced 19½ ft. on centers. A sidewalk is bracketed out on the north side (although the bridge now leans to the south). The floor-beams are suspended by plate hangers. The bottom laterals are angles, but the top laterals and the sways are rods.

Specimen stress diagrams are reproduced herewith. An interesting point in them is the compression shown in the eyebar diagonal and bottom chord.

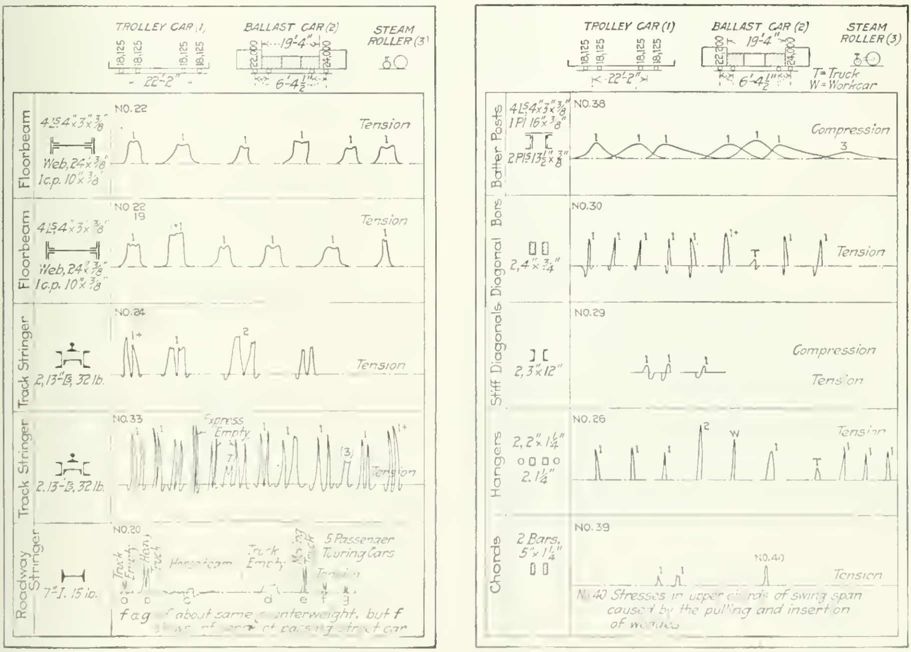


FIG. 2. TYPICAL AUTOGRAPHIC STRESS DIAGRAMS FROM WASHINGTON BRIDGE, STRATFORD, CONN.

News of the Engineering World

Proposed Burial of Garbage at San Francisco

Disposal of San Francisco garbage by burial was proposed on Nov. 20 by the only two bidders who tendered under the city's recent advertisement for disposal in accordance with plans submitted by bidders. The bids were under advisement at the date of the latest reports. Richard Schmidt, 857 Mills Building, San Francisco, offered to take all the garbage collected and delivered to him in the Islais Creek district, and bury it under 12 in. of earth or rock, the contract to run for five years, and the private scavengers to pay him 60c. per ton, of which he would pay 20c. to the city the first year and 25c. the remaining four years of the contract. The "sanitary fills" thus made, the proposal stated, would be "sanitary and without noxious odors and free from insects and vermin and satisfactory" to city and county officials. The second proposal was from A. B. Moffit, L. G. Bonzagni and Fred P. Smith, 105 Montgomery St., San Francisco. Two plans were submitted: (1) Burial within the city under a contract running from 1½ to 20 years, the material to be segregated and graded and then immediately sealed "within an impermeable covering, under the patent rights of Fred P. Smith," the scavengers to pay the bidder at least 60c. per ton and the bidder to pay the city 22½c. per ton, or a lump sum of $35,000 a year, as the city may elect. (2) Transportation by water and subsequent burial in one of three outside counties "in a manner satisfactory to the public health authorities having jurisdiction at said sites," the scavengers to pay as already stated and the bidder to pay the city 13c. per ton or a lump sum of $20,000 a year, as the city may elect, the contract to run 10 yr.

Chicago Transit Commission Makes Report

The Commission appointed Jan 31, 1916, to investigate the passenger transit facilities of Chicago and recommend needed improvements has prepared a report which was made public on Dec. 4. The Commission recommends that all the transit lines of the city, surface lines, elevated roads and the subways to be built, should be placed under one management to be under control of the City Council but with a Board of Supervisors in immediate charge with broad powers as to regulation of service, extension, etc. The new corporation should absorb both of the present surface and elevated companies, which should surrender their franchises. The new corporation should receive a franchise terminable at any time the city sees fit to acquire the property, and the city should have also a majority control of the corporation.

The present surface and elevated lines are carrying about 4,000,000 passengers daily (2,460,000 cash and 1,550,000 transfer) with 157,000 additional on the steam and electric suburban lines. To increase these facilities the Commission recommends a nine-year construction program involving a total outlay of about $100,000,000, beginning in 1917. A rapid-transit subway is to be built under State St. at a cost of $10,350,000 and subways for surface cars under Washington St. and Jackson St., at a cost of about $7,181,000. New rolling stock and extensions to surface lines account for about $19,000,000 expenditure. The entire program calls for the construction of 6 single-track miles of subway, 64.5 single-track miles of elevated lines, the surface lines are to have five miles of single track placed in subways, 111 miles of track is to be rebuilt, and 150 miles of new lines will be built.

Following this nine-year program a still larger program of new construction is advised which with the $100,000,000 above referred to will raise the total outlay to $260,000,000 and the total new construction to 53 miles of rapid-transit subways, 158 miles of elevated lines, and 525 miles of surface car lines. It is estimated that this amount of construction and investment will be sufficient up to the year 1950, on the assumption that 5,000,000 people will at that time reside within the city limits of Chicago, who will be adequately served by the transit lines above outlined.

Under the financial plan recommended, the city would use its present traction fund to build subways which will be owned by the city from the start. Its share in the net receipts of the operating corporation will be applied in such a way as to facilitate eventual acquisition of the entire properties by the city.

Among the first work recommended by the Commission is the four-tracking of the north and south elevated lines so that they may render a fast express service instead of a local service as at present, and additional tracks and extension on the east and west elevated lines.

There is to be a complete system of transfers between surface lines, elevated lines, and subways, and while a 2c. charge for transfers will be necessary at the start, it is expected eventually that free transfers can be given.

Chicago Paving Administration Under Fire

An investigation of Chicago paving methods by Prof. Ira O. Baker of the University of Illinois has resulted in accusations of very lax business administration, if nothing worse. The investigation was conducted for the finance committee of the City Council and with the assistance of the finance committee staff. A newspaper synopsis quotes Professor Baker as follows:

> Skimping on materials, inadequate and in many cases faulty specifications, inferior materials, poor inspection, absolute disregard of many tests in specifications, poor workmanship, and even payment to city inspectors by contractors for overtime or holiday work, seem to be the rule in paving work done by the board of local improvements.

Professor Baker estimates that about $400,000 a year is lost to taxpayers through inefficient or corrupt administration of the paving work. Specific instances are:

Shortage of material in concrete bases.............	$161,184
Skimping in use of cement for foundations.........	52,430
Shortage of bitumen in binder....................	92,730
Skimping in the use of asphalt for wearing surface.	78,777

The system of inspection in particular is condemned. The published digest of the report states:

> It seems to be common everyday practice, for inspectors to receive pay for overtime, holidays, and Sundays from the contractor, although they are employed to safeguard the interests of the city against the contractor. Such a practice goes to the root of the integrity of the whole inspection service. This, together with a radical disregard of specifications, cannot help having a demoralizing effect upon both contractors and inspectors. Inspectors are not wholly responsible, however, for poor inspection service because of the lack of proper instruction and because of the lack of requisite technical training.

Professor Baker states that 48 inspectors were placed on the pay rolls because of political influence; their previous occupations included bookkeepers, brakemen, barbers, reporters, etc.

Completion of the Ohio State Topographical Survey

The sixth state in the Union to complete its topographical survey, Ohio, make the list now Massachusetts, Connecticut, Rhode Island, New Jersey, Maryland and Ohio. The Ohio work has been put through very rapidly—about 15 yr. only were required. A complete final report is being issued. The first volume, dealing with the resurvey of the famous Ohio-Michigan boundary, is ready for publication. The resurvey was made in 1915 by S. S. Gannett, of the United States Geological Survey, whose detail account of the work presents an instructive commentary on the retracement of lost lines.

ENGINEERING SCHOOLS

University of Washington

The United States Bureau of Mines has selected the University of Washington campus as the site of a Government mining and metallurgical station for the Pacific Northwest states and Alaska. Congress has voted an appropriation of $25,000 a year for the maintenance of the station, but is expected to increase this amount when development demands it. The station will serve Washington, Oregon, Idaho, Montana and the coastal regions of Alaska from Ketchikan to Nome. The interior of Alaska will be served by a Fairbanks station. Dorsey A. Lyon will be in charge of the station. He was formerly professor of mining engineering at the University of Washington and is a specialist in electro-metallurgy. Three Government investigators will assist him. Electro-metallurgical treatment of ores will be the first work taken up by the station. The following year it will include in its experiments many problems of mining, milling and metallurgy. Electric furnaces will soon be installed in the present Mines Building and analytical laboratories, and offices will be established in the former Women's League Building.

The European war has temporarily held up plans for an aërodynamics laboratory at the University of Washington. An aërodynamic balance, which is the central instrument in the needed equipment, is not now obtainable. The Cambridge Instrument Co., of Cambridge, England, which has manufactured the few balances in use, is spending all its time in the manufacture of war munitions. An attempt will be made to bring the plans to America for construction. The study of aëronautics became possible at the university when W. E. Boeing, a Seattle capitalist and aëroplane enthusiast, gave the school an endowment to be used in building a laboratory. The present intention is to develop only the theoretical side, but it is hoped to have the Federal Government establish an aviation station close by.

Short winter courses in logging, lumbering and forestry will be given for the ninth time at the University of Washington, Jan. 3 to Mar. 30, 1917. This work is designed for men engaged in forestry and lumbering, who desire to increase their usefulness, and for those men who desire to enter these industries. There will be special courses for forest rangers and guards, loggers, lumber salesmen, architects, engineers and timber inspectors. It is not attempted to make a full-fledged logging engineer or forest ranger in these three months, but the men are given a sufficient foundation so that they can carry forward further work in these fields. A number of lectures and demonstrations will be given by men from lumber companies and the United States Forest Service.

University of Illinois

The new $250,000 Ceramic Engineering Building of the University of Illinois was dedicated Dec. 6 and 7. As shown in the accompanying view, this is a three-story structure covering an area 67x189 ft. It is built of materials that are representative of the ceramic arts, such as high-grade brick, tile, terra cotta, cement and gypsum products. Its laboratories are equipped with the latest types of apparatus needed for instruction and research in the manufacture of stoneware, china, brick, tile, sewer pipe, terra cotta, cements, glassware, sanitary ware, electrical and thermal insulating materials and other ceramic products.

Among the addresses at the dedication sessions are to be noted: "Ceramic Resources of America," by S. W. Stratton, Director of the United States Bureau of Standards, "Science in the Development of Portland Cement Industries," by J. P. Beck, Manager of the Portland Cement Association; "The Manufacturers' Dependence on Ceramic Engineering," by W. D. Gates, President of the American Terra Cotta and Ceramic Co.; "Ceramic Materials in Highway Construction," by W. W. Marr, Chief Highway Engineer of Illinois; "Ceramic Products as Structural Materials," by H. J. Burt, Structural Engineer; "Use of Ceramic Products in the Artistic Embellishment of Buildings," by Claude Bragdon, Architect.

NEW CERAMIC ENGINEERING BUILDING, UNIVERSITY OF ILLINOIS

NOTES

The Lower Otay Dam Bond Election, at San Diego, Calif., is to be reheld, through the medium of initiative petitions. As noted in "Engineering News," Nov. 30, 1916, p. 1057, the bond issue failed to carry in election of Nov. 17 because of the simultaneous submitting of another question. At first it was thought that the courts would be called in to validate the issue but it has since been decided to hold a new election.

East River Tunnel Holed Through—Of the four tunnels for the New York Rapid Transit System, the north tube of the one farthest advanced—between Old Slip, Manhattan, and Clark St., Brooklyn—was holed through at 10 a.m. on Nov. 28. Progress on these tunnels to Nov. 13 was given in "Engineering News" of Nov. 16. On Nov. 13 the two headings of the north tube of the tunnel mentioned were 190 ft. apart, in solid rock, and it was expected that they would meet about Dec. 1. At that time the headings of the south tube of this tunnel were 300 ft. apart.

The City Manager Plan for Cleveland, Ohio, is to be considered by a large committee. The Cleveland Real Estate Board has asked 65 local civic organizations to appoint representatives on the committee. The Cleveland Engineering Society has appointed a committee of three to consider this subject, two of whom will be delegated to attend a general conference on Dec. 15. The three men are: Chairman, Dr. C. S. Howe, president of Case School of Applied Science; F. F. Prentiss, first vice-president Cleveland Twist Drill Co., and Walter P. Rice, president Walter P. Rice Engineering Co.

Indictments for Criminal Negligence in the construction of the concrete building at 64th St. and Third Ave. in New York City, has been brought in against George G. Wilson, of the firm of general contractors for the building, and John Mahon, foreman in charge of the work on the top floor where the collapse occurred. The fall of this floor was reported in "Engineering News," Nov. 30, 1916, p. 1050. It is understood that the contractor denies that the supports under the floor were removed just prior to the collapse but admits that the forms may have been in process of removal and the struts being replaced under the stripped ceiling. The coroners inquest will be held Dec. 11 at the Municipal Building, New York City.

A Water Conservation Committee to study the subject and draft a bill for the conservation of the waters of Pennsylvania has been created as a result of a recent conference at Harrisburg. At the request of the governor, the chairmanship of the committee will be held by Dr. Samuel G. Dixon, commissioner of health. Dr. Dixon has announced the following other members of the committee: Gifford Pinchot, president National Conservation Association; Dr. Henry S. Drinker, president Lehigh University; William H. Keller, deputy attorney general; John B. Eichenauer, member Pittsburgh Flood Commission; George S. Webster, director Philadelphia wharves, docks and ferries; Prof. Edgar Marburg, professor of engineering, University of Pennsylvania: S. B. Elliot, member State Forestry Commission; J. A. Wells, vice-president and chief engineer Pennsylvania Water and Power Co. Other names will be added to the committee, which is expected to give particular attention to industrial wastes.

The United States Reclamation Service, according to the annual report of Secretary of the Interior, Franklin K. Lane, supplied water for irrigation last year to 857,000 acres of land, of which 800,000 were used for crops and produced an estimated value of $19,000,000. The cultivated acreage of the reclamation projects now exceeds the entire cultivated acreage of Delaware or Nevada, and the value of the crops produced on these projects exceeds the value of the crops of New Hampshire or Utah. The forty storage reservoirs on the reclamation work have a combined capacity of 9,000,000 acre-ft., sufficient water to cover the entire States of Massachusetts and Connecticut a foot deep There are on the projects 10,000 mi. of canals, flumes, tunnels and other conduits, and 75,000 structures of all sorts. During the year, construction work was carried on on 24 reclamation projects, 10 of which were finally completed so that public notices were issued opening the land to entry and water service. During the year the Service built 700 mi of canals, 80 mi of drains, 50 mi. of pipe line, 66 mi. of roads, 7,200 canal structures 600 bridges, 650 culverts and excavated about 10,000,000 cu.yd. of earth and rock. While a greater area of the reclamation projects was cultivated than ever before, settlement is still far behind the work of construction. The Reclamation Service is prepared to supply water to 1,680,726 acres, while only 857,000 were actually irrigated last year.

PERSONALS

Horace N. Trumbull has been appointed Advertising Manager of the S K F Ball Bearing Co., Hartford, Conn.

Harry M. Pierce has been appointed Chief Engineer of the E. I. du Pont de Nemours & Co., succeeding the late Maj. William G. Ramsay.

Thomas E. Jeffries, United States Assistant Engineer in charge of the Kanawha County work, with offices at Charleston, W. Va., has resigned.

E. K. Clarke, formerly with the bridge department of the Michigan Central R.R., is now Construction Engineer of the two Detroit (Mich.) plants of the Timken Detroit Axle Co.

H. S. Wilder, of Houston, Tex., has been appointed Highway Engineer of Houston County, the county commissioners of which have recently authorized $110,000 for road improvement.

James D. Callery has resigned as President of the Pittsburgh (Penn.) Railways Co. He will be succeeded on Jan. 1, 1917, by **Summer L. Tone,** Vice-President of the Duquesne Light Co.

W. M. Jacklin, Supervisor of Roadway of the Canadian Northern Ry. at Hornepayne, Ont., has been appointed Inspector of Maintenance-of-Way of the lines east of Port Arthur, Ont., with office at Toronto, Ont.

Charles S. Butts has been appointed Engineer of Construction of the new municipal dock at North Market St., St. Louis, Mo. He was recently Traffic Engineer of the Department of Public Utilities. The salary of the new position is $2,400 per annum.

Joseph E. Kuhn, Colonel, Corps of Engineers, U. S. A., who has been Military Attaché to the American Embassy at Berlin since December, 1914, has been recalled. He was appointed Military Observer with the German armies, but according to newspaper accounts he has had very little opportunity of observing.

Albert J. Himes, M. Am. Soc. C. E., has been relieved of his duties in charge of grade-crossing elimination work on the New York, Chicago & St. Louis R.R. in order to devote his whole time to valuation work, under the title of Valuation Engineer. **W. J. Bergen,** First Assistant to the Chief Engineer, has been appointed Engineer of Grade Crossing Elimination.

Cornelius Vanderbilt, who has been Divisional Inspector of the New York National Guard with the rank of Major, has been commissioned Colonel of the 22nd New York Engineer Regiment, one battalion of which is still on the Mexican border. Colonel Vanderbilt is a graduate in mechanical engineering of Sheffield Scientific School, Yale University, and for a time was interested in engineering work. He is now a capitalist and an officer and director of many corporations.

Raymond W. Parlin, Assoc. M. Am. Soc. C. E., Staff-Investigator of the Bureau of Municipal Research, New York City, has been appointed Deputy Commissioner of the Department of Street Cleaning of New York City, under J. T. Fetherston, Commissioner. Mr. Parlin is a graduate of the Massachusetts Institute of Technology in chemical and sanitary engineering He recently made a comprehensive study of street cleaning, some of the results of which were presented in a paper read at the Newark convention of the American Society of Municipal Improvements

OBITUARY

Albert C. Warren, Secretary of the Warren Brothers Co., Boston, Mass., died Nov 10. He was born Mar 18 1852.

Frederick Boldt, for many years prominent in the steel industry as founder and President of the Boldt Steel Casting Co., New Castle, Del., died Dec. 1, at his home in Chester, Penn

Charles Wiley Vice-President of John Wiley & Sons, the well-known publishers of engineering books, died Dec 3 at his home in East Orange, N J He was in his 83rd year

J. E. Dietrick, of Dietrick & Guth, Architects, Omaha, Neb., died Nov 6, aged 63 years. He went to Nebraska [illegible] years ago as a civil engineer. He was first employed by the Chicago, Burlington & Quincy R.R. and the Union Pacific R.R.

David Benjamin, head of the Pennsylvania Quarrying, Stripping and Contracting Co., and President of the Benjamin Iron and Steel Works, Hazleton, Penn., was killed on Nov. 28 by falling in front of the dinkey locomotive on which he was riding.

Frederick J. H. Merrill, M. Am. Inst. M. E., a mining engineer of Los Angeles, Calif., and a former State Geologist of New York, died Nov. 29 in his 55th year. He was born in New York City and was graduated from the Columbia School of Mines. For several years he was connected with the Geological Survey of New Jersey and later with that of New York.

Daniel O'Connell, head of the firm of Daniel O'Connell's Sons, General Contractors, of Holyoke, Mass., died Nov. 23. He was one of the last survivors of that race of Irish contractors whose careers started as day laborers in the period before the Civil War, when Irish labor was commonest on all construction work. He was born in Ireland in 1832, and his parents emigrated to this country in 1847. At 15 years of age he was a water-boy on the first Connecticut River dam built by the Hadley Falls Co. Later he was a railway laborer. From this he graduated into taking small contracts on his own account, and out of this grew a firm of general contractors which has executed construction work throughout central New England.

Micajah Terrill Burgess, a pioneer Western railway engineer died at his home in Salt Lake City, Nov. 23. He served on the engineering staff under the late Gen. Grenville M. Dodge, Chief Engineer of the Union Pacific R.R. during its construction period. Following the completion of the Union Pacific he worked as a surveyor with office at Salt Lake City, and he also served as chief clerk in the office of the Surveyor General of Utah. Subsequently he was engaged as Engineer of Location and Engineer of Construction on many early Western railway projects. Shortly after the San Francisco fire and earthquake in 1906, he established his headquarters as a surveyor in that city. A few years later he returned to Utah and retired as a farmer.

William E. Craighill, Colonel, Corps of Engineers, U. S. A., whose death was briefly noted in these columns last week, was born in Maryland, Dec. 20, 1863. He was a son of Brig.-Gen. William P. Craighill, former Chief of Engineers of the United States Army. After being graduated from the United States Military Academy at West Point in 1885 as second in a class of 39 cadets, he was commissioned Second-Lieutenant in the Corps of Engineers. During the War with Spain in 1898 he was offered and declined a commission as Major and Chief Engineer of Volunteers. In 1899 he was commissioned Major in the 40th Infantry and went to the Philippine Islands. From there he was sent to China during the Boxer uprising in 1900, being on the staff of the commanding general. Later he was reinstated in the Corps of Engineers and at the time of his death was in charge of the Boston district, Northeast division.

Harold Parker, M. Am. Soc. C. E, Vice-President of the Hassam Paving Co., Worcester, Mass., and former Chairman of the Massachusetts State Highway Commission, died Nov. 29 at his home in Lancaster, Mass., aged 62 years. He was born in Charlestown, June 17, 1854, and was a lineal descendent of the Massachusetts Pilgrims. He was educated at Phillips Exeter Academy and Harvard College. His engineering experience began at the Pennsylvania Steel Works, where he served for a time as a foreman. Later he returned to Massachusetts and with F. W. Bateman, of Clinton, organized the firm of Parker & Bateman, Civil Engineers, of which firm he continued to be a member to the time of his death. He was appointed a member of the Massachusetts State Highway Commission in 1900. Later he was made Chairman of the commission, in which capacity he served until 1911, when he resigned to become Vice-President of the Hassam Paving Co. He also served as Chairman of the Wachusett Mountain State Reservation Commission and as Chairman of the State Forest Commission. Mr. Parker was a member of the advisory board appointed in 1913 by Governor Dix to investigate and report upon the New York State Highway Department. He was a Past-President of the American Road Builders Association and of the Massachusetts Highway Association.

ENGINEERING SOCIETIES

NORTHWESTERN ROAD CONGRESS.
Dec. 7-8. In Chicago. Secy., J. L. Long, Moline, Ill.

PORTLAND CEMENT ASSOCIATION.
Dec. 11-13. Annual meeting in New York City. Assistant to General Manager, A. H. Ogle, Chicago, Ill.

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

The County Road Engineers' Association of Kentucky is to hold a meeting Jan. 17 to 20 at Bowling Green, Ky.

The Electric Power Club held its seventh semi-annual meeting at Hot Springs, Va., Nov. 15 to 18, the attendance comprising about seventy men, representing thirty manufacturers of electric motors, generators, transformers and industrial control apparatus.

The National Fire Protection Association will hold its next annual meeting May 8 to 10 in Washington, D. C. The winter meeting of the executive committee has been called for Dec. 15 by Chairman F. J. T. Stewart. The secretary is Franklin H. Wentworth, 87 Milk St., Boston.

The Cleveland Engineering Society on Nov. 21 listened to talks by F. H. Newell and Hunter McDonald and to a communication from Isham Randolph. The three speakers with M. L. Cooke were in Cleveland to attend a meeting of the plan-and-program sub-committee of the National Conference on Coöperation. Mr. Randolph's contribution was a brief autobiography limited to the earlier years of his career, to bring out the importance of the help and guidance obtained by the young engineer from his older professional brothers. Professor Newell sketched some of the phases of engineering coöperation. Mr. McDonald gave an advance summary of the elaborate printed argument which is being prepared at Nashville by a committee of the Engineering Association of the South to bring about the location of the government nitrate plant at Muscle Shoals on the Tennessee River.

The American Institute of Mining Engineers—The Committee on Nominations submits the following names as its nominees for officers in 1917: President, Sidney J. Jennings, New York; vice-presidents, Walter H. Aldridge, New York; Mark L. Requa, San Francisco; for directors, J. E. Johnson, Jr., New York; Allen H. Rogers, Boston; Howard N. Eavenson, West Virginia; Robert M. Raymond, New York; Willet G. Miller, Canada. The report of the Nominating Committee goes on to say that many letters have been received regarding the presidential nomination, and that some of the letters indicate that the authors feel that the nomination of president should be left entirely to the Committee on Nominations without any effort by the members at large to influence them, while others feel that the nominations are largely controlled by small groups and that the members at large can have little influence. As a result of this influence the majority of the Committee suggests that the method of making nominations be changed so that at least two candidates for the various offices be nominated, and suggests that the directors appoint a committee to investigate this question thoroughly.

Southwestern Engineering Society—A. F. Barnes, Dean of Engineering, of the New Mexico College of Agriculture and Mechanic Arts, State College, N. M., has been endeavoring to organize a Southwestern Engineering Society. Letters have been received from prominent engineers in New Mexico, Arizona and Texas expressing the need of such an organization. Among the men who have promised their support are Dean G. M Butler, University of Arizona, Tucson, Dean S. H Worrell, Texas School of Mines, El Paso; Professor Brenneman, University of New Mexico, Albuquerque; Samuel I. Bousman, Engineer for the Chino Copper Co., Hurley, N M.; H. L. Stevens, consulting refrigeration engineer, El Paso; E. H Baldwin, El Paso, Project Manager of the Elephant Butte

Dam; and S. O. Andros, Albuquerque, "Chairman of the New Mexico State Directors, Naval Consulting Board." The object of this organization will be to promote the science of engineering in the Southwest. The principle means for this purpose shall be: First, the holding of meetings for the reading and discussion of professional papers especially upon such questions as are peculiar to this region; second, to give opportunity for social intercourse and thus establish a common interest in the welfare of the engineering profession. Admission to this society will no doubt not only be open to practicing engineers, but opportunity to join will be given to any person so connected with engineering as to qualify him to coöperate with engineers in the advancement of professional knowledge. It is planned in a short time to call a meeting of those engineers that have shown interest in the matter and at such a time draw up tentative plans and program for a general meeting to be held at a suitable place at which time final organization can be effected.—A. F. Barnes.

Appliances and Materials

Sound-Absorbing Stone

Another sound-absorbing stone veneer has been put on the market—this time by the H. W. Johns-Manville Co., of New York City. It bears the trade name "Akoustolith" and is made under the patents of R. Guastavino and W. C. Sabine, who, it will be recalled, have developed a sound-absorbing dome tile. The new veneer has an absorbing capacity of from 38 to 57%, at the standard pitch of violin C, and is second only to hair felt. It is a molded material of concrete nature and is applied over any masonry surface. It can be made in tile or brick form or cast into ornamental pilasters, moldings, etc. It has about a third the weight of stone and is made in a variety of colors.

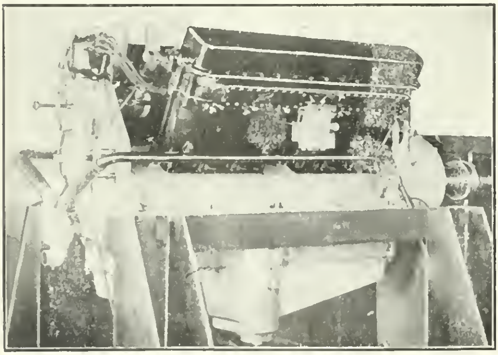
* * *

A 300-Hp. Aëronautic Motor

A 300-hp. aëronautic gasoline engine, the largest ever attempted, has been completed by Frank H. Trego, Chief Engineer of the Knox Motors Co., Springfield, Mass., in response to the demand voiced by U. S. Naval Advisory Board and the Navy Air Service. A year's study was spent on the design. The first motor, weighing 1,400 lb. complete with electric starting and ignition system, was recently run on a dynamometer at Springfield under full load for eight hours.

The general arrangement is that of a 12-cylinder 60° V-type. The crank case is of a special aluminum alloy, one piece each for the upper and lower halves. For support, a shelf running the full length of the case on each side takes the place of legs. The motor will enter a frame 15 in. wide—17 in. between holding-bolt centers. The cylinders are of aluminum alloy and have ⅛-in. cast-iron liners. They are cast in blocks of three and are open at both ends. Total piston displacement is 1,488.5 cu.in. Water jackets extend below the stroke. Cylinder heads are of aluminum alloy, cast in blocks of six. Each head carries four cast-iron valve seats, cast in, with each seat practically surrounded by the head water jacket.

Cam shafts and rocker arms are in the head; each shaft has eight bearings, and the rockers are supported above. All head mechanism is under forced-feed lubrication with drainage to the crank case. The head has a protecting cover. One end of the case supports a large alloy-casting support for the propeller shaft and starting motor. On the other end of the motor are the supports and housing for timing gears, water and air pumps, ignition apparatus and lighting generator. There is nothing on the outer sides but the carburetors. The main shaft is of chrome-nickel steel and has three bearings—babbitt in bronze shells. Connecting-rods are drop forgings; pistons are of aluminum alloy. The propeller shaft (3⅜ in. bored to ½ walls) is carried on heavy double-row ball bearings with double ball thrust bearings. Gears between the motor and propeller shaft allow various speed ratios, the preliminary tests being made with 1,600 to 1,140 r.p.m.



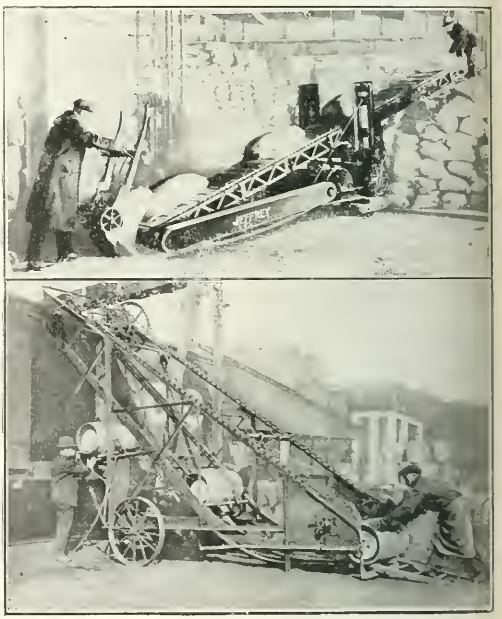
TREGO 300-HP. AERONAUTIC MOTOR

* * *

New Line of Portable Conveyors and Stackers

During the past year, the Jeffrey Manufacturing Co., of Columbus, Ohio, has completed the development and is now marketing a new line of portable conveyors and stacking machines. A combination of light weight and heavy duty is claimed secured. The conveyors are of the endless-belt type and are built in 20-ft. framed sections (each with its own belt) mounted on ball-bearing casters and with guarded chain belts connecting the end sprockets. A 5-hp. motor is sufficient for seven sections, the driving section being placed anywhere in the string. The belts are usually 18 in. wide and travel at a speed of 125 ft. per min. The capacity of such a conveyor is 1,500 80-lb. packages per hour.

There is a barrel loader, made up of a pair of triangular steel trusses, moved about like a balanced two-wheeled baggage truck, in which a pair of endless chains with crossbars engage the barrels at the ground level and roll them up an inclined track and let them off at an upper (8 ft.) or a middle (5 ft.) level according as the track may be set. A 2-hp. motor drives one of these machines and with it two men can handle up to 180 bbl. per hr. This loader weighs 3,200 lb. and costs about $700.



PORTABLE BARREL LOADER AND BAG STACKER

A portable stacker is also included in the new equipment This is of the full-apron type, for bags and miscellaneous freight, and has been built for up to 42x52-in. by 5-ft. 600-lb. bags. The loading boom is 24½ ft. long; the lower end is pivoted on a latticed steel frame carried by ball-bearing casters, and the upper end is lifted (to 14½ ft. maximum height) by hand-winch cables running to under-struts beneath the boom forward of the middle. The boom supports 6x12-in. wood flights mounted on two roller chains. A 2-hp. motor drives the stacker, which weighs about 2,700 lb. and costs about $750.

Engineering News

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Ten-Span Concrete-Arch Bridge Near Columbus, Ohio

By E. P. Knollman*

SYNOPSIS—Article gives in considerable detail the items of interest in the design and construction of a long reinforced-concrete arch bridge of no special complication. Interest of article is mainly in fact that it represents the latest standards of practice in concrete-bridge construction.

The Agler bridge, just completed over Alum Creek in Franklin County, Ohio, is located about 5½ mi. northeast from Broad and High St., Columbus, Ohio. The structure is of reinforced concrete with a total length of 1,166 ft. and an overall width of 27 ft. 2 in. It consists of ten arch spans of varying lengths, with three small trestle spans at the west end and three similar spans and curved retaining-wall approach at the east end. The length of the various spans, beginning at the west end, is as follows: Three 10-ft. 2-in. trestle spans, ten ribbed arches having the following clear spans—67 ft. 8 in., 90 ft. 8 in., 90 ft. 8 in., 113 ft. 8 in., 136 ft. 8 in., 136 ft. 8 in., 113 ft. 8 in., 102 ft. 2 in., 90 ft. 8 in. and 44 ft. 8 in.; three 10-ft. 2-in. trestle spans and a curved retaining-wall approach. All of the arch piers and eight of the trestle piers are supported on wood pile foundations. The bridge has a 20-ft. clear roadway and one 4-ft. clear sidewalk, the latter placed on the north side of the bridge so that the amount of snow and ice will be a minimum.

The bridge is so designed that all spandrel spans and the six trestle spans are of the same length. Floor-beams spaced 11 ft. 6 in. apart frame into spandrel columns, the distance between floor-beams being spanned by a 12-in. slab. Each arch consists of two ribs spaced 20 ft. on centers. In order to provide for variations in temperature and rib shortening, all arch ribs have a crown section in which the depth of the rib is less than the width. The crown sections of the arches vary from 25x34 in. for the 67-ft. 8-in. span to 39x42 in. for the 136-ft. 8-in. span.

In computing temperature stresses it was assumed that any rise in temperature would be balanced by rib shortening under dead-load. The ribs were designed according to the method given by Turneaure and Maurer, provision being made for a drop in temperature of 25° F., which, combined with rib shortening, made a total drop of 50° F. The bridge is designed for the following live-loads: For the floor and its supports a uniform load of 200 lb. per sq.ft. on the roadway and 100 lb. per sq.ft. on the sidewalks, each with 25% impact, or a concentrated load on the roadway of a 24-ton truck and a uniform load of 100 lb. per sq.ft. on the sidewalk, each with 25% impact; for the arch rings and foundations a uniform load of 100 lb. per sq.ft. on both roadway and sidewalk, each with 25% impact. The allowable stresses used in this design were as follows: Concrete in compression, 650 lb. per sq.in., except in arch rings, where 700 lb. per sq.in. (including rib shortening and temperature) was allowed; concrete in shear, 50 lb. per sq.in.; steel in tension, 16,000 lb. per sq.in.; steel in compression, not more than 15

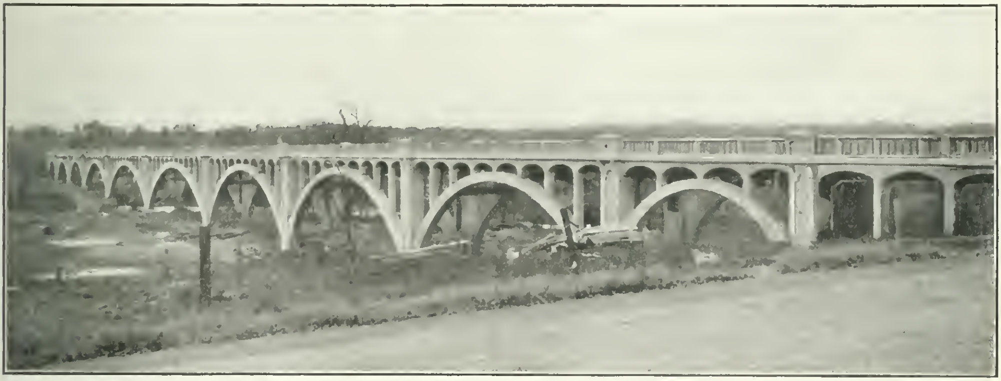

FIG. 1. VIEW OF ONE END OF THE COMPLETED AGLER BRIDGE IN FRANKLIN COUNTY, OHIO

times the unit compression in the surrounding concrete. The maximum load per pile is 20 tons. The entire bridge, with the exception of the concrete pavement and concrete railing, is built of 1 : 2 : 4 concrete, using Medusa portland cement, Canadian sand and crushed limestone.

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*Assistant County Surveyor, Franklin County, Ohio, Columbus, Ohio.

The concrete pavement is a 1 : 2 : 3 mixture of the same materials as the bridge proper. It is 5 in. thick and is laid on the 12-in. floor slab after the slab has been waterproofed with a layer of fabric and two coats of asphalt. The pavement is reinforced with a mesh weighing 28 lb. per 100 sq.ft., and is placed in the center of the 5-in. slab. Over each arch pier there is an expansion joint in the pavement. Kahn armor plate was used at all expansion joints.

The concrete railing is a 1 : 1½ : 2½ mixture of portland cement, silica sand and granite chips. The sand was graded from ¼ in. down and the granite chips from 1¼ in. to ⅜ in. All railing posts were tooled with a patent hammer and all web sections scrubbed so as to expose the aggregate. No tooling was done before the concrete was at least one month old and in tooling the large railing posts considerable difficulty was experienced in holding the edges true. Accordingly, for the small railing posts a margin of 1 in. around all corners was rubbed and the remainder of the posts tooled.

EXPANSION AND DRAINAGE

Expansion in the concrete railing was carefully considered, and in the design adopted there are no horizontal sliding surfaces and no inserts, but both ends of each 10-ft. 4-in. panel have vertical expansion surfaces. There is absolutely no connection between the railing posts and web sections. The expansion surfaces are separated by an air space of not more than ½ in. which was obtained as follows: The railing posts were poured; then a piece of heavy gage sheet steel was placed at the ends of the wet forms and ordinary shingles were used to wedge between the railing posts and the sheet steel. This wedging was carefully done so that upon removal of forms the ends of the web are parallel to the railing posts. Previous experience has shown that expansion or contraction is especially difficult to provide for in concrete railings and that the expansion joints in such a railing must be close together if unsightly cracks are to be avoided. In addition, a considerable amount of reinforcement should be placed in the railing.

In designing the bridge especial attention was given to drainage and expansion, and an effort was made to correct such defects as have developed in similar structures previously built in Franklin County. To provide for drainage, scuppers are so placed that the water will not flow over an expansion joint before reaching the inlets. The storm water is carried through 6-in. cast-iron pipe to a point about 10 ft. above the ground and there discharged. The drainage system is so arranged as to be invisible in a side view of the bridge.

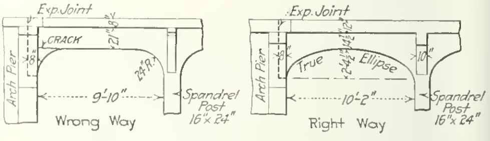


FIG. 3. WRONG AND RIGHT WAY TO DESIGN FASCIA GIRDERS

At expansion joints the horizontal sliding surfaces have been reduced to a minimum; and where they do occur, rolled steel or steel and bronze expansion plates are used. All vertical expansion surfaces are separated by a thickness of tar paper or Elastite expansion strip, and the vertical sides of all stringer bearings are beveled in order that the joints will not bind, but will tend to open whenever contraction takes place. In constructing the earlier sidewalks the tar paper at the vertical expansion joints was cut off about ¼ in. below the finished surface of the sidewalk. At such points spalling of the sidewalk has occurred from the surface of the sidewalk to the point where the paper was cut off. As a result, felt ½ in. thick,

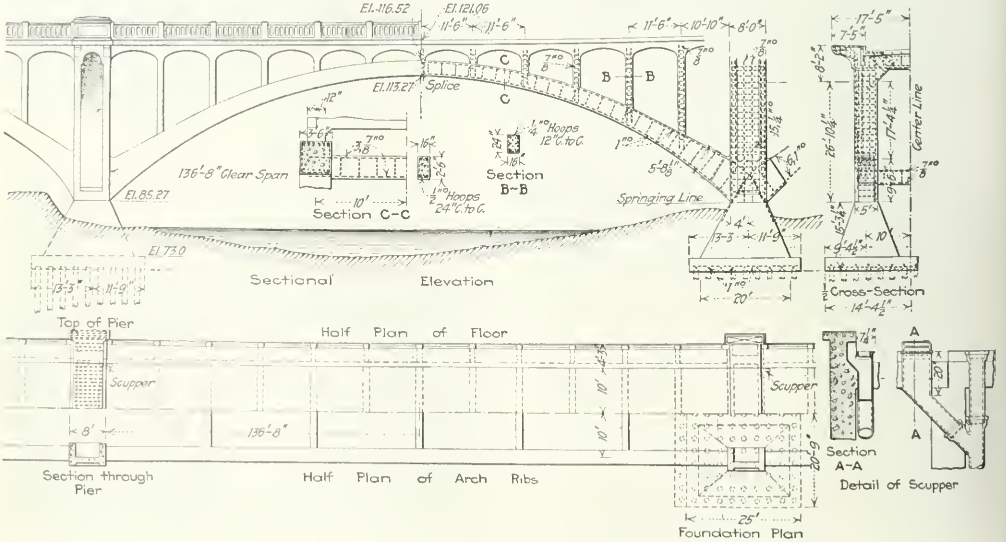


FIG. 2. DETAILS OF ONE OF THE LARGE ARCHES OF THE AGLER BRIDGE

extending through the surface of the sidewalk, is now used for all vertical sidewalk expansion joints.

The writer was resident engineer on the construction of a large ribbed arch bridge during the summer of 1914, in which the spandrel face beams were as shown at the left in Fig. 3. In several cases at expansion joints these fillets cracked, as shown. To remedy this defect an ellipse was used for the spandrel beams of the Agler bridge, as may be seen at the right in Fig. 3.

The outside faces of all arch ribs are divided into sections by means of rustications, as illustrated in Fig. 1. This improves the appearance of the structure to a considerable extent. In the opinion of the writer any means employed to break up large, plain surfaces improves the appearance of concrete work. When designing a concrete structure all construction joints should be located and an effort made to hide them by means of rustication or otherwise.

The exposed surfaces of the bridge are finished by rubbing in a thin mortar with carborundum brick when the concrete is from two to six days old, and later on when the work is finished the concrete is given a second rubbing with carborundum and water.

The bridge is wired for lighting, a 2-in. fiber conduit being embedded in the coping. This fiber conduit is weak at the joints, and a standard metal conduit is to be preferred. Fuse boxes of brass, with aluminum faces and doors, are used. They have hinged doors, are provided with locks and are placed on the outside of the bridge.

Construction Methods

Two stiff-legged derricks served for driving the Wemlinger sheet-steel piling for the coffer-dams, for excavating with orange-peel buckets, for driving the foundation piling, for depositing concrete, pulling sheetpiling and for backfilling. Fig. 4 shows practically all the equipment employed on the job. The light-weight Wemlinger sheetpiling was very satisfactory, as was the orange-peel bucket. The foundation piles were driven with No. 2 Union steam hammers. For the footing and pier-base concrete two Ransome "Bantam" mixers were used. The main concrete-mixing plant consisted of a ⅓-yd. Ransome mixer and an elevating tower. The concrete was deposited by means of chutes and buggies. The concrete mixer and elevating tower were moved twice during the construction of the bridge. Steam for the large concrete mixer, hoisting engines, pumps, derricks, pile hammers, etc., was piped from two central plants. Materials were hauled 1½ mi. from the railroad siding to the bridge site. Wagons were used for hauling, which cost 55c. per cu.yd. for sand and stone.

The arch centers are very light and were built as shown on the centering plan in Fig. 5. All centering was spiked, no bolts being used except where centering posts were spliced. For checking the intrados of the arches a board about 15 ft. long with one edge cut to proper radius was slid around the arch barrel. The first six arches were poured by starting at the haunches and completing one entire rib at one pouring, with the use of bulkheads. The other four arches were poured in sections, haunches first, then crown and lastly intermediate sections. The rib forms and all deck forms were so designed that they could

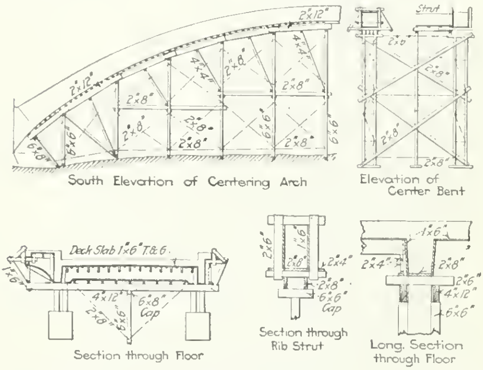


FIG. 5. DETAILS OF CENTERING FOR AN ARCH IN THE AGLER BRIDGE

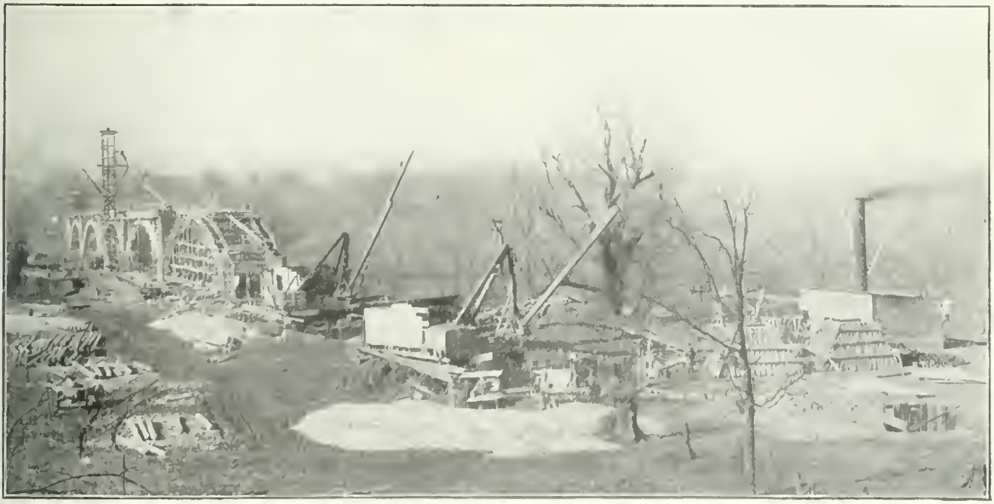


FIG. 4. VIEW OF AGLER BRIDGE UNDER CONSTRUCTION

be used several times. This was done with fair results. After being used three times, the $\frac{7}{8}$-in. forms were in such shape that considerable rebuilding and repairing were necessary. The writer believes that it would be advisable to limit the number of times forms may be used. The contractor states that he has applied for patents on the general centering scheme.

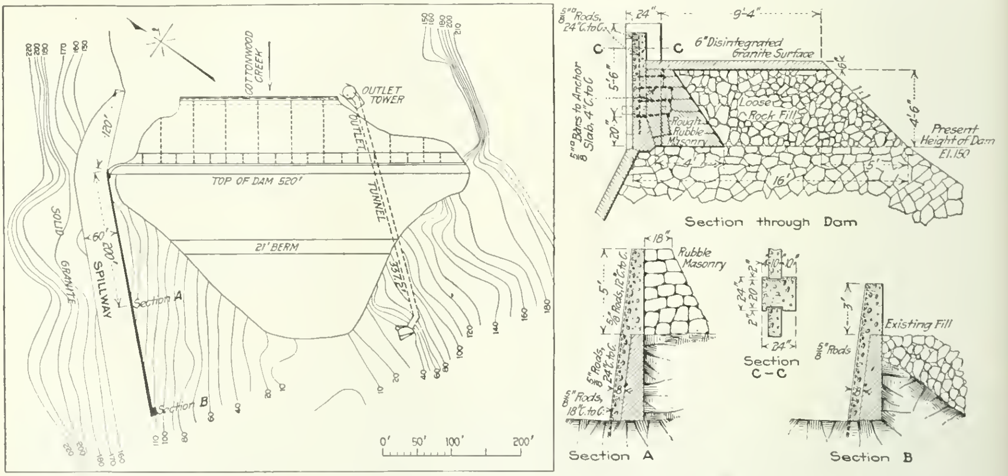
The bridge contract includes about 5,000 cu.yd. of excavation, 20,000 lin.ft. of piling, 5,100 cu.yd. of concrete and 202 tons of reinforcing steel. The total cost of the bridge is about $102,500, or $3.25 per sq.ft. overall, including cost of handrail and pavement. Construction was commenced in the summer of 1915 and the last concrete in the pavement was poured the latter part of October, 1916. To date no cracks have been observed in the structure anywhere.

The contractor for the bridge is the Stewart Engineering Corporation, of New York City. John Peake is County Surveyor. The bridge was designed by the writer under the supervision of Walter Braun, County Bridge Engineer. The computations were checked by W. J. Watson & Co., of Cleveland, Ohio. The writer was the resident engineer for the county.

⁂

Plan for Raising the Height of Morena Dam

As a measure of safety to prevent the Morena dam from being overtopped in case of another flood such as that which southern California experienced last January, the City of San Diego is making preparations to add 5 ft. to the height of the dam in order to increase the spillway capacity. City Engineer George Cromwell has recommended this improvement in a report that the city council has accepted, and it is expected that work will be commenced within a very few weeks.



DETAILS OF PROPOSED METHOD OF ADDING 5 FT. TO HEIGHT OF MORENA DAM, SAN DIEGO WATER-SUPPLY

The Morena dam is a rock-fill structure that was completed in 1912. Its reservoir was filled for the first time by the flood of last January. Prior to that time it had been considered that the spillways of both the Morena and the Lower Otay dam, which failed during this storm, were more than sufficient to care for any runoff that might come into either of the reservoirs. This belief, however, was erroneous, for the runoff into each of these reservoirs was much greater than the capacity of the spillway of either dam. The water level in the Morena reservoir was so low that the capacity of the reservoir absorbed the greater portion of the runoff, and the spillway took care of the remainder, although when the storm was at its height the water came within 18 or 20 in. of the top. It is feared, however, that should the coming winter season bring heavy rains the runoff will again exceed the capacity of the spillway, and with the increased height of the water level the dam will be topped.

Mr. Cromwell in his report makes the following conclusions after a careful study of the rainfall, runoff and flood conditions at the Morena reservoir for the past season:

> The water level in the reservoir stood at 138.5 ft. at 7 a.m. on Jan. 27, and during the 24-hr. period from 7 a.m. Jan. 27, to 7 a.m., Jan. 28, 1916, there was a runoff of 5,707,000,000 gal., or enough additional water to fill the reservoir to within 18 in. of the top of the dam with the spillway running wide open all the time. If the water level in the reservoir had stood at 141.5, or only 3 ft. higher than it actually was at 7 a.m. on Jan. 27, it would have been impossible to prevent the water from filling the reservoir and flowing over the top of the dam just as it did in the case of the Lower Otay.
>
> It is impossible to say just what would be the consequence if any considerable quantity of water was allowed to flow over the top of Morena dam, but there is a very grave question if the dam would be able to withstand successfully such a condition.
>
> Morena is a rock-fill type of dam and was not built to withstand topping like an overflow type of dam. It might survive such a condition; but we have no right to assume this, and it would be very unwise in my opinion to do so. There are several different methods by which we can safeguard Morena dam against the danger of overflow:
>
> 1. Protect the downstream face of the dam by paving with concrete in order to prevent erosion of the face in case water should flow over the top of the dam.
>
> 2. Enlarge the capacity of the spillway by deepening or widening.
>
> 3. Raise the height of the dam and thereby increase the capacity of the reservoir and the spillway at the same time. This scheme is shown in the accompanying drawing.
>
> 4. Keep the water level in the reservoir below the 141-ft. contour during the winter months, so that the reservoir will have enough capacity to absorb any flood of the same magnitude as the one on Jan. 27, 1916, without danger of topping.

The first method—paving the downstream face of the dam—was eliminated because of the expense. Officials doubted if $100,000 would cover the cost. Furthermore, the dam was never intended to be an overflow type of dam.

The second method appeared to be impracticable, owing to conditions on the ground which would prevent the widening of the spillway, and to deepen it would diminish the capacity of the reservoir.

The third plan—raising the height of the dam—appeared to be the most logical. By the addition of 5 ft. to the height of the dam the capacity of the reservoir will be increased above the present spillway crest, and at the same time the capacity of the spillway will be increased to such an extent that the water level in the reservoir can be maintained at the 146-ft. contour, or the crest of the present spillway, without any danger of an excessive flood like that of last winter topping the dam.

The fourth method—maintaining a low-water level—is suggested by Mr. Cromwell as an emergency proposition only, to be followed in case no other method of protection is possible. In his report he estimates that the amount of water which would be wasted in maintaining this low level would be worth at least $75,000.

In addition to raising the dam it is planned to deepen the lower end of the spillway and thus give a steeper grade, which will carry the waste off much faster than at present. It is also planned to place a log boom in front of the spillway to prevent the choking of the entrance with floating débris.

The engineer's estimates of the work to be done at Morena are as follows:

200 cu.yd. reinforced concrete @ $20	$4,000
400 cu.yd. rubble masonry @ $8	3,200
1,000 cu.yd. loose rock fill @ $3	3,000
100 cu.yd. surfacing material @ $1.50	150
	$10,350
Engineering and superintendence, 15%	1,542
Total cost of raising dam 5 ft.	$11,892

An appropriation of $15,000 is asked for the entire improvement, the balance of $3,108 to be expended for the log boom and additional repairs to the present spillway.

⁂

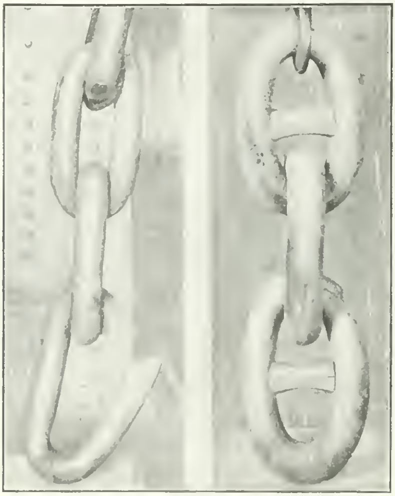
Large Chain Cables Now Power-Forged at Navy Yard[*]

By Frederic G. Coburn[†]

There has been developed, during the last two years, at the United States Navy Yard, Boston, Mass., a power-forging process for the manufacture of chain cables which has been highly successful. No great mechanical difficulty was experienced in the manufacture of chain by hand until diameters as great as 2¾ in. were reached; even that size was fairly well handled; but when the 3-in. cables were taken up, serious difficulties were encountered on account of the size of the metal, the mechanical difficulties involved and the very hard labor required of the chain makers' helpers. It was not only difficult to get chain makers to make good chain; it was exceedingly difficult to get them to attain a satisfactorily high rate of production and regularity of attendance.

When the Panama Canal Commission went into the market for the guard chains for the Panama Canal, which were 3 in. in diameter, the Boston Navy Yard was the only plant that could reasonably approach the requirements of the commission. A great part of these cables was made with open links—that is, without studs—and hence was inherently weaker than stud chain; and as the welds were not well made the ultimate breaking stresses obtained were low. Whereas 525,000 lb. ultimate breaking strength was required for stud-link chain and desired for 3-in. open-link chain, it was found necessary to reduce the requirement to 500,000 lb. and subsequently to 450,000. Private chain makers were given contracts. Their chain was not so good as that made by the hand-welders at the Boston Navy Yard; it lacked the uniformity in shape and size of link and was not so well welded.

The causes of the inferiority of hand-made welds become apparent after experience in the testing pit. The helpers can not hit hard enough with their sledges to drive the two scarfs together. The welding surfaces are not smooth, because they are formed by peening; pockets are thus formed, which retain slag; and the hammering does not work out this slag. Thus the weld is incomplete. Sometimes a pocket as big as a half-dollar is found, occasionally open to the sea by a small crevice. Fractures have been produced in proofing old chain which showed that not over 10% of the surfaces was welded; only the strength due to form, assisted by the tacking together of the scarfs, had held those links intact in service.



TWO 3¼-IN. POWER-WELDED TRIPLETS; ONE OPEN LINK, THE OTHER STUD LINK

Triplet at left broke under test at 532,000 lb. Chain at right weighs 595 lb. per fathom and runs 6 links per fathom—ultimate strength 612,000 lb.

In the large chain it was impossible to finish the inside of the link at the welded end, thus leaving a hollow and reducing the sectional area.

Another serious defect in the hand-welded chain is the wasting of the material, in the fire, just back of the weld.

⁂

Royalties on Iron Ore taken from mines owned by the State of Minnesota amounted to $475,000 for the three months ending Oct. 1. From present indications the total ore taken from the state mines this year will exceed 4,000,000 tons, and the royalties will be in excess of $1,000,000

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[*] Paper presented before Society of Naval Architects and Marine Engineers, at New York meeting, Nov. 16, 1916.

[†] Naval Constructor, United States Navy.

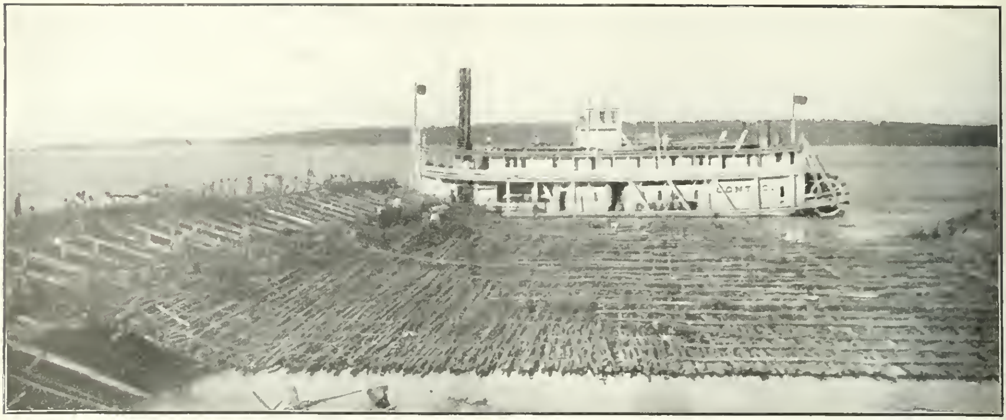

FIG. I. WEAVING A BRUSH MATTRESS ON THE MISSISSIPPI AT PANTHER FOREST, ARK.

Five Days on the Mississippi

By Frank C. Wight*

The Mississippi River is a curiously paradoxical stream. Its variability is invariable. Year after year its enormous drainage area delivers into the sinuous channel more water than the established banks can hold and there results a flood the height of which depends on the stability of the man-made defenses. When the water goes down, notable topographical and even geographical changes are revealed. Though you never can tell just what the river will do at any one place, you can always be sure that what it does will only be a duplicate of what it has already done at the same or at other places many times before.

The control of the Mississippi partakes of this same invariability. Many years ago engineers studied the river and devised certain methods to curb its power and make habitable its alluvial valley. Those methods have persisted in spite of a perennial crop of amateurs whose schemes and plans for river control have more of novelty than of merit. These facts have become so firmly embedded in the engineer's mind that he is apt to assume that so far as Mississippi River control is concerned there can be no new thing under the sun and he dismisses the work there from his mind except at time of flood, when he may wonder why certain apparently self-evident schemes have not been utilized to better protect the rich alluvial valley. The fact is that the protection of the Mississippi Valley has within the past few years taken on a somewhat new form. The general methods have not been changed, but more modern adaptations of these methods are constantly being attempted. Because the writer knew that a number of these newer schemes were being put into effect on the Third District of the Mississippi River Commission's work—that is, the district extending from just below Memphis to just below Vicksburg—he welcomed the opportunity of making an inspection trip during the month of October with Maj. John R. Slattery, Corps of Engineers, U. S. A., the officer in charge of the district.

Possibly the best way of bringing before the engineering world these newer methods of work on Mississippi River control is to give an account of this trip. It should be understood that similar work is under way both above Memphis and below Vicksburg, and the description which follows is indicative of what is going on along the whole stretch of the alluvial valley from Cairo to the Passes.

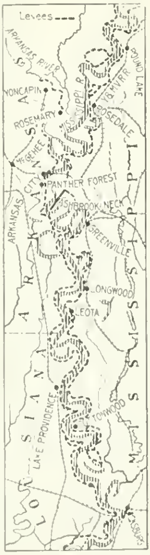

FIG. 2

As shown on the accompanying map, the whole of the Third District is protected by levees with the exception of the west bank on either side of the Arkansas River, and here new levees are under construction to close the gap through which high water enters to flood the territory surrounding Arkansas City, itself well guarded at its front from the direct rise from the Mississippi. Work elsewhere in the district consists in raising the old levees to a height indicated by the record flood of 1913, the construction of levee loops back of the levee lines threatened by caving banks, and the protection of banks. In all this work the distinguishing feature is the increasing utilization of machinery to replace man and animal labor and of concrete to replace wood and riprap in bank protection. In these improvements alone lies the difference in Mississippi River regulation of today from that of a quarter-century ago, and the essential elements in the new methods were all observed in the five-day trip down the 200-odd miles of river. The old levees were for the most part simple earth ridges placed by mule, negro and barrow or scraper from riverside borrow pits. The new levees are from 3 to 10 ft. higher and are widened in proportion plus the addition of a large landside banquette which adds strength and security against percolation. A few years ago the river engineers began to experiment with machines to build this enlargement—and incidentally to build new levees. The idea has so grown that now about 30 machines are in operation between Cairo and the Gulf.

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*Managing Editor, "Engineering News."

The chief difficulty in the use of such machines is to find a place within reach of the machine where sufficient earth can be excavated. Already the riverside pits adjoining the levee are as deep as safety permits. To dig on the land side is objectionable for numerous reasons, although allowable under extreme conditions. How the various machines at work in the Third District meet the requirements is set forth here. There has also been prepared (Fig. 4) a sketch drawn to scale showing the general conditions under which the machines in the district are working.

The Lidgerwood Cableway Near Round Lake

The first place visited was the stretch of levee elevation in the vicinity of Round Lake, reached from Memphis via the oft-flooded Yazoo & Mississippi Valley R.R. Here is operating the Lidgerwood cableway described by Major Slattery in his article in *Engineering News*, May 25, 1916, p. 986.

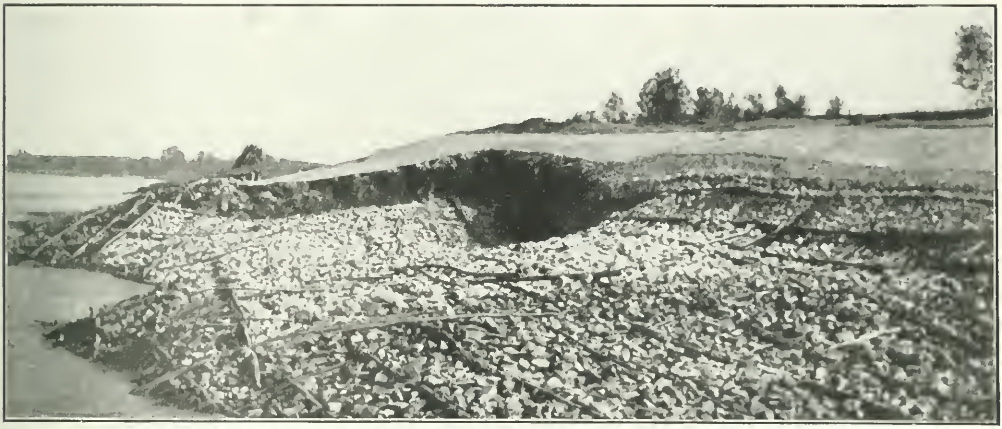


FIG. 3. CAVING BANK IN BRUSH MATTRESS BELOW CONCRETE BANK PAVING

The old levee here was 21 ft. high and had no banquette, and it had been built from borrow pits on the river side. After the 1913 flood it was determined that the tentative grade to which levees prior to that year were being built was from 2 to 3 ft. too low, and a general raising of the system to a new grade was therefore decided upon. It was also decided that the time had come to take up on a more general scale the construction of banquettes, as the system had reached a development that rendered it safe against all but extreme floods. The new height thereafter was decided upon of 24 ft., with the addition of a heavy banquette on the land side. The old and new sections are about as shown in Fig. 4.

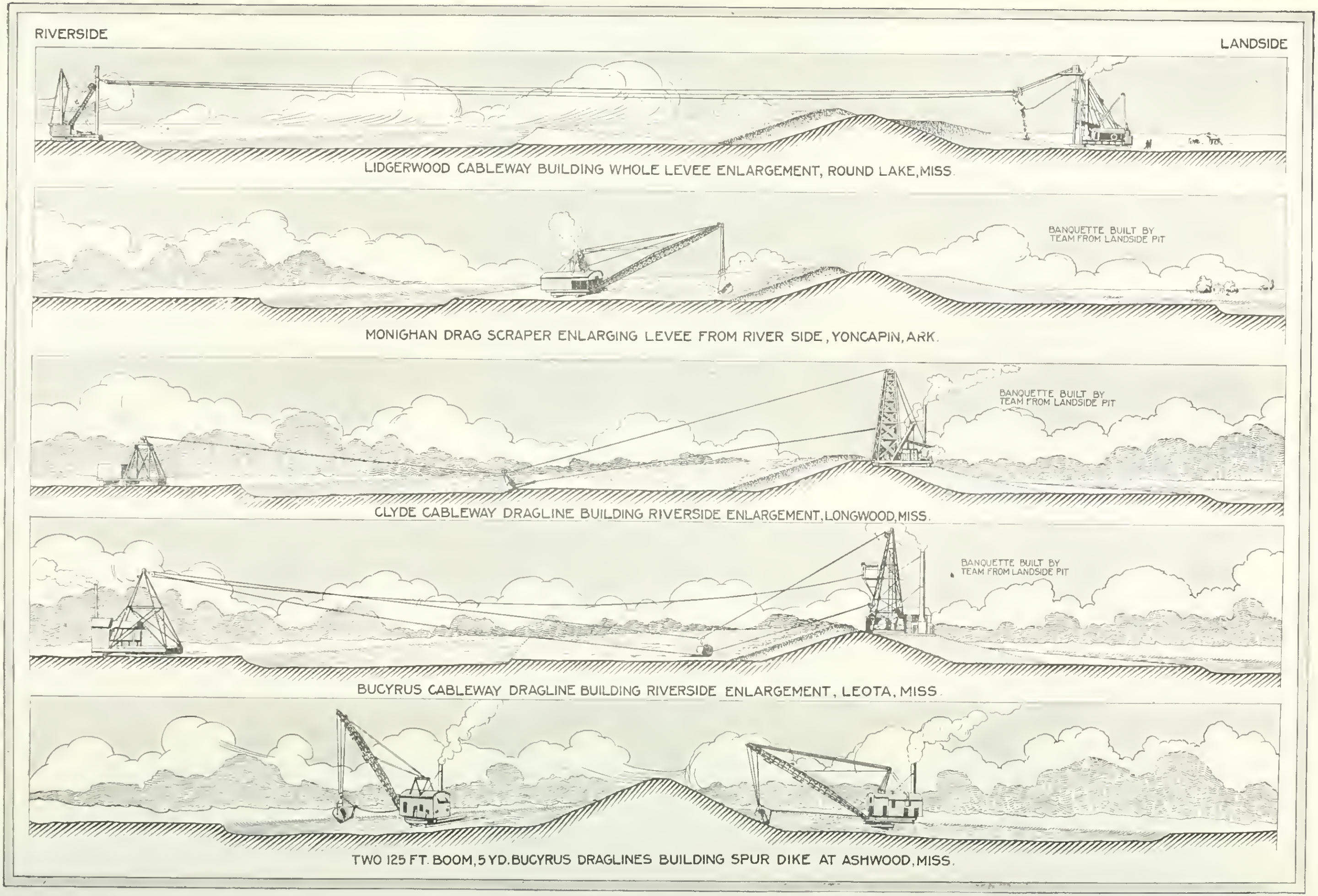
For numerous reasons—partly because of the unsightliness of landside borrow pits and partly because of unhealthy conditions arising from the stagnant mosquito-breeding water sure to collect in them, but mainly because of the reduction in the strength of the levee by landside excavation—it was decided that the extension of the levee should be made from dirt dug from the river side. But the old pit there was so deep, so wide and so saturated with water as to preclude the use of any ordinary machine and to make the haulage by animal power rather expensive. For these reasons the Mississippi River Commission purchased a new taut-line cableway excavator from the Lidgerwood Manufacturing Co.—a machine designed especially for this location.

The machine has a 3-yd. scraper bucket which digs in a limited area and is then lifted, carried through the air and dumped on the levee from a height of 10 to 40 ft. There are two movable steel towers about 660 ft. c. to c., the head tower being located entirely to the land side of the levee and the tail tower entirely to the river side of the borrow pit. The digging is all done beyond the old river end of the riverside borrow pits. The whole levee enlargement can thus be built in one operation from new ground on the river side, and this is the only machine on the river capable of doing this. With this machine as in all others, final smoothing of the surface has to be done by hand labor.

On account of some difficulties in maintenance, particularly because of an inexplicable rapid wear in the main cable, the machine has not been performing quite so well during the past summer as it did in the summer of 1915, as recorded in Major Slattery's earlier article. It is, however, digging now at about 19c. per cu.yd., which is probably considerably cheaper than the work could be done for by contract, using the old method of teams and scrapers. It is also claimed that the riverside conditions—that is, the extreme conditions of moisture and water in the borrow pit—make it practicably impossible to utilize any other machine at this location.

Government Camps Clean and Sanitary

The whole outfit is owned by the Government and operated by Government forces, and the camp showed the salutary effect of Government supervision. The tents are all of a special type devised by Major Slattery and built at the Government shop at Vicksburg. They are in effect portable houses with tent tops, consisting of screened side frames with canvas tops and provided with wooden floors and screen doors. The night-flying malar-


RIVERSIDE
LANDSIDE
BANQUETTE BUILT BY TEAM FROM LANDSIDE PIT
BANQUETTE BUILT BY TEAM FROM LANDSIDE PIT
BANQUETTE BUILT BY TEAM FROM LANDSIDE PIT

LIDGERWOOD CABLEWAY BUILDING WHOLE LEVEE ENLARGEMENT, ROUND LAKE, MISS.

MONIGHAN DRAG SCRAPER ENLARGING LEVEE FROM RIVER SIDE, YONCAPIN, ARK.

CLYDE CABLEWAY DRAGLINE BUILDING RIVERSIDE ENLARGEMENT, LONGWOOD, MISS.

BUCYRUS CABLEWAY DRAGLINE BUILDING RIVERSIDE ENLARGEMENT, LEOTA, MISS.

TWO 125 FT. BOOM, 5 YD. BUCYRUS DRAGLINES BUILDING SPUR DIKE AT ASHWOOD, MISS.

FIG 4 SKETCHES TO SAME SCALE SHOWING DIFFERENT METHODS OF BUILDING LEVEES WITH MACHINES IN THIRD DISTRICT, MISSISSIPPI RIVER

ial mosquito, whose activities were very evident in the pallor and languor of a number of the men we saw farther south, has a hard time getting at the Government engineer or laborer who stays inside of his Government-provided tent.

Furthermore, the camp at Round Lake had a cleaner and better-ordered aspect than some of those farther down the river, although of course some of the contractors observe the amenities of sanitation better than others. Taking it by and large, the negro laborers' camp is a pretty dirty place both morally and physically, so that the Government's efforts to clean up those which are under its charge are greatly to be commended.

At Round Lake we first saw the operation of sodding a levee, a common enough sight to those acquainted with Mississippi River work, but strange to the newcomer. Sodding consists in punching holes on 2-ft. centers on the side of the levee and depositing a few blades and roots of Bermuda grass in the holes thus made. It would apparently require the utmost optimism to hope that such a scanty distribution of these tiny plants would ever have any effect; but farther along we saw many miles of levee well covered with grass which had grown from just such a sparse planting.

Leaving Round Lake by team, we drove about a mile to the river, where we took up our week's quarters on the U. S. S. "Control," a sturdy, well-built, well-equipped sternwheeler which the Third District uses for inspection trips, surveys and tows. The river was near its lowest stage—about 6¾ ft.—which is some 50 ft. below the record flood height here. This meant that all bank protection work was exposed far down the mattress, that the banks themselves were high above the water and that the levees were all a mile or more inland. One realized the size of the river in flood after clambering up 20 or 30 ft. of slipping bank, walking two miles inland through cottonwood forests and cotton fields, and coming to a 20-ft. levee carrying on its top a pile of coal left for the excavators by a towboat during the last high water!

The first night we made a three-hour run down to Rosedale, the only night traveling done during the week. Navigation by night during a low-water period is not always soothing to the nerves, if the snag which we struck about an hour after we left Round Lake is any evidence. Collision with other vessels, however, need hardly be cause for worry, for in the five-day trip only *one* commercial steamer was sighted and that one was within rifle shot of Vicksburg.

Beulah Crevasse as It Is Today

Early next morning we started out from Rosedale in the omnipresent Ford, the only vehicle extant that can negotiate the Mississippi River roads. This particular machine was driven by an African aborigine who from appearance and clothing was only a few days removed from the Congo jungle, but who in time of stress could baby the engine with a facility equal to that of the best French chauffeur.

So conducted, we proceeded to the Beulah levee, made famous by crevasses in 1912 and 1913. Just about the site of the crevasses we saw our first teamwork. Here a few negroes and mules with drag scrapers are raising another levee to meet the new flood requirements. The camp reached the nadir of uncleanliness, and the men and mules both showed signs of wear.

At Beulah itself the record of the crevasse can be read in the eroded land area. The whole territory on the land side is deserted because of the two floods. The remnants of the closing trestle are visible at places about the earthfill. Along here, too, is what is known as the worst place on the Mississippi River. For a stretch of about 300 ft. the levee has literally dropped about 100 ft. and is sinking pretty nearly vertically at odd distances and odd times, while a bulged surface shows up far inland. It has cost the Government over $50,000 to bring the levee to its present level, and still there are signs of further subsidence, showing that the trouble is not yet over. Further enlargement of the levee is planned for the immediate future.

Up the Arkansas River

It had been planned to go up the Arkansas River in the boat to see the work there, but the extremely low stage prohibited this. There was in fact, tied up to the bank at Arkansas City, a packet which was drawing at the time only 18 in. of water, but which was held up from its customary trip up the river on account of prohibitive shoals. Instead of making the trip by boat, we took a train at Arkansas City, which might be called the Venice of America during three or four months of the year if one may judge from the mud lines that show about the top of the first-floor windows on all the houses.

The train took us to Yoncapin, on the Arkansas River, where the levees of that district are being raised. Here we saw two Monighan dragline boom scrapers raising the old levee from its elevation of 15 ft. to a new elevation of 20 ft., with a landside banquette (Fig. 4). This banquette, requiring about 1,800 cu.yd. per station, had to be built by separate excavation from the land side, while the elevation of the levee was done by excavation from the river side. The machines have been rebuilt so that each now has a 125-ft. boom and a 3-yd. bucket, which picks up the earth from the riverside borrow pit and swinging in a circle, dumps it on the levee. The contractor is getting about 12c. per cu.yd., which includes in one case the construction of a banquette, as previously noted, and in the other the construction of whole levee enlargement by a double handling of the work. In this stretch the borrow-pit area was heavily wooded and timber clearing was going on ahead of the machine. On another contract in this vicinity, another Monighan machine, which is working on trucks (the first two were working on rollers), is building a similar section of levee. This machine had to move three times to get the material to its proper place. The contractor is getting 11c. per cu.yd.

Still farther down the river is the scene of the Rosemary crevasse of last year, where teams are hauling earth from borrow pits in a wooded tract on the river side to fill up a 3,000-ft. break as an emergency job. As indicative of the difference in cost between machine and mule work, the contractor here is getting 25c. a cu.yd. The negro camp was characteristically bad.

On the way back to the boat, 30 mi. by Ford, we stopped for a time to see the setting up of an old Lidgerwood machine, which is about to go to work on the lower Arkansas River levee, where it will join the Mississippi levee and close the gap that now lets the water down on Arkansas City. This machine, operated from cableway, is one that was first used at the Sag canal enlargement for the Sanitary District of Chicago, then went into the Detroit channel work and finally to the New York Barge Canal at Rome. It still appears to be good for many yards of excavation. It will operate in practically the same manner as the other Lidgerwood machine at Round Lake.

Bucyrus Draglines Build Spur Dike

We reached the boat about noon and headed down the river for Ashbrook Neck, where two of the most modern machines on the river are being operated. Ashbrook Neck is a peninsula forming one of the famous Arkansas City-Greenville bends. For a number of years the bank has been caving at the narrow neck of the peninsula, now only 1,800 ft. across, at the rate of about 200 ft. per year, and the time is fast approaching when it would cut through and shorten the river about 6 mi. It is characteristic of the Mississippi that if it is shortened, it will attempt to make up its length some way or other: and if the Ashbrook Neck were cut through, there would be imminent danger of serious trouble at Greenville, at the foot of the bends. For this reason during the last year the commission decided to extend out onto the neck from the levee at its base a so-called spur dike of earth, and at the same time to revet the banks to retard the caving.

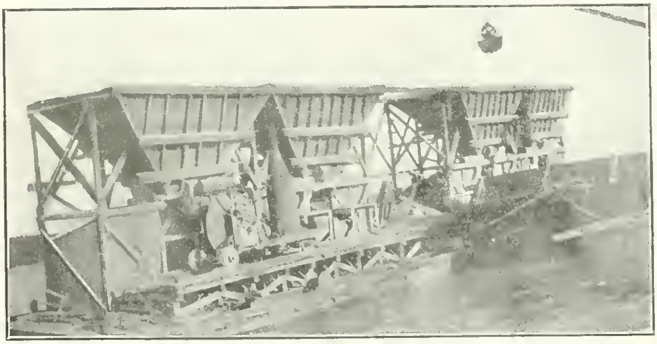


FIG. 5. CONCRETE MIXING PLANT USED ON BANK PAVING WORK

This new spur dike will be about 5 mi. long and will extend out to within 15,000 ft. of the other side of the river. It is an earth-fill from 21 to 35 ft. in height, with side slopes of 1 : 2½, and a top of 6 ft. It will be paved for some distance near the end on the side exposed to the flood current with 4 in. of concrete paving, which will extend down into a riprap-filled gutter at the river base. The end of the dike is curved to about right angles to its length, and the pavement will extend around the curved end to the straight portion.

To guard further against scour along the upper side of the dike, a system of permeable brush dikes will be constructed wherever the material is such as to be in danger from scour.

This dike is being built by the Government with two special Bucyrus locomotive-crane dragline excavators, with 125-ft. booms and 5-yd. buckets. These machines are working their way down through the wooded territory of the neck (Fig. 4), one machine on each side. The trees in front are cleared out by contract, and the two huge excavators working on tracks on 15-ft. sections move down the cleared space at the rate of about 130 ft. per day. The track is skidded along by the power of the machine. The ground is almost like brown sugar in its consistency and the machines, during the hours that we were there at least, worked to perfection. There will be about 1,750,000 cu.yd. of dirt in the spur dike, and the cost will be about $275,000. At present, however, the fill is being made at the rate of about 6c. per cu.yd. The machines now make from 1,500 to 3,000 cu.yd. per 20-hr. day.

Later in the day we stopped at Panther Forest, Ark., one of the worst caving banks on the river, where a willow mat (Fig. 1) was being woven. Repeated laying of mats here does not seem to prevent the caving, which shows up after every flood water.

How Concrete Bank Paving Is Built

Just above Greenville, where we tied up for the night, we saw the next morning our first concrete bank paving, a stretch of which had been in place for about a year. It was in remarkably good shape after having passed through one high water and, although in places covered with the alluvial deposit from the flood, still was intact except in a few places where the joint connection between the paving and the willow mat seemed to allow opening enough for erosion to start. In one particular place, a view of which is shown in Fig. 3, the cave has occurred in spite of the paving and the mat, but it will be seen from the view that this caving was confined to a small area, whereas if there had not been good protection, it probably would have extended along quite a distance. The paving is of unreinforced concrete 4 in. thick. It is laid directly on a 1 : 3 slope of the river bank, the slope being made generally by a hydraulic giant. It is laid without any joints and only above the willow mat, opportunity being taken at low water when this elevation is exposed. It follows the convolutions of the ground as it is smoothed up after the hydraulic giants work it to a fairly even slope.

The machine by which this paving is laid is shown in the view in Fig. 5. It is an ordinary barge on which are mounted on one side a series of elevated bins; down the middle a low trestle on which is a track for the concrete mixer, and on the other side a still lower track for the concrete car. The bins are filled up with river gravel by clamshells working from an adjoining derrick boom. Cement is loaded into the spaces underneath the gravel bins.

These bins, as shown in the view, have hopper openings, and the mixer can be run along the track to any one of the openings, and the car can be run on its lowest track to take the discharge from the mixer and to reach the derrick boat, which swings it into place on the river bank. The concrete is laid within reach of the derrick boat by merely dropping from the boom. Above that height wooden tracks, made up of 1x6's and tied together in 8-ft. sections, are laid up the bank and a car filled from the derrick is pushed up to dump clear to the top of the bank, where a 6x12-in. curb is let down into the bank to insure stability. Such work costs from 2¾ to 5c. per sq.ft., the lower cost not giving such good results and the higher a little too good. It is estimated that for 4c. per sq.ft. very good paving can be laid. This is about one-half the price of the riprap which it replaces. The gravel will make a concrete than runs about 1 : 3 : 6. It is not perfect concrete by any means, but it seems to be quite good enough for the purpose.

Clyde and Bucyrus Dragline Tower Excavators

Later in the day the boat stopped at Longwood Landing, Miss., and a 3-mi. walk brought us to the levee enlargement work there. Here the contractor gets about 14c. per cu.yd. for enlarging the levee from the river side, the banquette having been built the season before with teams, borrowing from landside pits. The machine used is a tower scraper of the slack-line cableway type, built under the Field patent by the Clyde Iron Works (Fig. 4). It is making from 900 to 1,500 cu.yd. per day of 12 hr., but on account of various difficulties, mainly logs and saplings in the ground, it rarely works over 9 hr. The span is about 500 ft., and there is a bottom-dump bucket of 5 yd. capacity on the machine. The tail tower is a low moving stand. At this particular place there is some difficulty because the banquette as built is not wide enough to carry the machine and a trench had to be dug into the side of the levee to carry the inside tracks. This is bad because every effort is made in the Mississippi River levee work not to disturb the integrity of old levees.

After going back to the boat again and traveling down the river some few miles, we came to Leota, Miss., where a 10-mi. levee enlargement is being made with a Bucyrus tower dragline scraper (Fig. 4), also of the slack-line cableway type, which uses a 6-yd. bucket that can be enlarged to 8 yd. by sideboards. The head tower is self-propelling, as are also the tail towers. It operates on the banquette, which has to be built ahead by handwork excavated from the land side. The cableway has a span of about 500 ft., and the drag-scraper when piling up the front and top of the levee seems to be most successful, the cost now running pretty close to 11c. per cu.yd. Such compacting as the levee gets in all these dragline machines is due solely to the dragging of the heavily loaded bucket up the slope. There is no dropping the earth from a height, as in the Lidgerwood tautline machines.

Mississippi River Work in Epitome

The next day we came to Cottonwood Landing somewhat farther down the river, where is now going on the most spectacular work on this stretch of the river. Everything of Mississippi River protection work is in sight at Cottonwood. On the river side a number of men are weaving a willow mattress. Farther down the stream a hydraulic jet is cutting down the bank to prepare the slope for the concrete paving, which is being placed on the slope already reduced, and back 500 ft. or more from the river a multitude of teams and men are building a new levee to take the place of the one that was destroyed as a result of violent bank caving after the flood of last year. A year ago this levee was 1,500 ft. inside the river, but when the water went down last spring, the bank caved back for 1,500 ft. and the levee slid into the river.

The levee work here is under three contractors, and it is of the highest type of mule and man construction. The camps appear to be fairly decent, and the operation of the work is very scientific. Practically all the earth is being placed with four-mule teams loaded from elevating scrapers and carried up to dump on the high levee slope (Fig. 6). The whole outfit comprises about 400 teams, 10 elevating graders, 150 1½-yd. wagons and wheel scrapers, all made by the Western Wheel Scraper Co.

The total yardage of this work is about 600,000 cu.yd. The promptness with which an empty team draws up to the scraper just as the old team is filled and leaves and the very little loss of time in this operation testify to efficient administration of the contract. It is emergency work, for the gap must be closed before high water, so the contractors are getting a good price.

On the afternoon of the fifth day out from Round Lake we steamed up the narrow Yazoo Canal to the end of the trip, the Government wharf at Vicksburg, where the construction and repair work for the district centers.

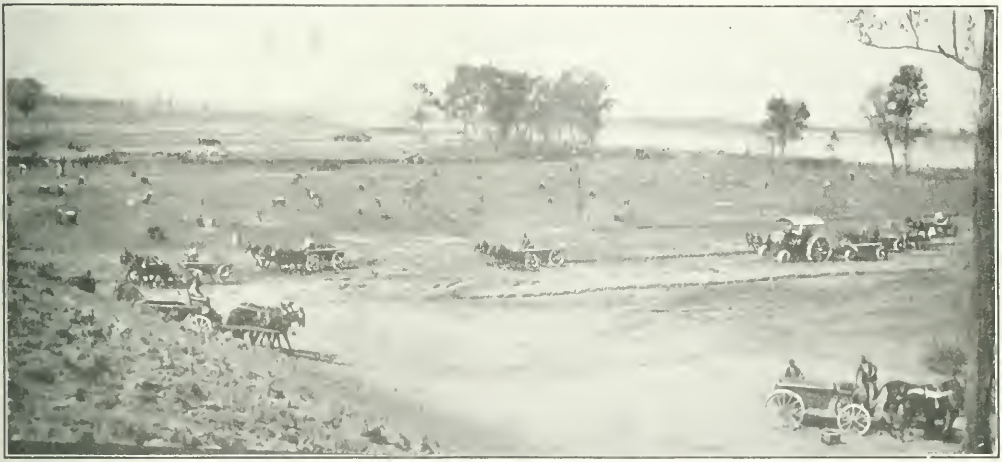


FIG. 6. TEAMS AND ELEVATING GRADERS BUILDING NEW LEVEES AT COTTONWOOD, MISS.

Vibrating Concrete Makes Dense Paving Mixture

For the purpose of obtaining the densest possible concrete for street pavements, a method of construction in which the layer of green concrete is gone over with gasoline-engine vibrators has been devised and patented by R. C. Stubbs, of Dallas, Tex. Several Texas cities have laid pavements under this specification in the last six years, and during the past month two "Vibrolithic" pavements have been completed in White Plains, N. Y., the first to be constructed in the East. Dallas, Tex., has the largest yardage; contracts were recently made at a single letting for 100,000 sq.yd. of this type of pavement.

While the use of the vibrator is the principal feature in the construction of this pavement, there are other noteworthy points in the method. Up to the time when the concrete has been mixed and placed on the roadbed the specifications and method of construction do not differ from ordinary good practice, except that the mix is somewhat drier than usual. But immediately after placing, raking and smoothing the freshly placed concrete to the true grade there is spread over the surface a coating of trap rock or granite (passing a 2-in. and retained on a 1-in. screen) to a depth of between 1 and 2 in. On this surface are then laid narrow flexible board platforms, the boards being laid parallel to the center line of the pavement. On these platforms the vibrators are rolled. The result of this vibrating or quaking is of course to force the surfacing of broken stone into the concrete and to flush out the surplus water and mortar. The vibrating is based on the theory that the mortar is the weakest part of the concrete, and where density is equal, the strength of the concrete varies inversely with the dis-

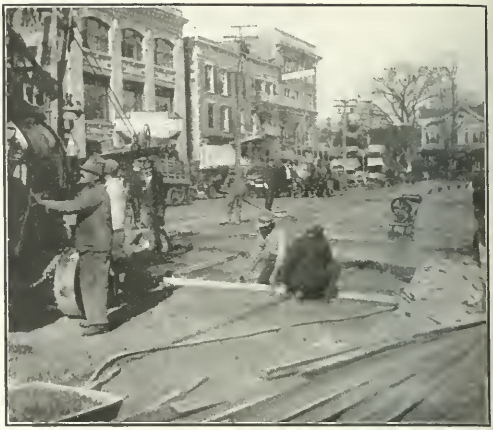


FIG. 2. SHOWING JOINT CONSTRUCTION OF "VIBROLITHIC" PAVEMENT

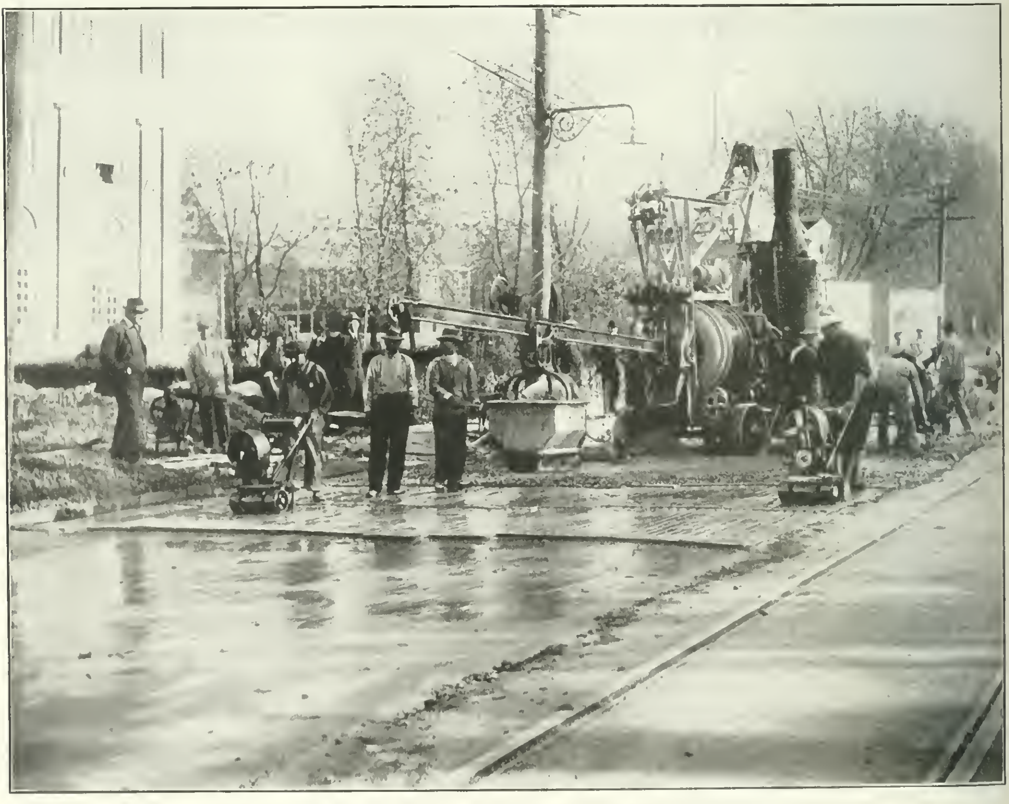


FIG. 1. CONSTRUCTING A "VIBROLITHIC" CONCRETE PAVEMENT AT WHITE PLAINS, N. Y.

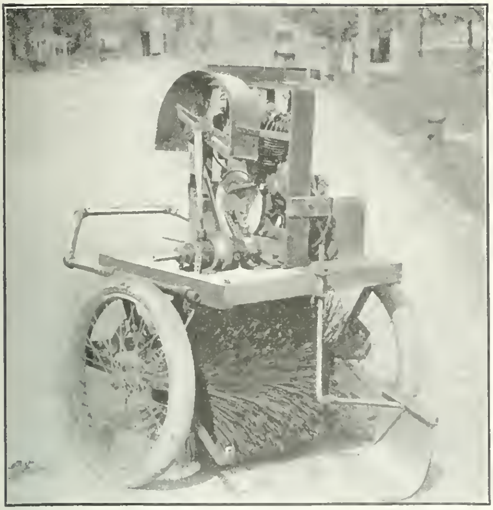


FIG. 3. POWER BROOM USED ON CONCRETE ONE OR TWO DAYS OLD

tance between the pieces of coarse aggregate; that the thinnest possible film of mortar between the stones, provided all the voids are filled, gives the strongest bond and is the ideal condition. Moreover, the denser the concrete the less the absorption of moisture and the less the subsequent expansion and contraction.

The pavement is laid without expansion joints at the curbs, but with transverse and longitudinal joints of ½x3-in. boards left in the bottom half of the pavement, as shown in Fig. 2. These divide the pavement into slabs 30 ft. long by half the width of the pavement. The upper 3 in. of the pavement, however, is monolithic, the joints merely being designed to form vertical planes of weakness where the slabs will crack uniformly instead of irregularly, if they crack at all.

After the concrete is a day or two old a high-speed revolving broom (Fig. 3) is passed over the surface, and any laitance and surplus mortar is removed, leaving a clean hard stony surface. On this surface is immediately spread a hot tar carpet, covered with pea stone or grit.

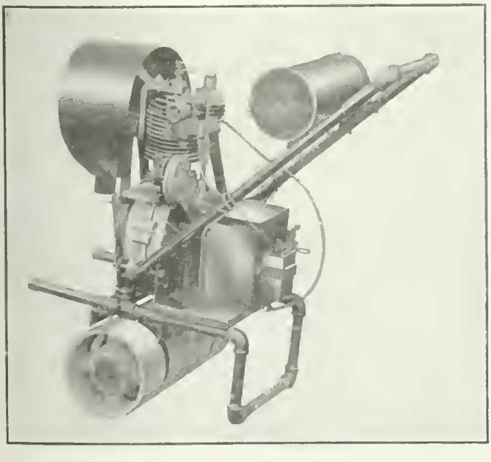


FIG. 4. PATENTED GASOLINE-ENGINE VIBRATOR

The object of the tar carpet is chiefly to protect the concrete during the curing process. It is designed to retain the moisture in the concrete until a complete set has occurred and to save the green concrete from the abrasion of traffic. The tar carpet is claimed to make it unnecessary to keep the concrete dampened or covered with water or earth, as in ordinary practice.

The distinguishing feature of construction, the use of a vibrator, unquestionably produces a very dense concrete. Pieces broken out of old pavements show the stones in close proximity to each other and a smooth, flinty plane of cleavage characteristic of a dense and thoroughly hydrated concrete. Both the vibrator and the process involving its use are patented. The machine itself is merely a 4-hp. motor-cycle engine mounted on a steel frame with steel roller wheels, as illustrated in Fig. 4. The pulsations of this unbalanced engine are about 1,000 per minute.

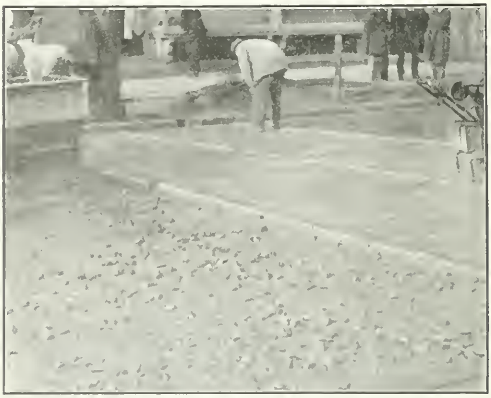


FIG. 5. CONSTRUCTION VIEW SHOWING BROKEN STONE ON GREEN CONCRETE READY FOR VIBRATING

The developer of this method of construction sums up its advantages as follows: The vibrations produce density in the entire mass, permit the economical addition of broken stone in the upper portion of the slab and bring to the surface a rich dense mortar to bind the added stone, while the stones being at or near the surface form the ultimate wearing surface. The seal coat of tar covered with pea stone, chats or torpedo sand forms the temporary wearing surface, improves the looks of the pavement, makes it noiseless, gives it a nonskid surface and aids in the uniform curing of the concrete.

The patents are controlled by a central organization, the American Vibrolithic, with present headquarters at Dallas, Tex. The intention is to allow the pavement to be laid by any reputable concrete contractor on the payment of a royalty. The work on Mamaroneck and Howard Ave., White Plains, N. Y., shown in the accompanying illustrations, was done by E. L. Erbeck, contractor, under the general supervision of Frank W. Sampson, Katonah, N. Y., Eastern representative of the American Vibrolithic. The contract price of these pavements was $1.85 per sq.yd.

Well-Unit Water-Supply at Aurora, Ill.

SYNOPSIS—The city's principal water-supply is obtained from a group of deep wells at the water-works. To increase the supply, wells have been driven in different parts of the city, having their own electric pumping plants so as to form independent units. Auxiliary pumps provide for increasing the pressure in the mains in case of fire. The results of pumping tests on the wells are given.

To provide a necessary increase in the capacity of the water-works of Aurora, Ill., the city has adopted the well-unit supply system. This consists of a number of deep wells distributed throughout the city, each operated by independent pumping units that deliver the water directly into the mains. In planning the system the wells are so located that the water pumped at each point has the shortest possible travel before being consumed, thus reducing to a minimum the friction loss in the mains. For this reason wells are located usually near street intersections, so that water can be pumped in four directions.

The City of Aurora secures its water-supply from wells sunk in the St. Peter and Potsdam sandstone, and for a number of years it has pumped all its water from a group of five wells at the water-works plant in the north part of the city, on the east bank of the Fox River. With the rapid increase of population in the past few years it became necessary to secure an increased supply of water. After an investigation of the situation the city officials decided that instead of sinking more wells near the water-works it would be advisable to adopt the well-unit system.

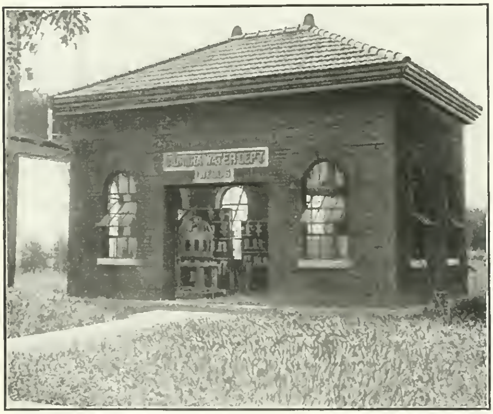


FIG. 1. PUMP HOUSE FOR WELL-UNIT AT TALMA ST., AURORA, ILL.

Progress of New Work

At present three of these new wells have been drilled. The first (known as well No. 6) is located at the corner of Talma and Binder St., in the southeastern part of the city. The second (No. 7) is in River St., in the southwestern part of the city. The third (No. 8) is located in the central part of the city, on an island in the Fox River.

Well No. 6 is 2,200 ft. deep. The first 300 ft. has a casing 18 in. in outside diameter, the balance being a 15-in. hole in the rock. In 1914 the city placed an order with the American Well Works, of Aurora, for pumping machinery for this well. The contract called for a combination deep-well turbine and booster pump for a capacity of 1,000 gal. per min., taking water at an elevation of 100 ft. below the surface of the ground and pumping against a pressure of 65 lb. at the surface. The unit was to be directly connected to a 125-hp. 440-volt two-phase 60-cycle vertical slip-ring motor running at 1,200 r.p.m. This had an automatic self-starter, with no voltage release and overload protection, and resistance with 50% full load at start.

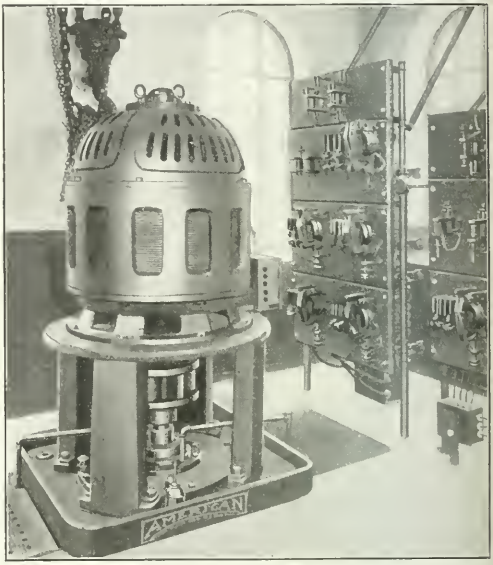


FIG. 2. INTERIOR OF PUMP HOUSE FOR WELL-UNIT SYSTEM

When the pump was installed, in May, 1915, it was found that the capacity of the well was only 240 gal. per min. at the 100-ft. depth. The city then decided to lower the turbine another 100 ft., thinking that as the well was new it would open up and flow more freely and give the desired capacity. But the capacity was only increased to 440 gal. As the demand for water exceeded the supply, the city finally decided it would pay to pump from a depth of 301 ft.; and it was estimated that the capacity of the well at this depth would be approximately 550 gal. per min. It was further decided to remove this turbine, which was designed for 1,000 gal. per min., and use it in well No. 8, which was then being drilled on the island, and from which a larger supply of water was expected.

A new unit of heavier duty was then ordered for the Talma St. well, No. 6. This is an "American" combination deep-well turbine and booster pump, provided with 38 lengths (8 ft. each) of 10-in. supporting pipe, shafting and bearings, and 40 ft. of 9-in. suction pipe. The line shafting is of 2-in. nickel steel. The lineshaft and turbine bearings are of the "oilless peg" type for water lubrication. The impellers and diffusers in both turbine and booster are made of bronze. This pump was designed to discharge 550 gal. per min. against a total head of 497 ft. when running at 1,150 r.p.m., on which was guaranteed an overall efficiency of 58% when using the 125-hp. motor.

The makers' diagram of the results obtained on the test shows that the pump delivers 650 gal. per min. against a total of 497 ft., with an overall efficiency of 61%, and 800 gal. per min. against a total head of 416 ft., with an overall efficiency of 56%. The quantity of water in this test was measured by a weir and checked by the city's water meter. After the official test, another test was made with the pump discharging directly into the mains. This showed that the pump discharged 630 gal. per min. against a total head of 497 ft. when running at 1,172 r.p.m., with an overall efficiency of 61%, and 750 gal. against a total head of 446 ft. when running at 1,167 r.p.m., with an overall efficiency of 59½%; that is, the pump had a range of from 450 gal. per min. at 556-ft. head to 750 gal. at 446-ft. head, with an overall efficiency of not less than 59%, which is 1% above the guarantee.

The River St. well (No. 7) was completed in 1914. The first 300 ft. has 18-in. casing, the balance being in rock, 15 in. inside diameter, to a depth of 2,262 ft. In January, 1915, the city bought an "American" pump (with impellers and diffusers), to have a capacity of 1,000 gal. per min. from an elevation 100 ft. below the surface. This unit was to be directly connected to a vertical 150-hp. motor having an automatic starter complete with no-voltage release and overload relays arranged for 50% full-load start. This installation is shown in Fig. 3.

To increase the pressure up to 105 lb. in the mains for fire purposes, this vertical deep-well unit will work in series with an "American" single-stage double-suction horizontal centrifugal pump directly connected to a 40-hp. slip-ring motor running at 1,800 r.p.m.

The pumps were installed and when tested the well would supply only 640 gal. per min., the water being lowered to 125 ft. from the surface, which was 25 ft. lower than the contract called for. The city therefore decided to lower the pump another 100 ft. The pump was again tested by the builders, and tests were also made by D. H. Maury, consulting engineer, Chicago. The results of the tests are summarized in tabular form and attention is called to the fact that the supply of water did not equal the capacity of the pump.

	Builder's Test	—D. H. Maury's Tests—	
Discharge, gal. per min. . . .	930	896.0	981.0
Total head, ft	424	426.6	410.6
Speed, r.p.m.	1,145	1,155.0	1,155.0
Pump efficiency, %	74½	70.4	70.1
Combined efficiency, % . . .		62.7	62.8

This unit is similar in construction to that furnished for the Talma St. well (No. 6). Fig. 3 is a cross-section showing the construction of the combined deep-well and booster pump furnished for well No. 7. It will be seen that these units are provided with water-cooled vertical roller guide-bearings in the upper frame, and water-cooled roller thrust bearing. The booster and turbine proper both have bronze inclosed impellers, removable bronze diffusers and removable bronze wearing rings.

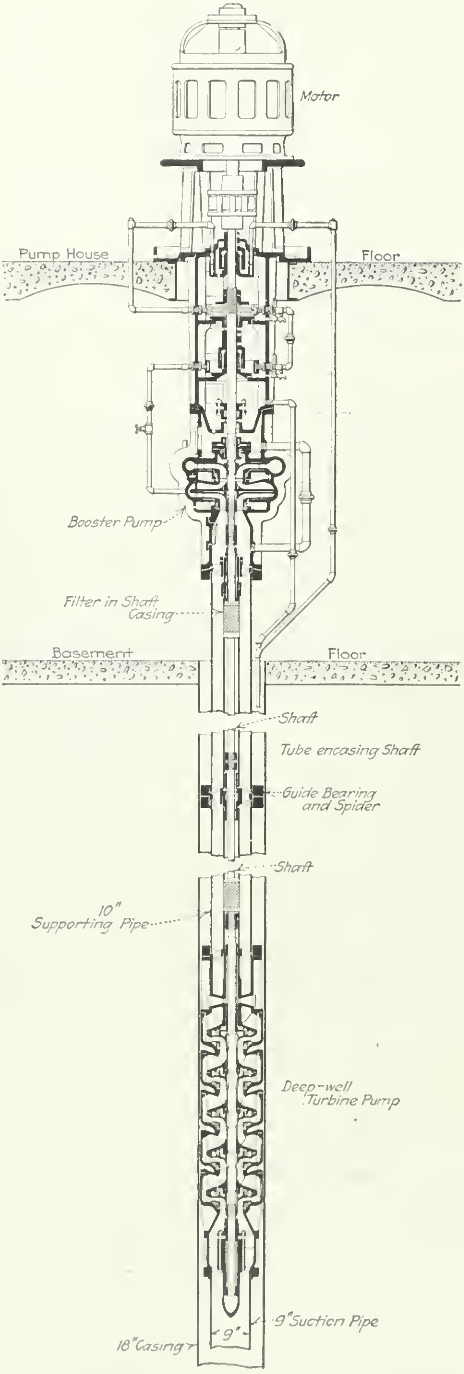


FIG. 3. DEEP-WELL PUMPING UNIT WITH TURBINE AND BOOSTER AT AURORA, ILL.

The method of lubricating the long vertical line shaft that drives the lower pump is peculiar to deep-well turbines built by the American Well Works. The line shafting is surrounded or incased in a sectional tube. The sections are fastened together by the line-shaft bearing, and the whole shaft casing is put under tension and steadied by spiders at the bearings, to make it rigid. The top length of shaft casing is provided with a filtering means, which allows part of the water pumped to enter the shaft protecting casing after it is filtered. Passages are provided through each bearing to allow the lubricating water to circulate downward and out into the well through ports in the top of the lower pump. This method of lubrication prevents contaminating the drinking water with oil or grease.

The island well (No. 8) was completed in September, 1916. The first 200 ft. has 18-in. casing, and the hole is then 15 in. in diameter to a depth of 2,305 ft. As before stated, the pumping unit originally installed in well No. 6 is to be used at this station.

Each pump house is a brick building with a basement; one is shown in Figs. 1 and 2. The current is purchased.

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Activated-Sludge Results at Cleveland Reviewed--II

By R. Winthrop Pratt* and George B. Gascoigne†

SYNOPSIS—A previous article described the plant in outline, the changes made in it since put in operation, and gave the clarification results obtained. This article deals with the ever-persistent sludge problem.

Sludge Disposal

The Cleveland tests indicate that at large plants the most important question with the activated-sludge process is an inoffensive and economical disposal of the sludge. This phase of the problem is particularly serious, as the two lake-front plants are located in residential districts and because this method of treatment produces excessive unit quantities of sludge. Consequently, particular attention has been given to the tests pertaining to the disposal of the sludge.

The schedule of operation as regards sludge disposal is divided into three stages, the first of which consists of changing the sludge to a comparatively stable condition. The material is then ready to pass through the dewatering or second stage without causing any objectionable odors even if the process should be delayed two or three days. The third stage consists of the final disposition of the material. As a preliminary step to the above-mentioned stages, tank concentration of the sludge may be desirable. The few tests so far conducted establish the idea of concentration by settling and the importance of especially designed tanks for the purpose.

Two Kinds of Activated Sludge

Activated sludge as known on the Cleveland work is of two kinds—plain and reaërated—the distinguishing feature being longer aëration for the latter. Both sludges have a chocolate color and a spongy and fluffy texture. At present the means of determining whether or not the plain sludge is in a proper condition is by its appearance, smell, and ability to settle rapidly, while with the reaërated sludge a sample is placed in a test tube and any change in color carefully noted. A more accurate method of identifying a properly conditioned sludge is badly needed. Upon standing, plain activated sludge, either in a liquid or partially dried condition (80% moisture), starts to decompose and in from 24 to 48 hr., depending upon the moisture content, will produce objectionable odors. If the sewage aëration period is lengthened to the point where stability obtains, this objectionable decomposition may possibly be deferred; the sludge then being in a condition to permit any reasonable delays encountered during the disposal process.

A very important feature of the activated-sludge process is the unit quantity of sludge produced and the relation that this bears to the quantity of suspended matter carried in the crude sewage. A number of results bearing on this relationship have been obtained that show a loss in solids owing to the treatment, varying from 0 to 50%. At this time it is believed that a loss of 35% represents approximately actual conditions. The crude sewage carries 250 parts of suspended solids, which represents one ton of dry solids per 1,000,000 gal. of sewage flow. Assuming a loss in solids of 35%, there would be two-thirds of a ton of dry solids, 2 tons at 75% and 26 tons (30½ cu.yd.) at 97½% moisture. The sludge with a 75% moisture content weighs 59 lb. per cu.ft.

Since the tests were started a sample of sludge has been withdrawn from the settling tank regularly and analyzed. (See accompanying table.) The nitrogen content of the Cleveland activated sludge is less by 1% than that which other experimenters are securing with domestic sewage. Apparently an allowance must be made for longer aëration periods, as when stability or nitrification is desired and when packing-house wastes, even in small quantities, are present in the sewage. Fertilizer concerns designate the nitrogen value of a tankage by means of "units of ammonia," a term that is equivalent to about 1.2 times the total nitrogen figure in the table.

SUMMARY OF ANALYSES OF CLEVELAND ACTIVATED SLUDGE

	% Moisture Content	% Dry Basis						
		Mineral Matter	Organic Matter	Nitrogen Total	Nitrogen Available	Phosphates (P_2O_5)	Potash	Fats
No. of Analyses.		20	20	19	13	18	3	19
Average .	97.5–98.0	51	49	3.21	1.65	1.73	0.29	6.77

The total nitrogen is determined in accordance with a modified Kjeldahl-Gunning-Arnold method (*Journal Industrial and Engineering Chemistry*, November, 1913), the available nitrogen by the alkaline-permanganate method, and the ether or fat soluble results are based on a 16-hr. period of extraction.

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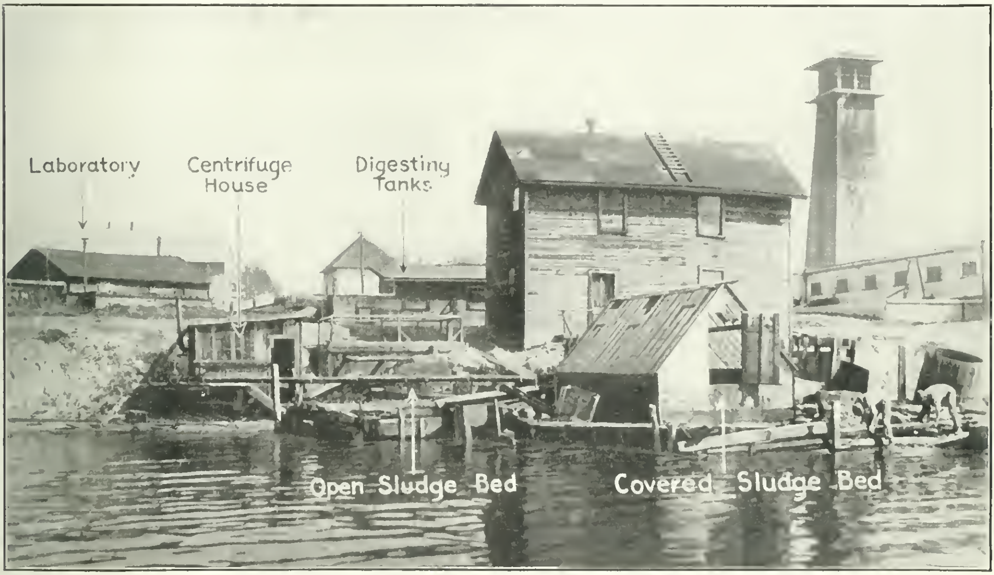
*Consulting Sanitary Engineer, City of Cleveland, Ohio.

†Sanitary Engineer, Subdivision Sewage Disposal, Cleveland, Ohio.

Continuous aëration of the sludge (97½% moisture) for a month reduced the fats 40% and the available nitrogen about 25%. The total nitrogen content remained constant, and if the period of aëration is reduced to five days, the original percentages obtain. Continued aëration has a tendency to reduce the quantity of sludge only slightly and sludge so aërated settles more rapidly.

Tank Concentration of Sludge

From the beginning of the tests the rapidity with which activated sludge settles has been an important feature of this process. Taking advantage of the same may offer a means of partially concentrating the sludge prior to reaëration or further dewatering. Tests so far conducted have been in tanks 5 ft. deep and in glass cylinders 9 and 15 in. in depth. A detention period of 4 hr. reduced the moisture content from 98 to 96% in the 9-in. glass cylinder, while a period of about 13 hr. was required to produce the same results in the 5-ft. From these results and others of a similar nature, it appears that the vertical velocity of subsidence from any given moisture content to another varies almost directly as the cube root of the depth of the tank. This indicates that a tank 20 ft. in depth will require a retention period of 36 hr. to produce the same moisture-reduction results. Before the tests are completed it is intended to try a tank of such a depth.



SLUDGE-DISPOSAL DEVICES AT CLEVELAND ACTIVATED-SLUDGE PLANT

It is desired to emphasize the importance of the foregoing idea in designing concentration tanks, and that local conditions will determine just what expenditure is justifiable for this purpose. Also, the idea of tank concentration is important when looked at from an operation standpoint, there being quite a saving when handling 20 instead of 40 cu.yd. of sludge per 1,000,000 gal.

At one time during the tests it was thought that the prestige as regards an absence of odors that the activated-sludge process has enjoyed from the first would be lost on account of difficulties incident to the disposal of the sludge. Recently, however, there has been developed a means of producing a stable sludge, thereby eliminating any chance of objectionable odors during the disposal process. In carrying out the tests, sludge is removed by the air lift from the settling compartment to one of the tanks not in regular use and is there reaërated for a relatively long period. Present tests consist of determining the results produced by varying the time and air quantity elements and determining whether or not a slight change in the condition of the original settled sludge appreciably alters the result. At present from 20 to 25 cu.ft. of air per gallon of sludge treated appears sufficient when the aëration is continued for five days—that is, 5 cu.ft. of air per gallon per day. Sludge analyzed before and after the reaëration period, again when partially dried (75% moisture) and when dry has from a nitrogen standpoint the same manurial value. The reaërated sludge dries on sand beds a little faster than the ordinary activated sludge. In a partially dried condition it retains its chocolate color, is porous and smells like earth that has been covered for a long period with leaves. In reducing the moisture content over a steam bath from 75 to 10%, a slight but unobjectionable odor can be detected.

So far no indications have developed that tend to make the success of this phase of the sludge problem doubtful. If such favorable results continue, an inexpensive means has been provided for eliminating any odors during the disposal of activated sludge. With current furnished at ¾c. per kw.-hr. the cost is estimated at 75c. per 1,000,000 gal. of sewage treated. Whether or not sludge can be reaërated more efficiently after tank concentration is a question.

In order to determine the possibility of digesting activated sludge, thereby eliminating any odors during the disposal process and reducing the volume of sludge to be handled, a tank 20 ft. deep was placed in operation April 21. At about 18-hr. intervals during the first month of operation activated sludge was applied to the tank and allowed to decompose in the bottom, the clear and supernatent liquid being withdrawn at each filling. In a month a thick scum developed on the surface, and odors, such as accompany digestion or septic tanks, became noticeable. It was impossible to continue applying sludge as the tank filled up. After this filling the tank was covered to inclose the odors, allowed to stand and the digestion continued on an anaërobic basis. At monthly intervals, and sometimes oftener, sludge has been withdrawn from the bottom of the tank and analyzed.

The indications of digestion after five months are an increase in the odors, a reduction in the nitrogen content of from 2.74 to 2.27%, available nitrogen from 1.63 to 1.08, moisture content from 97.4 to 90.8%, but no reduction in the volatile matter. The sludge resembles partially digested sludge. In operating this tank an attempt has been made to digest activated sludge, first with the aid of a regular application of fresh sludge and then without. It is intended to continue the operation by mixing fresh sludge with partially digested sludge withdrawn from the tank; the mixture then to be allowed to digest further in a separate tank located next to the one now in operation. When the treatment and disposal of the sludge as a fertilizer ingredient is not warranted, it is desired to emphasize the practicability of this method of sludge disposal as applied to remodeling present-day two-story tank installations.

Dewatering Process a Matter of Drying

The dewatering problem is a drying proposition and for convenience can be divided into two steps: A primary, which involves reducing the moisture content to a point where the sludge may be readily handled—about 75% moisture—and a secondary step, which involves expelling most of the remaining moisture. The latter should only be necessary when the value of the sludge as a fertilizer ingredient warrants.

Since the first of May plain and reaërated sludge has been partially dried on sand beds covered with a greenhouse type of construction. Only in special cases has the process been carried beyond a reduction to a 75% moisture basis. Owing to weather conditions, such as the frequency of rains, the drying of either plain or reaërated sludge on open beds is greatly retarded. Any retardation is a detriment, as it permits decomposition to become active, which condition is a forerunner of unpleasant odors.

Drying Sludge on Sand Beds

The covered bed is 10x20 ft. in plan, divided into sections as required, and was the sand bed used during the year 1913 for drying Imhoff sludge. The filtering medium consists of 12 in. of fine lake sand with the exception that one division of the bed was of a graded material. Sludge on the graded bed dries no faster than on the plain bed; consequently, it appears that sand is capable of passing the water as fast as it enters. The additional cost for graded beds, therefore, does not seem justifiable. The solid material in the sludge settles so rapidly that within 4 hr. it is possible to siphon off at least 6 in. of the supernatent water from a 12-in. dose. It appears that it takes about a day longer for the sludge to dry down when the 6-in. layer of the supernatent liquid is not withdrawn. Consequently, the water is siphoned off practically all the doses. As a rule, within 24 hr. all the liquid disappears from the surface of the sludge. Within 48 hr. a great number of small cracks develop, breaking the sludge into nearly equal portions, which feature is somewhat different from the larger and fewer cracks that develop in drying Imhoff sludge. The moisture content at the end of four days is about 80% and decreases thereafter at the rate of 1% per day to a 75% basis. Generally, at the end of six days the sludge can be removed with a potato fork.

The high moisture content of the sludge materially increases its ability to penetrate into the sand. Imhoff sludge will retain sand equaling 40% of its weight, dry basis, while activated sludge retains about 60%. The graded bed is at a disadvantage in this respect, its retention being 75% when a 1-in. layer of sand is used on top. As a consequence, cheese cloth and sawdust have been successfully used for separating the sludge from the sand, about four applications being all that the cloth will survive. Doses 12 in. in depth seem to permit the largest yield per square foot of bed, although the data pertaining to this point are not conclusive.

At no time is there any odor during the drying of the reaërated or stable sludge. In drying plain sludge a thin brown film immediately develops on the surface, which to a large extent prevents all odors until the film is broken up in being removed. Beneath the film the entire mass turns black, and in rehandling the sludge offensive and objectionable odors are produced, owing principally to the high moisture content of activated sludge—a condition that makes the unit quantity so high that an area at least ten times as large as that necessary for drying Imhoff sludge is required.

Sludge has remained on the beds until thoroughly dried, but the period involved—three weeks—makes the use of sand beds impracticable for completely dewatering sludge.

Drying Sludge By Centrifuging

In order to concentrate activated sludge from about 98 or 95% moisture a centrifuge was installed. It was a rotary machine made by the Cleveland Laundry Machine Co. with a 26-in. basket, and was belt driven with a friction clutch provided for starting purposes. The basket was lined with a ¼-in. wire mesh inside of which was placed a canvas bag. The sludge was admitted through an orifice located directly over the center of the centrifuge. After a cake was formed, it was necessary to remove and clean the canvas bag for any succeeding runs.

About thirty runs under varying conditions were made. In general, the results permitted the passage of about 3 gal. of water per minute through the canvas, but a mat developed next to the canvas within 5 or 6 min. after starting. Continuing the operation without applying more sludge tended to compact the caked layer, free the water that was held within, and in about 30 min. the cake was of such a consistency as to stand up. In the best run, when the basket revolved about 1,200 r.p.m., 60 gal. of 97½% moisture sludge was admitted in about 25 min., and in 2 hr. the moisture content was reduced to 84%. Two additional hours reduced the moisture content further to 80%, the final product being a cake ¾-in. thick.

After the mat has formed there is a tendency, owing to wave action, for the basket to become unbalanced; and as a consequence six vertical vanes about 2 in. deep were fastened to the wire mesh and spaced equally around the basket. The vanes prevented the wave action, but there was apparently no way to prevent a ⅛-in. layer of the mat next to the canvas from becoming dense. As soon as this happened, the water came to the inside surface of the cake and remained there. This fact suggests the possibility of a solid bowl type of centrifuge, in which the clear water can be removed without passing through the caked layer. In order to increase the porosity of the matted formation, garbage tankage was mixed with the sludge; but the results were not improved.

The results indicate that activated sludge might possibly be concentrated by centrifuging to approximately an 85% moisture basis. The trouble experienced is the same that is encountered in the use of presses either of the vacuum or pressure type. Increasing by more pressure the density of the formed mat simply limits the capacity of the apparatus prior to its efficient output. Consequently, if it is satisfactory for the process to be intermittent, some means must be provided for automatically removing the clear water, while continuous operation involves the removal of the mat or both the clear water and the mat. The results secured with the present machine, while not encouraging, lead the writers to believe that more favorable and satisfactory results can be secured with a centrifuge designed in accordance with the suggestions already made.

Centrifuges as built at present sometimes require screening the material prior to centrifuging and reduce the moisture content to only an 85% basis. Sludge so reduced could then be applied to sand beds. Points in favor of centrifuges are their capacity per unit of area required and low initial cost. A machine about 2 ft. in diameter, which has been simplified by its use in other fields and which is capable of handling the sludge from 2,000,000 gal. of sewage per 24 hr., should appeal to experimenters interested in the solution of the sludge-disposal problem.

During the tests in 1913 a Sweetland press was installed and used for pressing Imhoff sludge. The conclusion reached was that a press 15 ft. long with leaves 3 ft. in diameter, spaced 4 in. c. to c., will produce five tons of caked sludge—70% moisture—when operating 24 hr. each day. These results were produced with sludge containing 85% moisture, and it is believed they can not be equaled with sludge whose moisture content is from 98 to 95%. When operating three 8-hr. shifts (basing the capacity of a press upon the amount of cake produced) there is required a press for every 3,000,000 gal. of sewage treated. If, however, the number of presses is based upon the volume of wet sludge handled, one press is capable of dealing with the sludge from only 500,000 gal. of sewage.

Just how much sludge a press can handle efficiently is an open question. For a large installation a comparison must be made between a layout consisting of a small number of large presses and one with a large number of small presses. From the standpoint of efficiently using the labor, a large number of small presses seems preferable, but this may not be so pronounced with an hydraulically operated installation. In the year 1913 an actual bid price for the above-mentioned press installed was $4,500, which represents an expenditure of $1,500 per 1,000,000 gal. of sewage to be treated. An estimate of the cost of pressing activated sludge can probably best be made by comparison with sludge presses in use at chemical precipitation plants allowing for recent improvements in press design.

The drying of activated sludge to a 10% moisture basis would only obtain when the value of the sludge as a fertilizer ingredient warranted. During the present tests three attempts have been made with steam and direct-heat driers to reduce the moisture content of sludge from about 75 to 10%—a marketable condition. Also, some difficulty has been experienced in accumulating a quantity sufficient to get a normal run with a direct-heat drier. One run was attempted at the Cleveland garbage reduction works, but the quantity used—1,200 lb., 80% moisture—was not sufficient; it being impossible, owing to the small amount discharged from the drier, to judge the results of the test.

Results in drying Imhoff sludge at Cleveland and in an eastern city, in direct-heat driers, require 2½ tons of 40% moisture sludge to produce one ton of the dried material. In passing the sludge through the drier a large amount is burnt up or lost in the dustroom. Similar conditions are anticipated in drying activated sludge. The estimated cost of this method of drying is $3 per ton of dried material when using gas, which is cheaper than coal and which also permits a control of the flame length. It may be possible to secure a lower cost by staging the process—that is, first passing the sludge through a direct-heat dryer as a preliminary process and then through a steam-jacketed drier. High temperatures produce more efficient results with substances having moisture contents between 75 and 45%, and low temperatures act likewise between 45 and 10%.

Two tests have been conducted at the works of a local fertilizer company for drying reaërated sludge in a steam drier, which was a "Buckeye" of the steam-jacketed type, 6 ft. in diameter with paddle agitators. At the end of the first hour the material was in a "mushy" condition. About 1,200 lb. of sludge alone with a 75% moisture content was first tried, and after 2½ hr. of agitation, which is about twice the period of a usually successful run, the materials balled up. The balls were about the size of one's fist, caked hard on the outside, and the portion so formed represented about one-half of the final residue while the remainder resembled pea gravel. The operation was continued for 3½ hr., when the moisture content of a pulverized ball was 37% and of the pea gravel 21%. Although too much weight should not be given the results obtained from this one test, they tend to show that sludge alone cannot be economically dried in a steam drier to a 10% moisture basis. It is believed however that excessive balling up can be prevented. The nitrogen value of the sludge remained the same, and no odors were present.

No trouble at all was experienced in drying the sludge when mixed half and half with tankage. About 500 lb. of each material was used, the tankage having a moisture content of 45%. A run of 2½ hr. reduced the moisture content of the final product to less than 1%. When mixing the two products, the nitrogen value is reduced, tankage averaging about 2.75% ammonia; but the low amount of grease in tankage (3%) reduces the average for the mixed material.

Final Disposition of Activated Sludge

The final disposition of activated sludge has been given considerable thought and study. Its disposal as a fill on low ground naturally suggests itself, but our increasing standards as regards unsightly conditions, odors and nuisances demand that the material be disposed of without offense. Plain activated sludge with 75% moisture cannot, practically speaking, be transported to dumping grounds or storage sites where the sludge is accessible for agricultural purposes. Sludge of this character deposited on low lands subjected to rain, snow or floods will take up moisture and, owing to active decomposition, rapidly become offensive. Sludge in storage bins or trenches when covered over with a crust and apparently satisfactory but water-soaked may, when carted away and spread upon the ground, give the nearby treatment plant an undeserved black eye as regards odors.

Just what moisture content a sludge may have, and in what condition it must be in order to be satisfactorily used as a fill, is a question. Reaërated sludge with about 75% moisture has remained for two months in a box which was opened to the weather, and when removed no objectionable or unpleasant odors were noticed, while plain activated sludge when put to a similar test produced rank odors.

ACTIVATED SLUDGE AS A FERTILIZER INGREDIENT

A revenue from sewage sludge to offset the cost of operation of a treatment plant is of particular import at this time when our municipalities are in such financial straits. Consequently, a method of treatment that produces a sludge with a higher manurial value than any yet known method provides possibilities of fulfilling the above-named conditions. Apparently the activated-sludge process produces a sludge with a manurial value at least twice that found in any other sludge, but the ratio of solid matter to water from a dewatering standpoint complicates the reduction of the material to a marketable condition. An efficient solution of the secondary step of the dewatering process appears practical, but as much can not be said of the primary or concentration stage.

There does not appear any good reason to expect to use dried sludge other than as a fertilizer ingredient. The available nitrogen, which averages about 50% by the alkaline-permanganate method, classes the material as low grade. An accurate analysis can be considered a fair guide to the value of the product and probably more reliable than any field tests of less than five or ten years' duration. A price no better than 10c. per lb. is about all that can be expected for the ammonia and ½c. per lb. for the bone phosphates ($Ca3P_2O_8$). The amount of potash is negligible. There would then be, according to the average analysis, a gross return of about $8.20 per ton, dry basis, or for Cleveland conditions $5.50 per 1,000,000 gal. of sewage. A commercial demand for ammonia such as this country is now experiencing, and which it is prophesied will continue, may change conditions somewhat.

SUMMARY AND CONCLUSIONS

At Cleveland the solution of the sludge-disposal problem remains the important issue of the activated-sludge process of sewage treatment.

Unless the unit quantities of sludge produced are materially lessened, the use of sand beds for dewatering activated sludge is financially prohibitive.

Available data indicate that presses are apparently the best known method for effecting the primary stage of the dewatering process, irrespective of whether or not the sludge as a fertilizer ingredient warrants further drying.

Present data are not sufficient for estimating within narrow limits the cost of sludge disposal.

A revenue from activated sludge involves a large initial expenditure, coöperation with private interests, a commercial demand and the strongest assurance that any agreements will be faithfully observed for a long term of years.

Sludge to be disposed of as a fill must be, practically speaking, in a stable or nonputrescible condition.

Future tests in the main should be directed toward this phase of the activated-sludge problem. Of particular import are studies pertaining to centrifuging, tank concentration and the digestion of the sludge—the latter for providing a means of eliminating odors and reducing the unit quantities to be disposed of.

The writers have taken a great deal of pleasure in showing the activated-sludge installation to visitors during the past summer, and they desire to express their appreciation for the suggestions made during these visits. Robert Hoffman is chief engineer and commissioner of the Division of Engineering and Construction and is in charge of all sewerage and sewage-disposal improvements. The work herein described is under the supervision of the writers, with A. G. Husted, assistant engineer, in immediate charge.

Seatless Rapid-Transit Cars

To increase the carrying capacity of the rapid-transit railways in London, England, during the hours of peak load or congested traffic, the introduction of cars without seats has been proposed. It is considered impracticable to increase the length of trains and stations, or to increase the number of trains. According to *The Engineer* (London) the cars of the District Ry. have seating accommodation for about 48 passengers, while in a crowded train there may be almost as many standing, to their own and the sitters' inconvenience. Every person seated occupies approximately 6 sq.ft. of floor space, whereas he may stand comfortably in half that area. Hence, the removal of all seats from a car would add at once one-third to its capacity. But as the whole space could be used more efficiently the number of passengers would be nearly doubled with no more personal inconvenience than at present.

The Engineer says: "We do not think the traveling public would object to such cars if they were neatly designed. No one can now count with certainty on finding a seat, most of the journeys are short, and strap-hanging is a familiar exercise against which no one now thinks of protesting. Passengers as far as possible would stand round the sides, leaning against the walls, hence the windows would have to be reduced in size, and would be partly blocked by packed humanity. This is a comparatively unimportant matter, since artificial lighting is already the rule, but in any case might be met by roof lights made with any of the new unbreakable glasses. A padded rail would be provided to lean against, and if small arms were added they would make it easier to stand gracefully against the buffets and shocks of starting and stopping. From the roof would hang a forest of straps, and down the center, posts with long vertical rails might be arranged. The floor should be covered with a grid of some kind that would help to keep it dry in wet weather. More doors, of course, would be provided than at present, and the vestibules at the ends would be got rid of."

Completing the Municipal Bridge at St. Louis, Mo.

SYNOPSIS—The last link in this bridge over the Mississippi is the 3-mi. approach viaduct at the east end. Its design and construction are described. The work was done by city forces.

The great double-deck municipal bridge built across the Mississippi River by the City of St. Louis will soon cease to be an isolated and unavailable structure. The long viaduct on the east (Illinois) side of the river is nearing completion and will provide the necessary connection with the bridge proper. The highway portion of this approach will soon be ready for traffic. The accompanying illustrations show the work in progress. Figs. 1 and 2 show the erection of truss and girder spans respectively. Fig. 3 shows the placing of the last girder to close the gap, on Sept. 22, 1916.

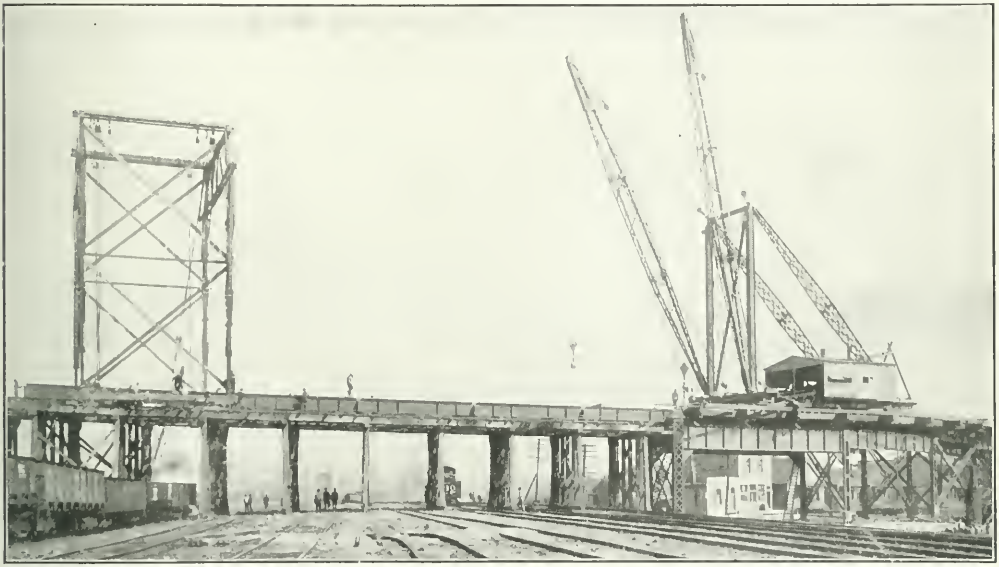


FIG. 1. ERECTING ONE OF THE TRUSS SPANS ON THE EAST (ILLINOIS) APPROACH TO THE MUNICIPAL BRIDGE OVER THE MISSISSIPPI RIVER AT ST. LOUIS, MO.

This shows the gantry traveler and one of the big steel derrick cars

The three 668-ft. river spans of this notable bridge were completed in 1912. Controversy developed as to the location of the west (St. Louis) approach, but after some delay this was settled and the approach was completed in 1911. The building of the east approach, however, required an additional issue of bonds. This was twice voted down, but finally the city secured the labor vote by agreeing that the work should be done by city forces (instead of by contract) and that only union labor should be employed. At the third election, in 1911, the bond issue of $2,750,000 was approved. Work was commenced early in 1915, but was delayed and hindered by several strikes and labor controversies.

The work is under the direction of the Board of Public Service, a special department being organized for this purpose, as described in *Engineering News*, Sept. 23, 1915. Clinton H. Fisk, Chief Engineer of Construction, is at the head of this organization; W. F. Collar is Superintendent of Construction. The working force approximates about 300 men, for steel erection, concreting, etc.

DESCRIPTION OF BRIDGE APPROACHES

The bridge is a double-deck structure, with the railway tracks on the lower deck. Beyond its east end, the upper (roadway) deck swings to the north and runs parallel with, but still above, the railway for about 2,300 ft. It then turns to the northeast (see Fig. 2), and extends for 3,000 ft. before coming down to street grade in the outskirts of East St. Louis, Ill. It ends with a fill about 510 ft. long, having concrete walls and parapets The maximum grade is 4.15%. The railway-viaduct approach continues in a direct line east from the end of the bridge and has a total length of about 13,000 ft. before coming to the ground level. Its maximum grade is 0.98%. The railway approach ends in an earth-fill 600 ft. long, this being followed by 1,800 ft. of earth-fill between retaining walls.

A footway (approached by stairs at the shore piers) has been maintained across the lower deck of the bridge for some time. The roadway approach, now nearly completed, will enable the bridge to be opened for street traffic. The railway approach will be finished a little later, but no arrangements have been made as yet with the railways that are expected to use the bridge. The car tracks on the roadways will be available only for east-side electric lines, the St. Louis street railway system having a gage of 4 ft. 10 in., so that no connection is possible. For the same reason the St. Louis street railway does not use the Eads bridge, which is crossed by the East St. Louis car lines and some interurban lines running to a terminal at the St. Louis end of the bridge.

The new east approach is mainly a plate-girder viaduct with spans of 60 to 75 ft., as described in *Engineering News*, Sept. 2, 1915. It has four through truss spans. Two of these are spans of 184½ ft. and 227¼ ft. on the railway portion, and one is a 263¼-ft. span on the roadway portion. All these cross the Illinois Central R.R. The fourth is a three-truss span of 296 ft., carrying the railway and roadway at the same level and crossing the Mobile & Ohio Ry. and the Southern Ry. The railway viaduct is designed for a live-load of 5,000 lb. per lin.ft. of track, and the roadway viaduct for a live-load of 100 lb. per sq.ft.

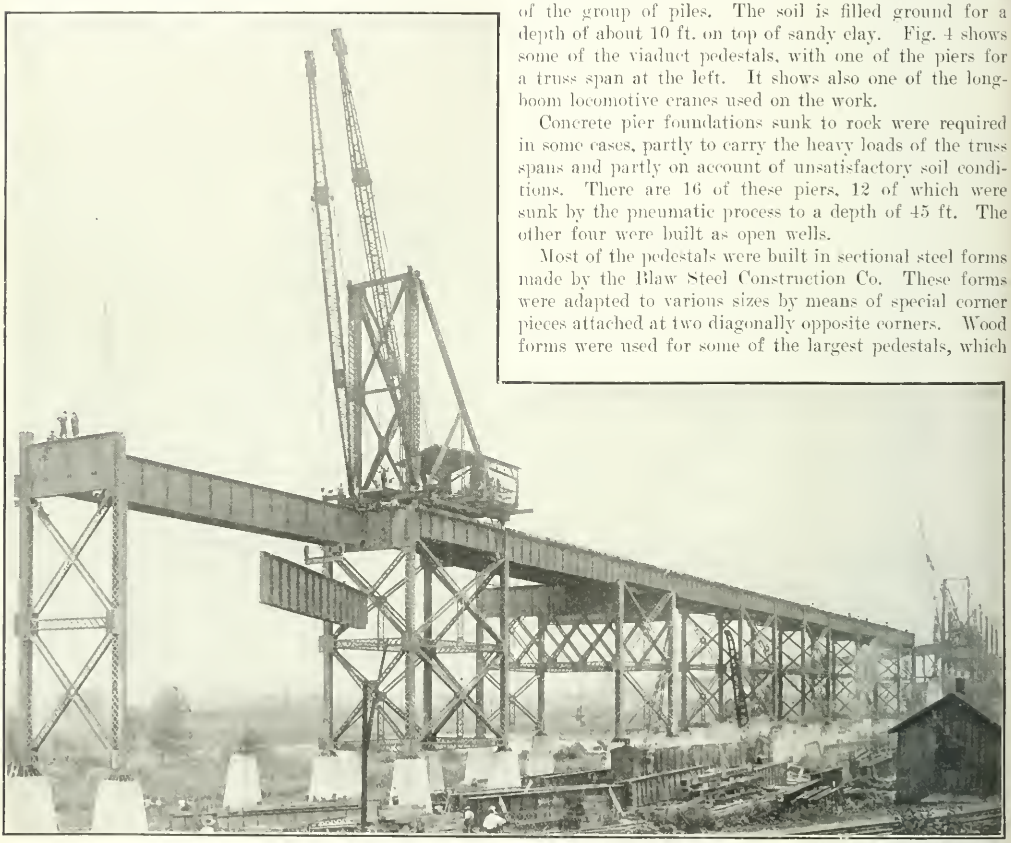


FIG. 2. STEEL DERRICKS ERECTING THE VIADUCT APPROACH

The derrick at the left is working on the combined railway and highway approach (having three-post bents). Note that both booms are carrying the girder. The derrick at the right is standing where the highway approach diverges (to the left), the railway approach continuing on a straight line

The ground is low, but it will be filled in later as the city (East St. Louis) grows; the pedestals for the viaduct columns are therefore carried up to the future street grade. The foundations are groups of concrete piles, driven to a depth of about 25 ft. The piles are of circular section about 15 in. in diameter, with deep vertical corrugations giving increased surface area, which adds considerably to the skin friction. A steam pile hammer was used, and a water jet assisted the work. The manufacture and driving of these piles were done by Charles N. Lund, of St. Louis, and formed the only part of the work done by contract.

Construction of Pedestals

The steel columns are carried on tapering pedestals, 4 to 6 ft. square on top, with sides having an inclination or batter of 1½ in 12. Each stands on a 12-ft. octagonal footing block about 3 ft. thick, which incloses the heads of the group of piles. The soil is filled ground for a depth of about 10 ft. on top of sandy clay. Fig. 4 shows some of the viaduct pedestals, with one of the piers for a truss span at the left. It shows also one of the long-boom locomotive cranes used on the work.

Concrete pier foundations sunk to rock were required in some cases, partly to carry the heavy loads of the truss spans and partly on account of unsatisfactory soil conditions. There are 16 of these piers, 12 of which were sunk by the pneumatic process to a depth of 45 ft. The other four were built as open wells.

Most of the pedestals were built in sectional steel forms made by the Blaw Steel Construction Co. These forms were adapted to various sizes by means of special corner pieces attached at two diagonally opposite corners. Wood forms were used for some of the largest pedestals, which were too large for the steel forms in hand and too few in number to warrant purchasing special steel forms. Owing to their height and tapered shape, the wet concrete exerted an appreciable upward pressure or lift upon the forms, and ¾-in. anchor bolts were built into the footings for the attachment of the forms. In one or two cases the forms shifted and had to be secured promptly, and in at least one case a steel form rose bodily and then overturned.

The concreting of the pedestals was done with a portable plant consisting of a car carrying the mixer and bins. The concrete was placed with drop-bottom buckets handled by a derrick car. One of the truss spans is at a height of about 50 ft. and is carried at each end by a pier having an arched opening in the central portion to reduce the weight. The concrete for this was placed by an A-frame derrick handling the drop-bottom bucket with a long boom.

For the truss spans, very heavy falsework was used, in some cases having double bents (braced together) placed between the tracks. On these were pairs of the floor stringers (for the viaduct span) used as transverse caps.

Details of Floor System

Owing to increase in wheel loads since the structure was first designed, it has been necessary to strengthen the railway floor system. This floor will have an open deck of ordinary construction, with rails laid on wood ties resting upon the stringers.

The roadway floor construction consists of a concrete slab resting on longitudinal joists and girders 4½ to 5 ft. apart. The concrete is extended downward to inclose the joists. This slab carries the wood-block paving. The car tracks are laid at the sides of the roadway and have 90-lb. T-rails of the Am. Soc. C. E. section. These are carried by chairs 33 in. apart on the outside girders and the 15-in. I-beam joists. These chairs have insulating strips and top clips that fit over the rail base. On the fill at the end of the roadway approach the car tracks are laid with Carnegie steel ties embedded in the concrete base for the paving.

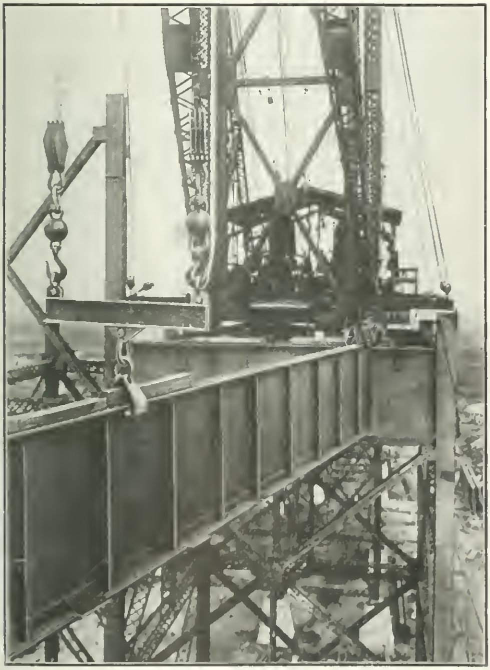


FIG. 3. PLACING THE LAST GIRDER TO CLOSE THE GAP: SEPT 22, 1916

Note the way in which the girder is held by clamps on a swing beam carried by two hoisting lines and booms

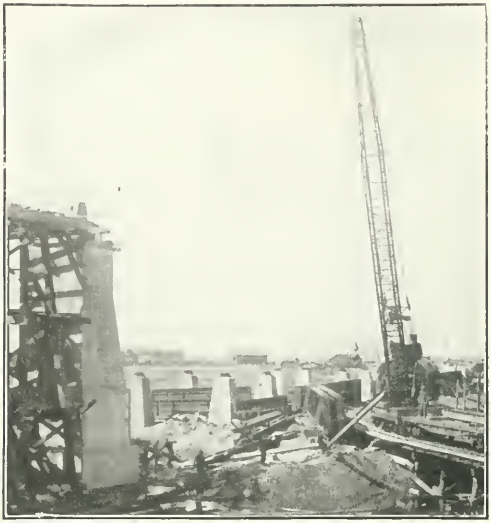


FIG. 4. PEDESTALS FOR VIADUCT BANK AND PIER FOR TRUSS SPAN

For erecting the steel viaducts two travelers were used, both running on the structure, as shown in Figs. 1 and 2. They were of steel construction, with platforms 24x65 ft., mounted on wheels on a track of 19½-ft. gage. Outrigger beams on each side of the platform provided a wide base for stability in making side lifts. Each had two masts 50 ft. high and two booms; the length of the booms was 100 ft. on one machine and 95 ft. on the other, with a 30-ft. removable section in the middle. For each boom there was a two-cylinder 10x12-in. engine with two drums and four winch heads operated through clutches. Two of the winches were for the guy lines used in swinging the booms laterally.

For handling long and heavy pieces both hoisting lines are attached to a swing beam or equalizer from which the load is suspended. This arrangement is shown in Figs. 2 and 3. The heaviest pieces handled were 38-ton girders and 35-ton top-chord sections for the middle truss of the three-truss bridge.

The traveler with 100-ft. booms could handle 30 tons at 60-ft. reach with each boom. The one with 95-ft. booms could handle 28 tons at 50-ft. reach. There were also three locomotive cranes, two with 60-ft. booms for 30-ton loads and one with a 75-ft. boom for 60-ton loads. A gantry traveler of timber construction, shown at the left in Fig. 1, was used in erecting the two-truss spans.

*

The Municipal Electric-Lighting Plant of Melbourne, Australia, was established by the City Council in 1894. The city has invested about $5,000,000 in the plant, and its net earnings above operating expenses in 1915 were $500,000. After paying interest and sinking-fund charges and deducting depreciation and reserves, the plant made a net profit in that year of over $200,000. The base charge for current is 7c. per kw.-hr., which is the lowest in Australasia. The government of Victoria is now proposing to take over this municipal plant and operate it in connection with the city street-railway lines. This change, however, is opposed by the city authorities, who claim that since the city has established and built up a profitable electric business, it should continue to own and control it.

New Railway in Indiana for the Pennsylvania System

SYNOPSIS—This 41-mi. line is an important link for a high-speed train service, and its construction includes a number of interesting features. The construction work and the types of bridges are described.

The new railway between Indianapolis and Frankfort, Ind., now being built by the Vandalia R.R. (under the name of the Indianapolis & Frankfort R.R.) will give the Pennsylvania System a direct line of its own between Chicago and Indianapolis. Although only 41 mi. in length, it will be an important link. At present the Pennsylvania has a route from Chicago over its own line (the Panhandle) to Kokomo, Ind., and thence by trackage rights over the Lake Erie & Western Ry. to Indianapolis, beyond which it has its own lines again to Cincinnati and Louisville. The new route will be over the Panhandle to Logansport, the Vandalia to Frankfort, and then the new line into Indianapolis. The distance will be about the same, but the traffic facilities will be much improved. The cost will be about $4,000,000.

The line runs approximately north from Indianapolis, and connects two east-and-west lines of the Vandalia R.R. It has an ascending grade for a few miles from each end, and then crosses flat country. The maximum grades are 0.3% northbound and 0.5% southbound. There are few curves, and the sharpest of these are only 1°, except for the junctions at either end, where trains run at reduced speed.

The line begins at Ben Davis, six miles west of Indianapolis, on the St. Louis division of the Vandalia R.R. It runs north to Lebanon (27 mi.), where it is elevated but keeps on the outskirts of the town. Thence it continues to Frankfort (14 mi.), connecting with the Michigan division of the Vandalia R.R. at a little distance west of the town. Here there will be a general revision of tracks. There are no other towns of importance, and only a few local stations will be built.

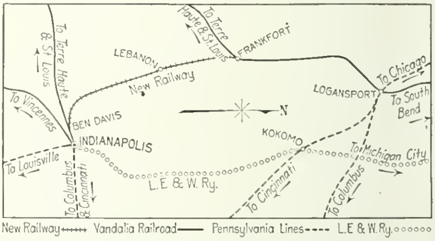
This new line was proposed and surveyed about four years ago, and surveys were again made in 1914, but definite action was not taken until 1916. Construction was commenced in May, and it is expected that the line will be put in operation next summer.

Being intended for heavy and high-speed traffic, all grade crossings of railways (steam and electrical) and highways are avoided. There are also 24 under-grade and two overhead crossings of highways. This necessitates a large amount of bridge work. The country is mainly flat, with some rolling ground, and the line is mainly on fill in order to cross above roads and railways. The cuts and fills are being made for single-track at present, in order to complete the connection as soon as possible; but all structures are built for double track. The heaviest fill is on the six miles at the south end of the line, and the construction of this was described in *Engineering News*, Oct. 26, 1916.

The earthwork (for single track) includes about 2,700,000 cu.yd. of fill, 230,000 yd. of cut (exclusive of borrow-pits) and 60,000 yd. of masonry for 47 bridges (double track). There will be 33 concrete bridges and 14 steel bridges, only three of the latter having truss spans.

There are five borrow-pits and all the excavation is done by five Bucyrus steam shovels. Most of the filling is done from temporary trestles, using standard-gage 12-yd. dump cars (averaging 10-yd. loads). Narrow-gage equipment, with 4-yd. dump cars, is used for a borrow-pit serving some of the lighter work near the northern end of the line. The temporary trestles have bents of four posts (two batter posts) and two diagonals, all round timbers with square cap and sill. Longitudinal bracing is placed between bents at intervals.

The width of roadway at subgrade is 24 ft. for the present single track, to be widened to 36 ft. for double track, with tracks spaced 13 ft. c. to c. In some places three tracks are to be provided, the third being a relief track for freight traffic, and near Frankfort there will be a four-track section. The tracks will be laid with 100-lb. rails and white-oak ties, with 24 in. of gravel ballast under the ties. The slopes of the fills are 1 on 1½, and probably these will be sown with clover. The right-of-way averages 100 ft. in width, and is inclosed with woven-wire fencing on galvanized steel posts of circular section. Lugs stamped out of the steel serve to hold the fence wires. This fence is topped with a single strand of the very heavy barbed wire designed for use in entanglements on the European battlefields.



MAP SHOWING NEW FRANKFORT & INDIANAPOLIS R.R. AND ITS RELATION TO THE PENNSYLVANIA SYSTEM

At the crossing of the Cincinnati, Indianapolis & Western Ry., near Indianapolis, the grade of this line was lowered (to a maximum of 5 ft.) for a distance of about 1,000 ft., in order to avoid undue height of fill. This was done at the expense of the Vandalia R.R., and was the more easily arranged since it improves the grade of the older line.

Bridge Design and Construction

Three interesting features in regard to the bridges are the number and variety of these structures, the use of concrete arches for the standard highway crossings, and the attention given to the effective appearance or ornamentation of the bridges.

The concrete is made with washed and graded gravel, but as the fine and coarse materials tend to segregate during shipment, a stock of sand is kept on hand in case the gravel as delivered should be found to have too small a proportion of fine aggregate. In some cases gravel is used for concrete in the lower portions and stone for that in the upper portions. The mix is 1 : 2 : 4 for reinforced work and 1 : 3 : 6 for footings. About 10% (by weight) of hydrate of lime is added to the cement in order to make the concrete dense and waterproof, and to make it flow readily around the reinforcing bars without being made too wet or sloppy. The arches and flat-top spans are waterproofed with Barrett, Minwax and Lewis compositions. Over this is 2 in. of concrete, with expansion joints. The backs of abutments and wing walls are given a single coat of tar.

For exposed surfaces, the only treatment during construction is to spade the coarse material away from the face of the form. After removal of the forms, these exposed surfaces are rubbed down with a cement brick and water and painted with a thin cement grout. This gives a smooth surface of uniform color. The rubbing brick is made of a 1 : 3 mix of cement and sand.

An effective appearance of the concrete and spans is obtained with very simple treatment. The spandrels have panels outlined with V-grooves, all edges are chamfered, and the copings of bridge and wing walls are unusually deep and massive. At the crown, beneath the coping, is the date (1916), and an unusual feature is that the figures are raised instead of being sunk in the concrete, as is the usual practice. This requires special care in the removal of the form. On some of these structures the raised figures are reinforced by ¼-in. horizontal rods, which are wired to the main reinforcing rods and project slightly into the figures.

As a rule, the arches are built for full width in one operation. In some cases, where the supply of material was insufficient for this, they were built in parallel sections or ribs, with no bonding between them.

The standard highway bridge has an arch of 40 ft. span and 8 ft. rise, with a clearance of 16 ft. at the center and a width of 32 ft. between curbs or parapet walls. The arch is a true ellipse. For the crossing of the old National Road (near Indianapolis) a 50-ft. arch span is used, with ornamental parapet walls which are cast in place. The Sugar Creek bridge has three 65-ft. elliptical arches. Instead of a parapet wall there are concrete posts carrying a railing of two lines of pipe.

Flat Slabs Also Used

Flat-slab spans of I-beams and concrete are used where headway conditions do not permit of arches. An interesting structure of the flat-deck type is a two-span bridge near Indianapolis which has a 35-ft. span over the Rockville road and a 27-ft. span over the Danville interurban line of the Terre Haute, Indianapolis & Eastern Ry., which runs alongside the road. The outside girders have curved ends resting on the abutments and center pier. Rectangular boxes of reinforced concrete are used for large culverts and for private farm openings or cattle passes. These range up to 18x10 ft. For smaller openings, 24 to 48 in. cast-iron pipe is used. This is either ordinary pipe or special culvert pipe of the lock-joint type, in 6-ft. lengths. At drainage ditches, 30-ft. deck-girder spans on concrete abutments are used, so that these can be removed by a derrick car to permit the passage of dredge boats (as required by law). For some of the steam and electric railway crossings, there are steel truss spans of about 124 to 180 ft. There is only one girder span, 81 ft. long. The bridges over steam railways require high abutments, as a clearance of 22 ft. is required by law.

Another interesting structure will be a highway bridge over the four-track line near Frankfort. This will have a central plate-girder span with wood floor, supported on concrete bents, while the side spans (over the slopes of the cut) will be of concrete slab and beam construction.

The formation is mainly stiff clay, with some gravel, but in some places the clay is very soft. For bridge foundations 20-ft. timber piles are used, driven 14 to 18 ft.; but 40-ft. piles are required where the ground is soft. The spacing is generally 36 in. c. to c., or 33 in. in soft soil.

For delivery of materials, spur tracks are laid from the several railways crossed, and carried along the right-of-way.

Construction Methods

In view of the large number of bridges and the necessity for pushing this work rapidly, the contractors installed several concreting plants, but (as noted above) scarcity of labor prevented all of these being operated simultaneously. Most of these were fixed plants with 1-yd. drum mixers, and timber elevator towers with booms and spouting of the Insley design. The booms were mainly of timber, so built that the main spout from the tower passed through the boom and had its outer end suspended from the end of the latter. In this way the boom and spout were raised and lowered as a unit.

At Lebanon there are several bridges (of various types) within a short distance, and for this work a portable concreting plant was rigged. It consisted of a flat car, with elevator tower at one end, 50 ft. high above the car floor, with the guides or leads extending nearly to the ground, so that the bucket could drop beneath the floor level to receive concrete directly from the ¾-yd. Lakewood mixer at this end of the car. Behind the mixer was a 24-yd. storage bin, with floor sloping forward, so that the material was chuted to the charging hopper of the mixer when lowered to rest on the floor of the car. Behind the bin and at the rear end of the car was a hoisting engine and vertical boiler, and also a separate boiler for the mixer engine. The concrete material was handled from cars or stockpile to the bin by means of a locomotive crane with grab bucket. This machine was used also to unload coal, and to do the excavating for the bridge foundations at this point.

In the arch falsework the lagging is carried on three-segment plank ribs supported on three lines of square posts connected by transverse diagonal bracing. Three sills (at right angles to the tracks) are laid on the unexcavated core between the sidewalks, and on these are round posts about 4 ft. high supporting heavy longitudinal caps of square timber. The posts of the centering are carried by these caps, each post resting on a pair of wedges which provide for adjustment and for releasing the centering after the arch concrete has set. The concrete is left usually for 28 days before this is done. The plank ribs of the centering are spaced 30 in. c. to c.

The contract for the entire construction was let to the Dunn & McCarthy Co., of Chicago, which is doing all the work with its own forces (without subletting).

Labor has been hard to get and hard to keep, and progress has been delayed in this way. To expedite the work numerous concreting plants were installed, but several of these were idle at times owing to lack of men. There are seven camps on the work. The contractor has a superintendent on each residency and a general superintendent for the entire work. The railway company furnishes rails for the temporary tracks, and also the cement, reinforcing bars and hydrate of lime. The contractors furnish gravel, form material, ties, spikes and track bolts, and use their own excavators, dump cars, locomotives and concreting plants.

The line is divided into four residencies, with Resident Engineers as follows: A. F. Dye, 6 mi. (at Indianapolis end); H. L. Hodges, 10 mi.; W. N. Nickerson, 11 mi.; Will Duncan, 14 mi. H. T. Whitney is Engineer in Charge, and W. R. Britton is Assistant Engineer in Charge.

In connection with this new line improvements will be made on the present line of the Vandalia R.R. from Logansport to Frankfort, 37 mi. Grades will be reduced to a maximum of 0.3% southbound and 0.5% northbound. It is being double-tracked at each end, and this work will be extended over the entire distance within two years. There will be also a rearrangement of terminals at Logansport to improve the connection with the new line.

This work is being done by Culbertson & Son, of Cleveland, Ohio, who are using two steam shovels with 2½-yd. buckets, and trains of 12-yd. dump cars. The work-train locomotives are rented from the railway. In widening on grade reduction a single-track cut at the new grade is cut through, and track laid in it. Then the old track is torn up, and the steam shovel widens the cut for the second track. At road crossings, the fill is leveled and spread by slip scrapers. This improvement work is under the direction of H. C. Johnson, Division Engineer.

The construction of the new line and the improvement of the present line are under the direction of F. T. Hatch, Chief Engineer, and Maurice Coburn, Principal Assistant Engineer, of the Vandalia R.R. The bridges were designed by J. E. Starbuck, Bridge Engineer of this railway.

Lighting Freight Yards

The lighting of freight yards is an important matter in railway service, not only to increase the rapidity and efficiency of operation of the yards, but also to reduce the damage to freight and equipment. In a report presented at the recent annual meeting of the Association of Railway Electrical Engineers it was shown that the lights may be supported either by towers, poles or catenary construction. Towers may be built to any desired height, and the cost per foot of height decreases as the height increases. As a rule this system is not economical, on account of the high cost and the possibility of future changes or removal of the yards, which would make the towers useless. Catenary construction is excellent in allowing proper location of units, but is expensive and subject to rapid deterioration.

For wide spacing of units, towers or poles are the most economical—poles being preferable in the majority of cases. For close spacing of units, catenary construction is the cheapest and most satisfactory. The usual space between poles for distribution lines is about 100 ft., and the most economical installation will use these poles for supporting the lighting units. This would allow lights to be placed either 100 ft. or 200 ft. apart and approximately 35 ft. high (35 ft. being the most practical mounting height on wood poles).

Yard lighting is of most importance in relation to classification yards, and a typical arrangement of units for such a yard (operated by gravity switching) is shown in Fig. 1. The lights on the approach to the summit, or hump, should be spaced as shown in Fig. 2, being placed on that side of the track from which the car cutters operate, and at a distance from the track equal to one-third their height. The lamp should be covered by a reflector to screen the light from the trainmen's eyes and prevent its interference with signals. On the ladder tracks the spacing should not exceed that given in Fig. 2 (75% of this distance is preferable); the lights should be placed as close to the switches as possible and every switch should have a light within 40 ft. In the body of the yard the lights in each row should be spaced as in Fig. 2, and the spacing of the rows should not exceed the distance there given (75% of the distance being preferable). The lights in adjacent rows should be staggered.

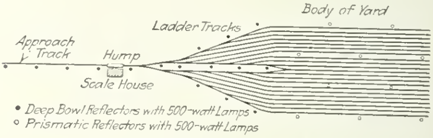

Body of Yard
Ladder Tracks
Approach Track
Hump
Scale House
• Deep Bowl Reflectors with 500-watt Lamps
° Prismatic Reflectors with 500-watt Lamps

FIG. 1. PLAN OF TYPICAL ARRANGEMENT OF LIGHTS FOR CLASSIFICATION YARD

In repair yards the endeavor should be to have each car evenly lighted on the roof and sides, and as much light as possible thrown under the car. There should be a row of lights in each space between the tracks, with a height of 16 ft. and a spacing of about 30 ft. Tungsten lamps of 100 or 200 watts are best for this service, with a shallow dome reflector that covers the filament to about 10° below the horizontal. For storage yards, all that is needed is general illumination sufficient to permit safe passage among the cars and to discourage lawlessness. A system similar to that recommended for the body of a classification yard is satisfactory, although a lower intensity of illumination may be permitted. Another method is to use searchlights or projectors at one or both ends of the yard, throwing the light down between the rows of cars, but this is objectionable on account of the glare.

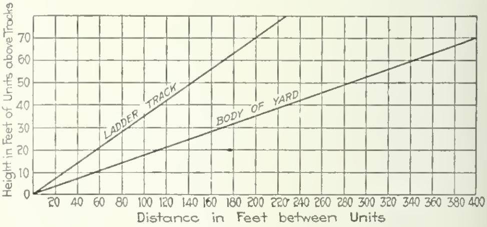


FIG. 2. DIAGRAM FOR HEIGHT AND SPACING OF LIGHTS IN CLASSIFICATION YARDS

Flood lighting for yards was suggested in the discussion. W. J. Davis, of the American Lighting Co., considered this system efficient and economical for freight yards, and probably superior to other systems. At each end of the yard would be a battery of flood-light units, at a height of not less than 75 ft., and so mounted that the beam of light would be practically horizontal. This arrangement would flood the whole yard with a soft and uniform light. On the other hand, J. L. Minick, Pennsylvania R.R., did not consider this system suitable for general use. In classification yards, for instance, spot lighting for each switch is necessary, and flood lighting would not meet the requirements.

How To Save the Horseshoe Fall at Niagara

That the great Horseshoe Fall on the Canadian side of the Niagara River appears to be delivering now a much smaller volume of water than it did a score of years or more ago, is the testimony of many observers. The responsibility for the diminution in the great cataract has been almost universally laid upon the diversion of water from the river for use in power development. Based on the general acceptance of this theory, a powerful body of public opinion has been arrayed against the proposition to divert additional amounts of water from the cataract for power development.

This opposition has been so influential that there has been general acceptance of the idea that further diversion should not be permitted; and for the past three or four years attention has been directed to schemes for obtaining power from other sources at Niagara, such as the Whirlpool Rapids below the falls.

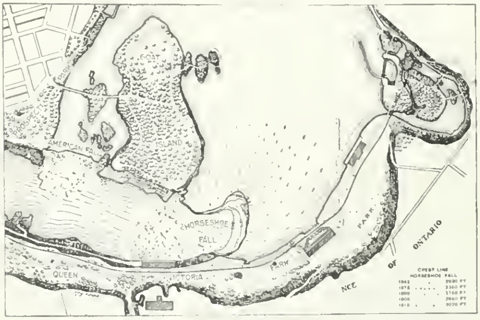
John Lyell Harper, a well-known engineer, has just published a pamphlet entitled "The Suicide of the Horseshoe Fall," in which he maintains that the apparent diminution in the flow of water over the Horseshoe Fall is not due chiefly to the comparatively small percentage of water diverted for power purposes, but to gradual changes in the contour of the precipice over which the water flows, the effect of which is to concentrate the flow in the center of the river so that a much smaller proportion than formerly is discharged over the precipice at the sides of the fall.

The accompanying drawing, reproduced from Mr. Harper's pamphlet, makes apparent the great changes which have taken place in the outline of the Horseshoe Fall during the past 75 years. While the precipice on the Goat Island side is practically unchanged, the rapid erosion going on at the toe of the horseshoe has moved the precipice at that part of the fall a considerable distance upstream.

The visitor at Niagara who views the fall from Goat Island now sees a huge mass of solid green water plunging over the precipice at the toe of the horseshoe, while only a thin veil of water flows over at the sides. It is obvious that with the concentration of the flow in the center of the stream, erosion there tends continually to become more and more rapid, and the concentration of flow at that point becomes still greater. Mr. Harper says:

> An entire cessation of the diversion of water from the river for power would not retard the self-destruction of the horseshoe form, but would rather tend to accelerate it. No negative action can preserve the horseshoe, but positive action must be taken with courage and intelligence, and as soon as possible, so that the greatest scenic spectacle in the United States may not be allowed to commit suicide.
>
> It should be the policy of those controlling the falls at Niagara to have constructed in the bed of the river, above the Horseshoe Fall, invisible current deflectors which would make impossible the gathering of the whole river into a deep narrow gorge, and would again deflect the water over to the sides and heels of a reëstablished horseshoe. This would not only improve the present spectacle, but would cause the whole contour of the fall to wear uniformly, so that coming generations in viewing its beauty may also have before their eyes the emblem of good luck.

Mr. Harper further points out that the American Fall, on the eastern side of Goat Island, delivers only 5% of the total flow of the river, yet it forms at least a quarter of the total scenic spectacle. If the flow of the river in the Canadian channel were spread around the whole length of the horseshoe, as it is along the crest of the American Fall, Mr. Harper believes that not more than 35% of the total discharge of the river so distributed would cover the entire precipice at the Horseshoe Fall with a cascade more than twice as deep as that of the present American Fall, and would produce a scenic effect equal in grandeur and greater in extent than the present fall.



CATARACT AT NIAGARA SHOWING THE RECESSION OF THE HORSESHOE FALL SINCE 1842

LENGTH OF CREST LINE OF HORSESHOE FALL

1842	2,030 ft.
1875	2,350 ft.
1890	2,750 ft.
1905	2,850 ft.
1916	3,020 ft.

Mr. Harper is Chief Engineer of the Hydraulic Power Co. of Niagara, and is a member of the American Societies of Mechanical Engineers, Civil Engineers, and Electrical Engineers, and the electrochemical society. He makes no suggestion in his pamphlet as to the methods by which the "invisible current deflectors" which he proposes could be constructed in the bed of the river above the Horseshoe Fall. Those who have visited Niagara and witnessed the wild torrent of water which sweeps down the rapids above the falls can form a conception of the heroic task that would be involved in building any structure in those seething waters which could withstand them.

The importance of the matter brought forward by Mr. Harper, however, certainly challenges attention. No one will seriously question the desirability of utilizing Niagara's power as a great national or international resource, so far as it can be done without serious interference with its beauty as a spectacle. Even an amateur in hydraulic engineering can see that Mr. Harper's diagnosis of the chief cause of the lessening in beauty of the Horseshoe Fall has every element of probability in its favor; and it is evident that the deterioration of the fall is likely to proceed at an accelerated pace unless something is done to restore the conditions of a century ago.

Notes from Field and Office

Illustrations of piledrivers built by railways—Dynamite increases flow of well from $3\frac{1}{3}$ to 22 gal. per min.—Concreting train for street-railway work—Improvised dragline—Simple azimuth determination Placing assembled coffer-dam—Heavy haulage for tractor

Piledrivers Designed and Built by Three Railways

The two general types of track piledrivers are the turntable driver and the boom driver. A turntable driver, designed and built by the Engineering Department of the Chicago, Milwaukee & St. Paul Ry., has as a special feature a pair of rockers which serve as a support for the leads while they are being raised and lowered. This piledriver is self-contained, no idler car being required during transportation. The forward reach is 18 ft. and the side reach 20 ft. This driver is used with both steam and drop hammers. It is illustrated in Fig. 4 (right-hand) equipped with a 4,000-lb. drop hammer and 65-ft. leads.

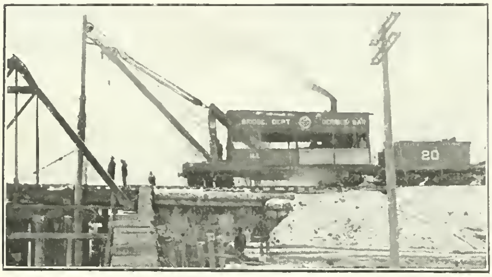


FIG. 1. OLD STYLE DERRICK CAR AND PILEDRIVER X-20 OF ILLINOIS CENTRAL

Horn connection on boom end holds lead to boom when driving piles. Lifting capacity of 15 tons. Data from A. S. Baldwin, Chief Engineer, I. C. R.R.

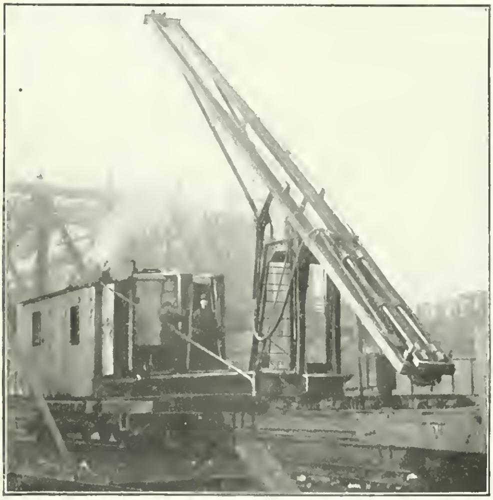


FIG. 2. GRAND TRUNK PILEDRIVER BUILT OF OLD-BRIDGE MEMBERS

Photograph from H. R. Safford, Chief Engineer, Grand Trunk Ry. System, Montreal

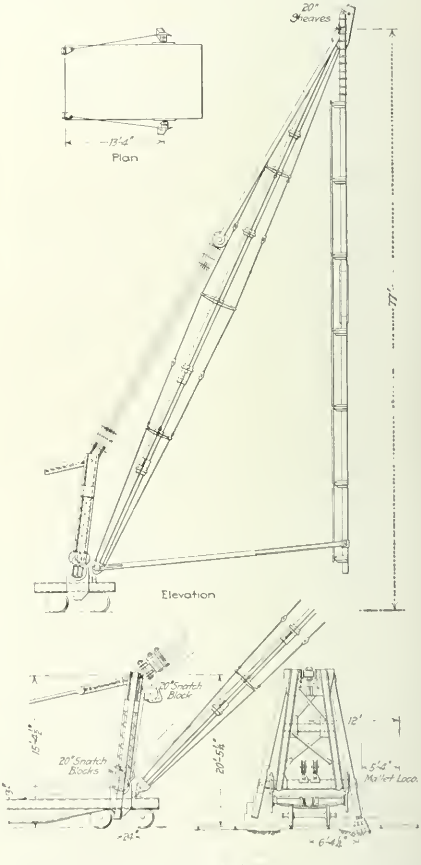


FIG. 3. BUSINESS END OF MILWAUKEE PILEDRIVER WITH PENDULUM LEADS FOR LONG PILES

Data furnished by C. F. Loweth, Chief Engineer, Chicago, Milwaukee & St. Paul Railway Co.

The Grand Trunk Ry. also is using piledrivers of its own design and built in the company shops. Fig. 2 shows this. An auxiliary deck, swinging about the center of the car, carries leads, boiler and engine. The leads may be raised or lowered, by shifting the hammer. The

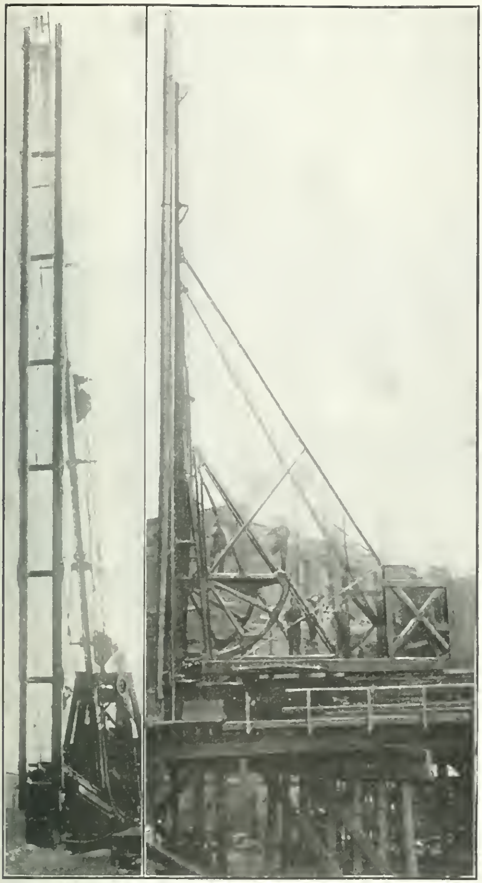


FIG. 4. MILWAUKEE DERRICK CAR EQUIPPED WITH 76-FT. (LEFT VIEW) AND 65-FT. (RIGHT) LEADS

Photographs from C. F. Loweth, Chief Engineer, C. M. & St P. Ry., Chicago

driver can be moved in a half-minute after driving has stopped. The car is propelled by double reversible engines attached to the underside of the car sills and connected to the axles. It is equipped with airbrakes.

Good examples of the boom type of piledriver are in use on the Illinois Central R.R., having been designed and built by that company. These are really bridge erection derricks, and are used to considerable extent for that purpose and for handling and unloading heavy material. The piledriving equipment consists of a set of leads swung from the end of a 40-ft. boom for use with drop hammers and a 50-ft. boom for use with steam hammers. Piles may be driven 30 ft. ahead of the forward axle and 21 ft. from the center of the track, provided an outrigger, consisting of block-and-fall, is put out on the opposite side. The latest of these cars are built of steel, with the exception of the floor and house. They are equipped with chain propellers and air brakes, and some of them have sufficient air capacity to operate pneumatic tools.

Another rig of the kind just described was designed for driving 70-ft. foundation piles on the Chicago, Milwaukee & St. Paul Ry. The boom is of steel pipe, while the 76-ft. leads are pin-connected at the top and connected to the bottom of the boom by an adjustable steel frame. With this equipment thirty long piles could be driven in a 10-hr. shift. It is illustrated in the left-hand view of Fig. 4.

*

Dynamiting a Deep Well To Increase the Flow

A water well near Kennett Square, Penn., was "shot" a short time ago to increase the flow. It was 600 ft deep, started at the top of a hill of elevation 460 ft. G. F. Alderson, Kennett Square, describes the work in *Engineering and Mining Journal.* After drilling through 84 ft. of stiff clay and hardpan, solid rock was encountered with successive strata as follows:

	Ft.		Ft.
Sand rock...	121 0	Gray granite with green serpentine seams.......	2 0
Flint rock ..	90 0	Gray granite.......	40 0
Blue granite	17 5	Blue granite...	3 0
White quartz.. . . .	1 2	Gray granite	72 0
Gray granite	47 8	Bastard granite.. .	84 0
Blue granite . .	17 5		
Gray granite with quartz seams	10 0		
Blue granite broken	10.0	Total...	516 0

An 8-in. steel casing was sunk to rock and grouted to exclude surface drainage; the hole through the rock was 6 in. At 600 ft. the flow was measured and found to be only 3⅓ gal. per min. To go deeper would mean expensive pumping equipment. It was thought that a discharge of nitroglycerin would shatter some of the water-bearing strata.

Indications were that the stream supplying the well was about 320 ft. below ground level. Just below this point the well was bridged by means of a ball of stiff wire forced to the desired depth. Concrete was placed upon this. Mr. Alderson describes the shooting, as follows: "A special type of solidified nitroglycerin—which is commonly used for shooting oil wells—formed the charge, which consisted of 190 qt. The explosive was packed in 10 tubes, 5¾ in. in diameter and 7 ft. long. These were placed in the well one above another, and the whole was discharged by dropping a jack squib down the well.

A column of water 500 ft. high was blown from the well, following which the latter was tested. The test pump working continuously for 7 hr. pumped 10,000 gal., which was at the rate of 22 gal. per min.

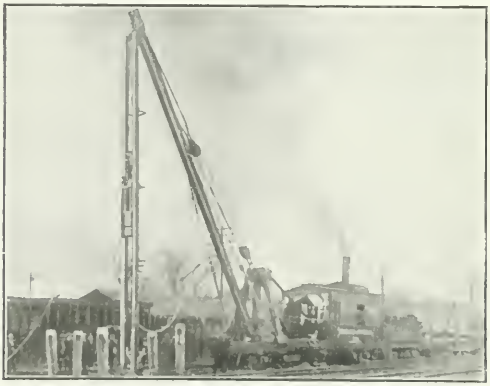


FIG. 5. STANDARD STEEL PILEDRIVER OF ILLINOIS CENTRAL R.R.

Leads are connected on end of boom by a pair of lugs and bolts. Machine (X-24) has lifting capacity of 35 tons and one or two steam hammers can be operated, capacity is 40 wood piles or 35 concrete piles per day Data furnished by A. S. Baldwin, Chief Engineer, Illinois Central R.R.

Concreting Train for Street-Railway Work

A concreting train of specially interesting design is used by the Detroit United Ry. for building the concrete base for tracks in paved streets at Detroit, Mich.

At the rear end of the train is a 35-ft. steel-frame motor car carrying a 2-yd. mixer of the drum type. The charging side is inclosed in order to avoid dust from the cement, etc. On the discharge side the concrete is delivered into an inclined chute and deposited between the rails, directly under the center of the mixer. At the forward end of this car is an inclined bucket elevator, which receives the material from the conveyor belt noted below and delivers it to a charging hopper.

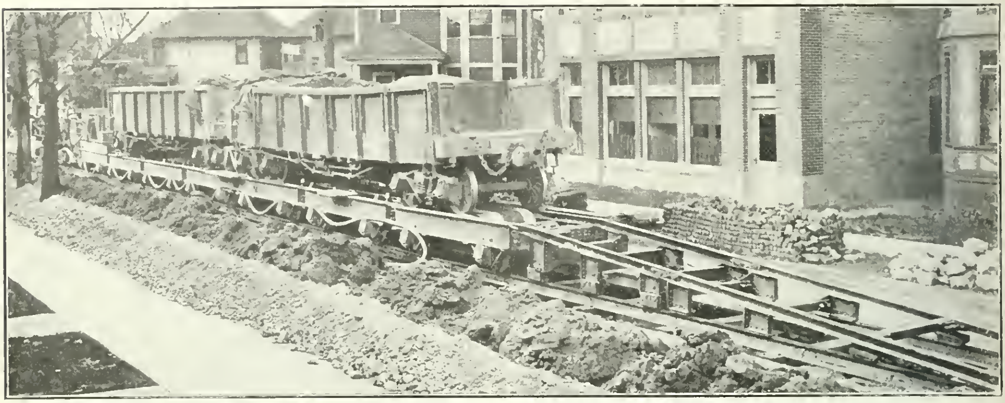


FIG. 1. MATERIAL END OF CONCRETING TRAIN AT DETROIT
The two cars drop gravel upon a belt conveyor which delivers the material to the mixer car at the left

The mixer car is shown in Fig. 2 with the converter and one of the gravel cars at the right. At one end of the upper deck is a standard carrying a trolley pole. At the opposite end is a platform for the men who control the supply of aggregate, feed the water and dump the cement into the hopper. There are two men on the mixer car.

The forward end of the train consists of a series of seven four-wheel steel-frame trucks carrying a belt con-

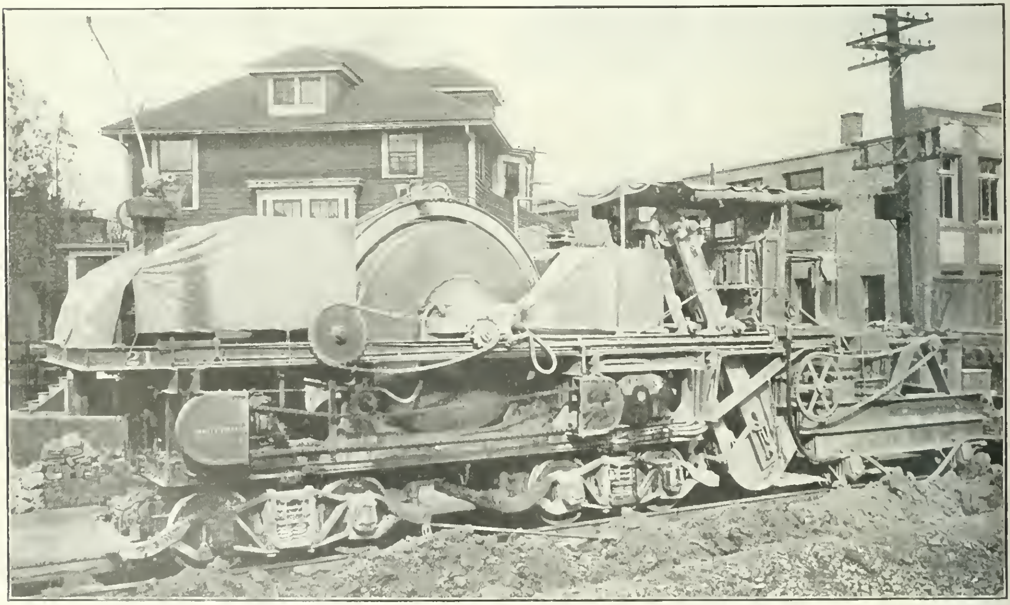


FIG. 2. MIXER CAR OF CONCRETING TRAIN ON THE DETROIT STREET RAILWAYS
Next to this car is a truck carrying the head of a conveyor belt which travels under the dump car shown at the extreme right

veyor 36 in. wide and 80 ft. long. They also carry a standard-gage track, the end of which is connected with the surface track by an incline (with inclination of 1 in 3) supported by structural-steel frames. Feather rails, resting on the surface track rails, form the forward end of the incline. This part of the concreting train is shown in Fig. 1. The rear truck of the portable conveyor (which is next to the mixer car) carries the driving mechanism and the tripper or chute for discharging the material from the end of the conveyor belt, as shown at the right in Fig. 2.

The track being blocked up to grade, the train is run upon it. A motor car then pushes onto the track over the portable conveyor two hopper-bottom gondola cars, each holding about 30 yd. of graded gravel and sand. The hoppers are opened gradually, and the contents fall upon the conveyor belt. This delivers the material to the elevator, which in turn delivers it to the charging hopper. This supply is sufficient for one shift, and between the shifts empty cars are removed and loaded ones put in place.

As the concrete is spouted into place, the train backs away, and the concrete is dressed to surface and floated by hand. This outfit is used also to place the concrete filling between ties, after the track is completed.

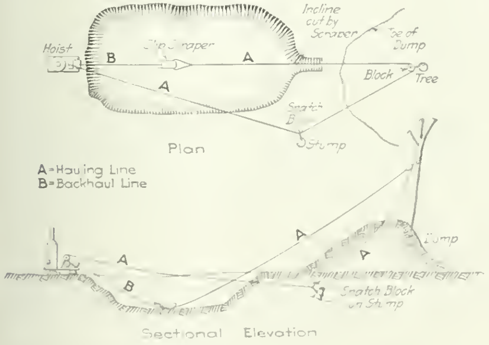
The car has two 80-hp. motors on each truck, and an 80-hp. motor that drives the mixer, elevator and belt conveyor by means of sprocket chains. With this outfit about 350 cu.yd. of concrete can be placed in a 10-hr. working day. There is a crew of 11 men with the train.

The plant was designed by John Kerwin, Superintendent of Tracks, Detroit United Ry., and was built at the company's track-department shops under his direction.

⁂

Improvised Dragline Rig

In excavating the foundation pit for a set of floodgates in the Brevoort levee, in Indiana, the contractor rigged up a dragline outfit, as shown in the accompanying sketch. A hoisting engine was placed at one side of the pit, with a backhaul cable hitched to an ordinary slip scraper. The hauling line was run clear of the pit through a snatchblock at one side and then up to a block attached to a tree in line with the hoisting engine, from which the cable led back to a bail on the scraper.



IMPROVISED DRAGLINE RIG FOR FOUNDATION-PIT EXCAVATION

Men in the pit held the scraper by its handles to give it a load and start it up the incline, which it cut for itself. One man was stationed on the dump. Some trouble was experienced in dumping, but on the whole the rig worked very well; as the excavation was small, nothing more elaborate was needed. The material was a soft and wet but very sticky mud, in which the men worked with difficulty, both in the pit and on the dump. The engineer was J. S. Spiker, of Vincennes, Ind., and the Vincennes Bridge Co. had the contract for the drainage outlet, including the concrete work and gates.

⁂

Simple Azimuth Determinations

By J. K. Finch*

The writer desires to call attention to the computation of azimuth by direct solar observation, described in "Field Book Sheet for Azimuth," in *Engineering News*, Aug. 24, 1916. This method is gradually coming into more extended use in general surveying practice, as it gives a sufficiently exact result (about ±1′) without the necessity of staying in the field over night for a Polaris observation at elongation. It is also preferable to using a solar attachment, when only one or two determinations of azimuth are required. It seems, however, that many surveyors are deterred from using it owing to the somewhat formidable-looking formula advocated in most textbooks and also in the article above mentioned.

At the Columbia University summer school of surveying, Camp Columbia, we have required students to use all three methods and, in computing azimuth from a direct observation, have used the following formula:

$$\cos A = \frac{\sin d}{\cos l \ \cos h} - \tan l \ \tan h$$

where A is the bearing of the sun (the sign of A from the computation determines the quadrant; thus if A is plus in the forenoon the bearing is N.E., if minus S.E.; and similarly in the afternoon, N.W. and S.W.); and d = declination; h = observed altitude; and l = latitude.

This formula not only has the advantage of lending itself to simple logarithmic computation, but does not involve all the additions and subtractions that are required in the usual formula.

The following example illustrates the form of computation:

	Angles	Anti-Logs	Logs	
l	41° 03′ 45″		Log cos = 9 87737	Log tan = 9 94012
h	26° 11′ 15″		Log cos = 9 95297	Log tan = 9 69178
			Sum = 9 83034	
d	−20° 49′ 37″		Log sin = 9 55090	
		—0 52549	Diff = 9 72056	
		0 42845		Sum = 9 63190
A	S 17° 27′ 30″ E	—0 95394 = diff = nat cos A		

Due attention must be paid to the sign of the declination, which determines the sign of the first term of the equation.

This formula will be found on p. 223 of the "Standard Field Tables of the General Land Office, U. S. A." A modification of the same formula was proposed in *Engineering News*, Mar. 6, 1913, in an article by Louis Ross.

[The formula quoted by Professor Finch is given and explained in Johnson's "Theory and Practice of Surveying," seventeenth edition, p. 99, and it is in pretty general use in the West, where surveyors are required to make frequent azimuth determinations in surveys and resurveys in the location of section and quarter section corners.

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*Department of Civil Engineering, Columbia University, New York City

The "Standard Field Tables of the General Land Office," referred to by the author, is a pocket-book that should be in the hands of every surveyor. While primarily designed as an aid in public-land surveying, the tables are of the utmost value to all surveyors.

Inquiry is frequently made for traverse tables. This book, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 60c., contains latitudes and departures to four places for each $\frac{1}{4}$°, for distances 1 to 100. There are also tables of stadia coefficients, of natural sines, cosines, tangents and cotangents, logarithmic tables of trigonometric functions and of numbers, besides tables and formulas for astronomical work.—Editor.]

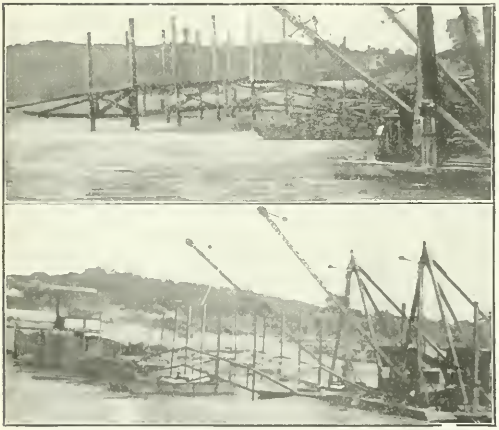
⁂

Placing Wood Coffer-Dams Without Driving

By K. H. Shriver*

An interesting method of building wood coffer-dams is being used at dam 24, Ohio River, by the Sheridan Kirk Contract Co. These coffer-dams are known as the box type and are 20 ft. wide inside sheeting, at an elevation of 16 ft. above low water.

The method of procedure is as follows: A framework of wales and vertical posts, consisting of five panels 17 ft. long, is built on a decked barge, which is towed to the site; the frame is raised by two derrick boats, and after connecting to the preceding section it is lowered to the bottom of the river. The sheeting is then placed and spiked to the wales, and the coffer-dam is filled to a depth of 5 ft. with material excavated from the river.



SETTING COFFER-DAMS: TIMBER FRAME SUSPENDED, AND COFFER-DAM IN PLACE, DAM 24, OHIO

The remaining two rows of wale timber are then placed and bolted, and the sheeting is cut off to grade, when the balance of the fill is made and leveled to the top of the sheeting.

The frame is made up of two rows of wales on each side, 3 ft. and 8 ft. from the bottom, bolted to 2x12 vertical posts, spaced 8½ ft. c. to c., resting on a decked barge 24x100 ft. The wales are 6x8's, 18 ft. long, having a 6-in. lap joint: the rods ⅞-in. round, 22 ft. long. The struts or spreaders are 2x12's, 20 ft. long. They are placed directly above each rod and cross-braced.

The lifting tackle consists of two slings, each made up of six lines of ¾-in. steel cable, which are made fast to the top wale at each upright. The work is being done under the direction of Maj. I. H. Jackson, Corps of Engineers, U. S. A.; E. H. Groot, Junior Engineer, is Assistant in Charge for the Government.

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*Junior Engineer, United States Engineer Office, Racine, Ohio.

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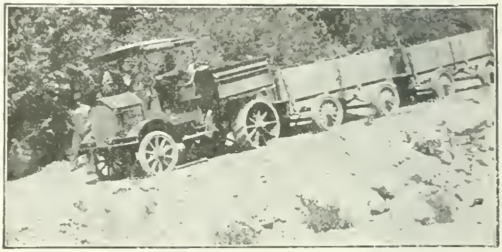
Heavy Haulage for Tractor and Trailers

Following a series of tests, tractors and trailers are now hauling ore from the Cardiff mines in the Big Cottonwood district of Utah in place of hundreds of teams formerly employed to haul the ore to the smelters in the valley and bring back coal and other supplies. Eleven demonstration trips were made by a tractor with trailers, under the direction of L. B. Stone, the data thus collected being published in the *Salt Lake Mining Review*. The equipment consisted of one Model 36 Knox tractor having a 5-ton ore body and two 5-ton Troy trailers equipped with steering apparatus, roller bearings and 36x7-in. rubber tires. On the down trips from the mine the trailers were held back by the brake on the tractor, even on grades as steep as 16%. The tractor treads were steel, 14 in. wide and fitted with diagonal cleats.



TRACTOR AND TRAILERS ON DOWNGRADE FROM CARDIFF MINES IN UTAH

On the 11 trial trips 272,660 lb. of ore was hauled, and 27,080 lb. of coal was transported from the valley to the mines, the average amount of coal per trip being two tons.

The gasoline consumption was 21 gal. per round trip, and the round-trip consumption of oil averaged 2 qt. The distance covered on each trip down comprised 9 mi. in the cañon proper and 7 mi. across the valley, the latter strip including one steep hill. The vertical lift in the 16-mi. journey is 3,050 ft. It is notable that the radiator did not overheat.

⁂

Large Engine Crank Welded at Pumping Station

The cast-steel drag-crank web of a 20,000,000-gal. pump at Queen Lane Pumping Station, Philadelphia, found to have a fracture starting at the inside corner of the rectangular hole and extending all the way across the web on an angle of 45°, in a cross-section measuring 8x8½ in., was "Thermit"-welded in place without having to remove the crank from the engine, which operation would have entailed considerable labor. John H. Burt

Superintendent of the city shops, describes this work in the house organ of the Goldschmidt Thermit Co. At the same time this weld was to be made it was decided to install a later-type drag crankpin of 12-in. diameter, and the shops worked day and night making this pin while the old pin was being drilled out and a slot 1⅛ in. wide was being drilled for welding purposes through the fractured web.

The position of the fracture in the web made welding difficult, as it was desired to have the riser on the outside of the web to insure that the best material would be in the hole that carries the drag-crank check plates. This made it necessary to turn the crank at an angle of 45°, and this operation had to be performed at some depth in the crank pit. To do this a working floor was built in the pit.

The crankshaft itself was 18 in. in diameter and it turned in babbitted bearings, one of which was against the face of the broken web. To prevent the heat from injuring the babbitted bearing the crankshaft was raised ⅜ in., and a stream of water was played on the metal.

It was expected that 8 or 10 hr. would be required to preheat the crank, but after the burners had been blazing away for 8 hr., it was found that although the crank web was at red heat, the heavy portion of the web was black. Asbestos, 1½ in. thick, was then placed over all of the exposed portion of the crank web to reduce radiation, and 2 hr. later the thicker part began to glow; in 4 hr. a good working heat was attained.

At 11 p.m. 250 lb. of "Thermit" was ignited, and at 3:30 a.m. flask and sand were removed. The weld was excellent, and the riser and gates were cut off and the hole finished out, when the new crankpin was shrunk in the opposite web.

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To Mark a Brown Print White

An inquiry was published in *Engineering News*, Nov. 23, as to what solution will mark a van dyke white. I wanted to know this myself a short time ago, so I went into the laboratory and tried soda, ammonia carbonates, acids and peroxide, but could find no single solution that would bleach out the brown. In drawing lines with the pen, however, I discovered that at the intersection of some of them the print turned white. A mixture of these two was made and a clear white surface was left under brush or pen.

The two substances are hydrochloric acid and peroxide of hydrogen. No treatment seemed to be needed after applying the solution. EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Penn.

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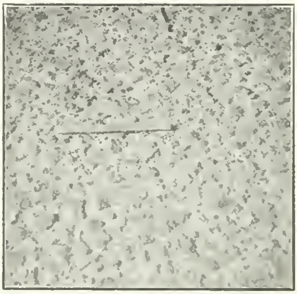
Rough-Surface Asphalt Paving

A new type of asphalt pavement, constructed by the penetration method, is being tried out by the Massachusetts State Highway Commission on some roads in the third division, where F. C. Pillsbury is division engineer. The purpose is to devise a bituminous surface suitable for hillside paving, where there is considerable horse-drawn traffic, for there has been a pretty widespread complaint over the slipperiness of the various forms of bituminous road surfacing used in the state.

The construction of this pavement differs from the regular bituminous macadam road constructed by the penetration method in that all the asphalt is applied at one and the same time. No seal coat or second application is made.

The pavement is constructed by spreading a layer of No. 1 stone (passing 3-in. and retained on 2-in. circular opening) to such thickness that it will roll down to a depth of 3 in., and then applying 2¾ to 3 gal. of hot asphalt per square yard, in one application, as already noted. The resulting pavement is very rough, with projecting stones, as shown in the accompanying illustration. Pavements of this type have been in use for about a year without showing any tendency to ravel or of the stones to loosen. In any but icy weather the surface offers a good footing for horses, and motor vehicles do not skid on it.



ROUGH SURFACE ASPHALT PAVEMENT

Many special types of bituminous road construction have been developed in this state, but the cheapest and most satisfactory for moderate traffic conditions appears to be a hot mixed gravel and asphalt. During the past season some special apparatus, including a 20-ft. portable drying drum, has been developed for constructing this type of road.

The chairman of the Massachusetts State Highway Commission is William D. Sohier, and the chief engineer is A. W. Dean.

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Tunnel Surveying by String Where Transit Failed

By A. L. Plimpton[*]

The article on "East River Tunnel Surveys," by C. M. Holland, in *Engineering News* of Oct. 5, 1916, brings to mind the survey experience that was had in the work of constructing the Boston main drainage system about 35 years ago in connection with giving the line for the tunnel under Dorchester Bay.

This tunnel, one of the very first that was ever constructed under the sea for sewerage purposes, was about 1⅓ mi. in length and about 140 ft. below low water. To facilitate its construction there were three working shafts about 3,000 ft. apart. The line had to be dropped down the shaft in each case and then was extended from the very short length thus obtained into the headings.

At the outset the usual method by means of a transit was followed. As the work progressed, greater and greater difficulty was experienced in giving sights on account of fog and smoke, which could not be driven out.

Finally, one of the headings was in so far beyond where accurate line had been determined that it had become a very serious matter, and still the transit could not be used. It was then decided to try and see what could be done by the mechanic's method of stretching a line. The scales in the roof for recording the position of the line were about 300 ft. apart, which meant stretching a line for about 600 ft. in order to locate a new scale.

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[*] Civil Engineer, Boston, Mass.

The finest trout line was purchased, at a cost of about $7, and the party went down to see what could be done. It was found that it was impossible to stretch it so as to lift it off the bottom without breaking it, as it would not hold its own weight. The writer, who was one of the engineering corps, happened to have a ball of linen thread and suggested trying that the next time in place of the trout line. This was done, and its strength was such in relation to its weight that it could be pulled so that the sag was not more than 4 ft. It looked as though something could be done by using 10c. worth of thread in place of the trout line.

Posts were wedged between roof and bottom (so as to be absolutely solid), one back of what we will call Scale 1, and the other beyond, toward the heading, where Scale 3 was to be placed; No. 2 scale was midway. No attempt was made to place Scale 3 accurately, but care was taken merely to have the line come somewhere near the middle of it, as shown by the thread held approximately on line. After the scale was secured in place, the thread was stretched and fastened on one side of the posts, and careful readings were taken at each of the three scales. This was done in the following manner:

There was a sliding vernier on each scale, and a tiny plumb-bob was suspended from the vernier so as almost to touch the thread. A little silver plumb-bob that had been made for a watch charm was used for the purpose. The observer gave directions to his assistant how to move the vernier by placing himself so as to note the final coincidence in a vertical plane of the stretched thread and the line to the plumb-bob, which were both illuminated equally on each side by candle light. It was perfectly surprising with what accuracy the vernier could be moved off of line and again set by the same or by a different observer, by this method. It must be understood that the conditions were perfect for this kind of work, as it was absolutely still down there in the bowels of the earth, not a current of air to disturb the line or the plummet.

When several readings had been taken with the thread on one side of the 3x4-in. upright posts, it was changed to the other side of the posts and a new set of readings taken. The exact position of the center line on the new scale was then worked out in the office on cross-section paper.

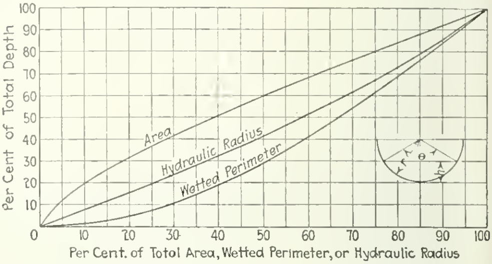
The agreement of the results of the two lines run in determining the position of the center line on the new scale was so perfect that this method was followed all through in the work of the tunnel, even at the outset while working from a new shaft when a transit could have been used.

And thus instead of its being the difficult and long operation of trying to set a transit up on line and sighting under all sorts of atmospheric conditions, it was a perfectly definite method of procedure in each case, and one which took but little time. When the work was completed, the thread was cut down and left there; and the party came out, with the feeling that they had got results.

The headings in each case met with very slight error, the greater part of which was undoubtedly due to the error in transferring the line down the shafts and not to extending it.

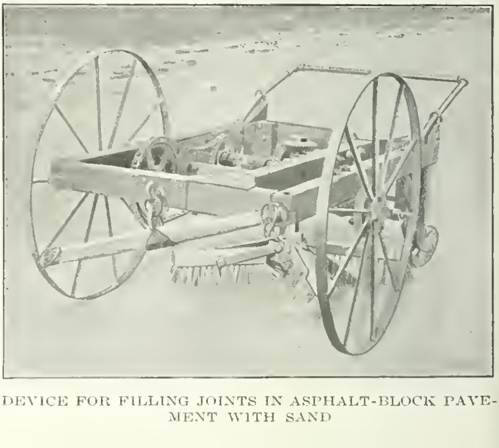
FINE AGGREGATE

Curve for Design of Semicircular Flumes—The computation of the area and hydraulic radius for any given depth of water in a semicircular flume requires the use of somewhat long and complicated formulas. The accompanying curve gives the percentage of total area, hydraulic radius, or wetted perimeter for any percentage of total depth. The total area and the full-depth hydraulic radius for various diameters are generally given in the catalogs of the various flume companies or can be obtained from the "functions of numbers" tables in any handbook. The computation of A and r for fractional depths then becomes, by means of this curve and a slide rule, a very simple matter.—Lewis M. Hammond, Assistant Engineer, United States Reclamation Service, Provo, Utah.



CURVE FOR SEMICIRCULAR-FLUME COMPUTATIONS

A Sand-Spreading Device for filling joints in an asphalt-block pavement is shown herewith. It was used by the Asphalt Block Paving Co., Toledo, Ohio, on Shaker Boulevard between North Moreland and Coventry, suburbs of Cleveland, Ohio. The device consists of four ordinary street brooms, fastened to arms at right angles to each other, which revolve as the two-wheel truck is moved. The driving mechanism is a sprocket and chain attached to the axle, which operates a pair of bevel gears through another sprocket and shaft. The carriage is intended to be drawn by a horse. Obviously, the same device could be used for spreading grout on other block pavements.



DEVICE FOR FILLING JOINTS IN ASPHALT-BLOCK PAVEMENT WITH SAND

Topographic Surveys by the U. S. Geological Survey have now covered 41% of the entire area of the country, according to the annual report of Secretary Lane, of the Department of the Interior. During the year ending June 30, 1916, 22,715 sq.mi. were mapped topographically, making the total area in the United States surveyed to date 1,237,520 sq.mi. Topographic surveys were made in 29 states, 17 of which coöperated in the work. In the Division of Water Resources 1,302 river gaging stations were maintained in 1916.

Editorials

Engineering News as a Christmas Present

One of the pleasures which come to the subscription department of *Engineering News* at each recurring annual season of Christmas cheer and good will is the letters received from those who desire to give a year's subscription to *Engineering News* as a present to some friend.

These letters come from many different sources. Many are from mothers who desire to send to a son engaged in engineering work a present that will be at once a help in his daily tasks and a weekly reminder of the giver. Others are from wives who wish the paper sent to their husbands—a class of subscriptions especially noteworthy as conclusive proof of conjugal affection, for wives with engineer husbands are generally thoroughly familiar with the usual desire of engineers to preserve the back numbers and back volumes of *Engineering News* for reference, and realize even better than their husbands what this means in demands on space and necessity of handling and dusting.

Still other remittances come from manufacturing and business firms who desire to present a year's subscription for *Engineering News* to some of their employees.

The rapidly growing custom of widespread distribution of Christmas presents is in danger of self-destruction because of the too-common practice of giving as a matter of obligation instead of giving in the Christmas spirit of good will, and also because of the too-common practice of giving presents which are for show rather than use and which the recipient is puzzled to know what to do with.

At this time of world-wide scarcity and countless appeals to one's sympathy and purse, it is surely an appropriate time to cut out presents of the useless order and to substitute in their place presents like that suggested above, which are a direct help to the recipient in his daily work.

Letting Contracts on the Cost-Plus-a-Percentage Basis

The unprecedented conditions in the labor and material market at the present time have given a great stimulus to the plan of letting contracts on a cost-plus-a-percentage basis, instead of at a fixed price. A notable example is the contract for which bids were opened last week for the construction of four battle cruisers for the United States Navy. These vessels are to be very much larger and faster than any vessels ever built in an American shipyard. They are to have six times as much horsepower, and are to develop 14 knots higher speed than the largest vessel hitherto built for the United States Navy. In the act authorizing these vessels, on account of their more or less experimental character, Congress provided that the Secretary might at his discretion let contracts for them on a cost-plus-a-percentage basis.

In the bids submitted last week by the Union Iron Works of San Francisco and the Fore River Shipbuilding Corporation of Quincy, Mass., both concerns pointed out that their reasons for submitting their bids in the form of cost plus a percentage was not alone the novel character of the vessels, but the great uncertainty as to prices which will govern for material and labor during the construction of the vessels. It is estimated that these vessels will require at least four years to construct, and no one on earth is wise enough to predict with any accuracy what the prices of labor and of steel will be even twelve months hence.

Under ordinary conditions, a contractor in submitting bids makes contracts in advance with the concerns which are to supply materials, etc., so that he can know definitely in advance what the cost of the material will be. The Union Iron Works in submitting its bid declared that it had found it impossible under present market conditions to cover by option or provisional contract a large percentage of the material required for the battle cruiser. Such estimates for the vessels as have been prepared show a cost which will already considerably exceed the appropriation made by Congress.

The conditions cited in connection with this huge contract are typical of conditions existing in connection with nearly all contracts at the present day. Concerns with a good reputation and financial responsibility are not inclined to endanger their solvency by making close bids on work when it is necessary to run the risk that materials and labor both may increase in price 10, 20, or 30%, or even more during the period while the construction is in progress, and the added risk that difficulty in obtaining materials or labor may delay the completion and subject them to a penalty. Under these conditions the interests of the taxpayers will generally be better served by letting contracts for public work on a cost-plus-a-percentage basis wherever the law will permit this, than on the usual fixed sum basis.

Engineering Work and State Highway Legislation

The American Highway Association has rendered a useful public service by issuing at this time, shortly before the assembling of most state legislatures, a review of legislation concerning state highway departments. The review has been prepared by R. Walter Moore, Chairman of the Association's Committee on Legislation.

It is to be hoped that one particular sentence in this review will be read and taken to heart by the legislators in whose hands it will be placed. Under the heading "Engineering Work," Mr. Moore says: "No state highway department can be of more than nominal service without a capable engineering bureau."

To members of the engineering profession this may sound like a platitude; but any one familiar with the conditions under which country highway work is done knows that there is a deep grounded opposition in many parts of the country to the employment of an engineer in connection with highway work, or what amounts to the same thing, to the payment of salaries sufficient to enable competent engineering service to be secured.

In order to make certain that the technical work of a state highway department shall be under the direction of a competent engineer, it is recommended that unless some member of the state highway commission is required by the law to be an engineer, a clause should be inserted in the law reading:

> The state highway commission shall appoint a state highway engineer, who shall be a competent civil engineer, experienced and skilled in highway construction. He may appoint, subject to the approval of the commission, such technical assistants as may be necessary for the proper conduct of the engineering work of the commission.

In connection with the engineering work of state highway departments, sharp criticism is made for the indefinite responsibility at present existing for the safety of highway bridges. Recommendation is made that legislation should be enacted providing that all bridges on roads built or maintained with the aid of state funds shall be inspected annually by the state highway department which should also inspect all bridges of more than 20 ft. span on roads not built or maintained with the aid of state funds. Any bridge found to be unsafe should be immediately posted by the state highway authorities, which should serve notices on the local authorities responsible for the bridge ordering them to make necessary repairs, and in case of failure to make such repairs reporting the case to the Attorney General.

In reviewing the organization of state highway departments, Mr. Moore unfortunately fails to make clear the great advantage in having state highway commissions made up of three or more members, with the term of office of only one member at a time expiring. Under such a commission a continuous organization is generally maintained and the periodical "clean sweeps" are avoided, which experience has shown are only too apt to occur when a state highway department is in charge of one man. The advantage of maintaining a continuous organization is obvious to all members of the engineering profession and ought to be made clear to the general public.

Combinations for Conservation of Natural Resources

Eight years ago the attention of the public was effectively directed toward the need of conservation of the Nation's resources, by the famous Conservation Congress held at the White House. That notable meeting, however, made only a beginning in the necessary work of public education. Since that meeting, some of the leaders in the conservation movement have diverted it from its original great purpose and concentrated their efforts to oppose grants by the Government to private parties for the use of natural resources still in public ownership. The far greater problem of checking the enormous waste now going on as a result of present methods of utilizing natural resources is almost unheeded.

While the politicans have used the conservation movement for political purposes, engineers, who better than any other class appreciate the vast importance of real conservation to the public welfare, have steadily continued to agitate the subject. The National Chamber of Commerce announces that a referendum vote is about to be taken on the question, "Shall combinations to conserve natural resources be permitted?" The taking of this vote is the result of recommendations by a committee, the chairman of which is a noted engineer and which has in its membership two scientists who may well be ranked as engineers. The committee is made up of W. L. Saunders, past-president of the American Institute of Mining Engineers, chairman; Prof. W. B. Clark, State Geologist of Maryland; John H. Fahey, former president of the National Chamber of Commerce; Charles F. Keith, president of the Southern Pine Lumber Association; and Dr. Charles R. Van Hise, president of the University of Wisconsin.

The recommendation of this committee is that in industries which involve primary natural resources, where cooperative agreements will tend to conserve these resources, to lessen accidents and to promote the public interest, Congress should pass legislation permitting such agreements to be made without infringement of the Sherman law. The committee bases this recommendation on its studies of lumber, coal, oil and ore production.

What the committee points out has been in fact well known to engineers for a considerable time. In coal production, for example, the late Joseph A. Holmes, when head of the Bureau of Mines, pointed out that the strenuous competition and low price at which coal was produced made it impossible for the coal operators in many parts of the country to take out the maximum amount of coal from the seams that they worked. In order to maintain their place in the competitive struggle and keep out of bankruptcy they were practically obliged to take out the most easily mined part of the seam and leave the rest in the ground, to be forever unavailable for the use of humanity.

Practically the same thing has been going on in the lumber industry, as has been repeatedly pointed out by Federal experts in the Forest Service. The intense competition in the lumber business has forced lumbermen to cut from their lands the best timber that can be most readily marketed, leaving the slightly inferior qualities to decay in the forest and furnish a readily available fuel for forest fires.

It is in petroleum and natural-gas production, however, that the most criminal waste is going on, as it has been going on ever since the industry began, notwithstanding the wide public attention called to this waste at the Conservation Congress of eight years ago and notwithstanding repeated demonstrations of the need of effective measures to prevent waste.

At the recent American Mining Congress at Chicago a paper was read by Max W. Ball, of the United States Bureau of Mines, showing that at the present rate of consumption of petroleum the entire petroleum resources of the United States will be exhausted in approximately 30 years. The following extract from Mr. Ball's paper indicates something of the criminal wastefulness with which the natural resources in petroleum and natural gas are being exploited:

> Are we practicing conservation? Within the last few weeks I have seen millions of cubic feet of natural gas wasting into the air—gas so rich in gasoline that it dripped from the trees like an April shower. I have seen wells capable of yielding 40,000,000 cu.ft. of gas each being deliberately drowned out by pumping water into the gas sands. Reckless drilling, defective casing, careless plugging are flooding great areas with water and losing forever enormous

> quantities of oil. It has been testified before the Corporation Commission of Oklahoma that ordinary methods leave from 25 to 85% of the oil in the ground, and this estimate is concurred in by careful engineers and practical oil men.
>
> Nor are these underground losses the only ones. When the oil is brought to the surface before transportation and market are ready for it, it must go into storage. Indeed, in many fields oil has been produced before storage was available, and millions of gallons have gone down the streams or seeped away from earthen reservoirs. Even when the best steel tankage has been provided, evaporation losses still go on. Cushing crude stored in steel tanks for a few months lost approximately a fifth of its gasoline content. The State Mineralogist's office of California has estimated that even with the heavy oils of that state the loss by evaporation represents perhaps 25% of the total value of the production at the well. An official of one of the largest companies in the Midcontinent field recently told me that last year fire destroyed 6% of his company' production.
>
> Just consider these examples; 25 to 85% left underground; 20 to 50% of the value of oil produced lost through evaporation in storage; 6% of stored oil lost by fire! These losses are staggering and are not exceptional! What a small percentage of this wonderful natural resource is saved to run your machine or to deliver goods at your door or to plow the fields from which your food must come!
>
> If we feel these losses in the high prices of the present day, how much more will we feel them five, ten, twenty or thirty years from now? Is it not time we considered them seriously and tried to determine upon some remedy?

Mr. Ball further shows how in the rush to develop a new oil field and the mad competition between the different drillers the natural gas that precedes the oil is frequently allowed to waste itself entirely and the oil deposits are tapped with such haste and carelessness that water often invades the field and drowns out the oil when but a small proportion of that available has been drawn off.

In hearings before the Senate Committee on Public Lands, Jan. 12, 1915, it was shown that the companies which exploited the famous Glenn pool of Oklahoma spent $11,260,000 in drilling wells, when if the whole pool had been exploited by one producer who would have handled the work properly, all the oil could have been obtained for $3,177,000.

Mr. Ball urges that to furnish at least a partial remedy for the appalling waste now going on, the laws should be so amended that oil lands will be divided up into larger tracts, so that producers will not be under the same necessity as now to rush the work of draining off the oil at a sacrifice of all other considerations. Mr. Ball concludes his paper as follows:

> If you would prevent waste of oil and natural gas, if you would do away with careless drilling methods, excessive production charges and storage losses, if you would insure the production of the maximum amount of oil at the minimum cost, if you would help to maintain a reasonable price for petroleum and its products in the years to come, then do your part in creating a public sentiment in favor of adequate acreage.

Mr. Ball's recommendations illustrate well the crying need of a better Federal mining law to govern the titles to mineral deposits. To show the active interest that engineers are taking in this aspect of the conservation movement, it may be noted that the Mining and Metallurgical Society of America has just completed a letter ballot of its membership on 33 questions in connection with proposed revision of the Federal mining law. In addition, it has submitted the same questions to a number of other organizations in the mining industry where a similar ballot could be taken.

These illustrations indicate that some engineers, at least, are endeavoring to do their duty in informing public opinion and making it effective toward bringing about intelligent legislation in the public interest. Surely there was never a time within the memory of men now living when the need was more obvious of utilizing without waste the natural resources that furnish the materials necessary for life. It may be hopeless to expect very much remedial legislation at the present short session of Congress, but the work of indicating the direction that legislation should take in order to protect the public interest ought eventually to be effective.

Letters to the Editor

Should Engineers Take Part in Politics?

Sir—Certainly an engineer should take part in politics, for the reason that every loyal citizen of a republic is in duty bound to do his part toward making an efficient government. If there exists a "polluting influence of politics and politicians," it is due to the supineness of honest, decent and intelligent men, who draw their skirts away from the political cesspools in self-centered righteousness and let the evil grow to the satisfaction of ward heelers.

Many professional men of the highest standing in law, medicine and even the ministry have entered political work to the civic improvement of their community and the honor of their profession, and without ceasing to be a lawyer, a doctor or a minister. Engineers, as a class, have not, and this neglect has not added recognition or prestige to their profession.

When we consider the immense portion of the money of taxation that is expended for public engineering work, for roads, bridges, water-supply, sewerage, canals, lighting, the regulation of rivers and the reclamation of swamps and arid wastes, it is *not* to the credit of engineers that so few are sitting as members of councils, as municipal, state and national representatives to formulate policies and procedure for the government in public work. The engineer has been content to serve only as a hired man. Let us get off the pedestal of aloofness and take our part as American citizens. LEROY K. SHERMAN.

Chicago, Ill., Nov. 27, 1916.

Sir—The reply to the important question, "Should (American) Engineers Take Part in Politics?" raised on page 1001 of your issue of Nov. 23, might be taken from the different articles and even advertisements in that same number of *Engineering News*, thus incidentally proving what a wealth of thought can be abstracted even from an engineering periodical—provided it is a good one.

I am sorry indeed to read that a few mere appeals to join some others in such an important and infrequent matter as the election of a President of the mightiest of republics, if not of nations, shocked Mr. Dabney's professional sensibilities so considerably. He certainly never was a member of any of the democratic engineering societies of Europe. If he had been, he would have succumbed to heart failure before now, for even such renowned and powerful organizations as the Verein Deutscher Ingenieure have been guilty—very guilty. If I rightly remember, this society wanted to qualify young engineers by means of examinations to wrest from the public service those branches that were better intrusted to competent engineers than to incompetent lawyers.

But there are higher things than political jobs—than mere loaves and fishes. The circumstances of the entire engineering world should be such that its members can attain the highest. They should be enabled to devote their talents to the welfare of the commonwealth. If engineers should throw themselves into that "low political scramble," they should go in to make themselves felt and the more respected, which the American engineer, compared with those abroad, is not. Once having his rightful place in the community, he will find opportunity for his reasoning powers to be of greater benefit to the American people than is now the case.

The American masses are of a materialistic turn; they never will respect where there is not prosperity, and the American engineer is not prosperous. The body of American engineers is not constituted by that very small percentage of them who have offices. Most emphatically not. And that small percentage is not qualified to judge whether the greatest part by far—the engineer wage earners—should mix in the fight or not.

As I said, that number of *Engineering News* was full of information bearing on the subject. Glance through the list of men without positions, the jobless. Again, page 1010 tells a striking story of what the navy offers to the cream of America's engineers, men of about 40 with a highly successful past—$10 a day. It is unnecessary to enlarge on this. It states plainly that engineering in America is a disillusion financially and, as America is materialistic, socially, as well.

But there is hope. Mr. Fleming in the same number and in previous issues has proved to be a champion of the cause. He has demonstrated the fitness of the engineer to take part in public affairs, and he has discussed the engineer as a writer of fiction. It was the gladdest note I ever read in any American professional publication.

It brought visions of bygone days in Europe, in Australia, even in the lost corners of semi-barbaric Asia, where there was at any rate time to read, to relax the mind. What does the American engineer know of literature or art or of music? Back bent over a table, or from dawn to dusk in the dirt, is his part in both daily work and recreation. For concerts he has no money, and of art he sees glimpses only amid a holiday crowd.

Should American engineers join in politics? Yes, most emphatically, yes. Not for the loaves and fishes, but because they, with their intellectual powers, with the invariably accompanying sense of fairness and right, should wrest the affairs of state out of the hands of grafting politicians, to elevate themselves and with them the entire nation. Our profession, in which there is no give and take, has shaped the engineer into the honest man he is. His contact with men, his thorough education, have predestined him to be an admirable leader; and if it were only as a means to the end, the American engineer should mix in politics—and not for a presidential election only.

JAN SPAANDER,
(A neutral and appreciative guest of America).
Brooklyn, N. Y., Nov. 27, 1916.

[Mr. Spaander's arraignment of American engineers is rather severe as applying to them as a class or profession, for it would apply with equal potency to most other Americans. Moreover, if his acquaintance with the lives of many of our best engineers had been broader, he would know that the love of literature, art and music is not so rare by any means.

It is unjust to say that engineers have been nonentities in American civil government. Many an engineer in the same quiet, unassuming and unpretentious way that he has accomplished great objects in engineering, accomplishes an equal amount of good for the city, state and nation. The unwritten, little known part of the biographies of these men often shows a most unselfish devotion to the public welfare. And while it is true that many reforms require a more militant spirit, we should not overlook this other means of serving the public.—Editor.]

Sir—I note in *Engineering News* of Nov. 23, p. 1001, a letter from my good friend, Maj. T. G. Dabney, deploring the active participation in national politics of civil engineers—members of the American Society of Civil Engineers.

I certainly share his feeling that our honored organization, as such, should keep out of politics. But I also feel that we should, as individuals, have as patriotic a desire as any other citizens of the Republic to promote what each conscientiously believes to be for the greatest good of the land of his birth; and that all engineers who think alike should combine to bring about those results which they believe will conduce to the greatest good.

When we become engineers, we do not cease to be citizens; and the duties of citizenship should be discharged as conscientiously as any trusteeship that we hold as professional men.

The question arises, Will the participation in politics of men whose standards of honor are as high as those embraced by our profession tend to lower those standards, or will they help to raise the grade of political morals? I believe in the latter alternative.

Major Dabney mentions two appeals made to him by prominent engineers, holding opposite views as to the presidential candidates. I was the Chicago member, making my appeal for President Wilson, but asking no contribution to the expenses of the campaign. I sent out a large number of personal appeals for the man of my choice and was much gratified by the responses. Some men whom I felt sure were rock-ribbed Republicans replied that they would vote for Mr. Wilson.

I believe that engineers should make themselves felt in civil life as well as in civil engineering. I want to say further that in our association with one another our political leanings should make no difference in our professional brotherhood. In a long professional life I have never been influenced in employing assistants by their political faith. All that I have wanted to know about them has been their ability to do the work and their conscientiousness in its discharge. ISHAM RANDOLPH.

Chicago, Ill., Dec. 1, 1916.

Detecting Initial Stress in Bronze

Sir—Referring to the editorial in the issue of *Engineering News* for Nov. 23, headed "More Evidence of Unreliability of the Stronger Bronzes," I think that a short statement in regard to what was actually found as the cause for the difficulty with the manganese-bronze rolled material on the Catskill Aqueduct will be of service in making clear to engineers that, *with proper inspection and under proper specifications*, rolled manganese bronze would appear to be an entirely satisfactory material, in places where its resistance to corrosion and its strength are desirable qualities.

Alfred D. Flinn, Deputy Chief Engineer of the Catskill Aqueduct Board, presented a paper to the American Institute of Metals at its meeting in September, 1915 (published in the *Proceedings* of the society), in which he describes in detail the difficulties that had been experienced. This paper is very complete and instructive. Prior to this time, the matter had been referred to in *Engineering News,* as you state, and in some of the trade papers.

The same troubles have been experienced in other places with the same material, but in the case of the Catskill Aqueduct, conditions were so serious, and the amount of money involved was so great, that especial attention was directed to the difficulty.

At the same meeting of the American Institute of Metals referred to, a paper was read by P. D. Merica and R. W. Woodward, of the United States Bureau of Standards, which gives a very complete account of the investigation which the Bureau made in this connection, and in which are given a number of valuable references. The reference to which attention should be especially called is the paper by Prof. E. Heyn, of the Royal Technical Institute of Charlottenburg, presented to the Institute of Metals as the May lecture before that body in 1914. This is a very complete, theoretical and practical exposition of the subject of internal strains in cold worked material. The subject was investigated by Dr. Heyn on account of the cracking of steam turbine blades made of nickel steel containing about 25% of nickel. Strain diagrams were given of this material and of various nonferrous alloys. This paper is the basis of the work done by the Bureau of Standards here referred to.

The difficulties that arose in the case of the Catskill Aqueduct material are quite common in other brasses and bronzes that are subjected to cold work such as drawing, stamping, etc. For instance, in cartridge cases made of brass, difficulty is frequently experienced by the material cracking after it has been in storage for a while; and for this reason, the phenomenon is usually referred to as "season cracking." This cracking has been known for many years, and has been ascribed to many causes; but since the paper by Professor Heyn appeared, and since the investigation by the Bureau of Standards has been made, it would appear perfectly clear that the real cause is an excessive initial strain in the rolled material due to the rolling; or in the case of drawn or stamped material, to the cold work and consequent local strains set up by the method of manufacture.

It may be of interest to note that these initial stresses, according to Heyn, were as high as 22,100 lb. per sq.in., these measurements being taken five days after the bar had left the drawing die. Two years afterward, this strain had increased to 26,600 lb. per sq.in. These figures were the maximum tensions found by Heyn's method in a bar containing 57.8% copper, 40.8% zinc, and 1.35% lead. The tests of the Bureau of Standards show maximum tension stresses in material that had not been used of 94,000 lb. per sq.in. Of course, this is exceptional, although there were a number of instances where the stress was from 17,000 to 34,000 lb. per sq.in. It is evident that such initial stresses in the material inevitably resulted in failure, particularly when additional stresses were introduced in service.

It is well known that annealing will relieve internal strains if properly conducted, and the results of Professor Heyn's tests show this effect very markedly. For instance, the bar above referred to, when heated for three hours at 160° C., reduced the maximum tensile stress to about 15,000 lb. per sq.in.; while heating it for three hours at 230° C. reduced the initial stress to 3,500 lb. per sq.in.

The tests of the Bureau of Standards confirm this, and show that a temperature of 400° C., for a period of one hour, reduces the initial stresses to a safe limit without altering the physical qualities.

It therefore appears entirely possible, as stated before, to use manganese bronze or other high-strength brasses, provided proper methods of manufacture are used, and checked by proper inspection.

Inasmuch as Heyn's method of determining these internal stresses is rather complicated, and more suitable for laboratory purposes than for ordinary inspections, although it gives accurate results, the writer devised a method which is quite accurate, although not so accurate as Heyn's method, and which would appear to be suitable for ordinary inspection. It consists in cutting from a bar of the material a longitudinal strip of segmental section, the included angle at the center being 30°. If there be an initial strain in the material, this strip will not be straight as it was originally, but more or less curved. It is quite easy to measure the deflection of the curve, and knowing the length, it is quite easy to figure the approximate initial strain.

This method was submitted to the Bureau of Standards, who tested it and found that the facts are as above stated. The results obtained are given in the following table as found in three different cases:

Change in Strain at Outside Fiber, Author's Method	Maximum Strain at Outside, Heyn's Method
+30,000	+34,000
4,720	6,000
+41,000	+94,000

With regard to the accuracy of the method, it should not be forgotten that the bending of the strip does not entirely relieve the strain, and that the method is therefore only approximate; but it appears to afford a good idea of the magnitude of the strains, and therefore I feel that it is of value for inspection purposes.

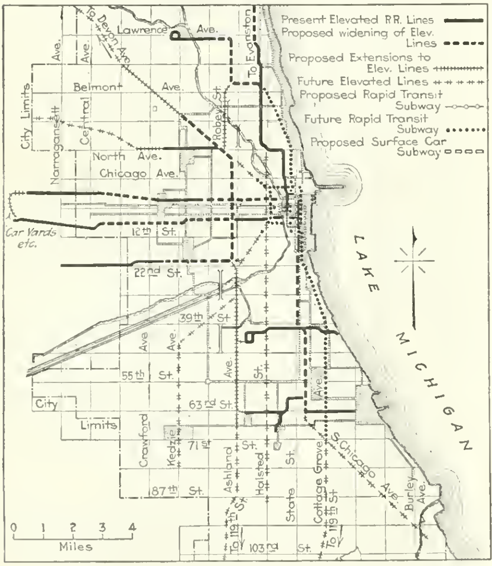
In conclusion, I feel that such a magnificent metal as manganese bronze, which is so suitable for many purposes, should not be handicapped in its application by the idea that it is inherently, and for some mysterious reason, defective; and I believe that with proper inspection, and under proper specifications, the bad name that it has acquired in many quarters will be changed, and its use will increase as it should. S. W. Miller.

Rochester, N. Y., Nov. 25, 1916.

The Future Rapid Transit System of Chicago

The further development of the passenger railway lines of Chicago, planned by the Chicago Transit Commission, was briefly described in the last issue of *Engineering News*. The accompanying map shows the location of the principal lines which it is planned to enlarge and extend.

As shown by the map, the principal feature of the development the Commission has planned is the provision of rapid transit by four-track elevated lines instead of by subways. The Commission points out that the investment necessary to build an elevated railway is about one-fourth as great as that necessary to construct a subway and the traffic capacity of the two are equal. In Chicago there is no such great concentration of traffic in one direction as exists on the long narrow area of Manhattan Island. In Chicago the chief transit lines radiate from the central business district, and rapid transit service can be secured at the least outlay by adding additional tracks to the present elevated lines with some extension of the elevated system in outlying parts of the city. In the central business districts, however, where obstruction of streets by additional elevated tracks would be impracticable, subways are to be constructed. The difficulties in building these subways will be greater than those which have been encountered in New York or in Boston, on account of the soil conditions. With proper care, however, the Commission believes that subways can be constructed without serious damage to the buildings along the route.



PROJECTED RAPID TRANSIT SYSTEMS FOR CHICAGO

In addition to the subways for the rapid transit lines in the congested district, the Commission has recommended additional subways in this district to remove the surface cars from certain crowded streets. Some rather serious difficulties in subway construction are introduced by the existing network of small tunnels in the central business district, used by the Illinois Tunnel Co. for freight distribution in small-size cars. The subways will have to pass above or below these tunnels, and the difficulties of construction are thereby considerably increased. If any further extensions of the Illinois tunnel system are made, the franchise should require the location to be such that no interference with subways for city passenger traffic can result.

The estimated outlay for the construction program which is to extend over nine years, but a considerable proportion of which will be carried out during the next three years, is $100,000,000. The enlargement necessary to provide for the city's growth over a longer period, during which it is estimated the city may reach a population of 5,000,000, will involve an eventual outlay of $260,000,000. This makes the rapid transit development of Chicago as an engineering enterprise rank among the largest now projected in the world.

In undertaking this work, Chicago has certain great advantages through the concentrated financial control of its surface railways and of its elevated lines; and further, because of the large financial interest which the city already has in the surface lines.

To finance this great enterprise will require the united strength of the municipality and the corporations. The advantage of having the entire system, surface lines, elevated lines, and subways, operated under one management, is so obvious that this recommendation of the Commission will doubtless receive general approval.

The members of the Commission, which was appointed nearly a year ago, are Bion J. Arnold, of Chicago, William Barclay Parsons and Robert Ridgway, of New York City.

⁂

Mechanical-Filter Standards

Capacity rates for water filters of the mechanical type, with special reference to filters for other than municipal purposes, formed the subject of a report of a committee of the American Society of Mechanical Engineers, submitted by George W. Fuller, chairman, at the recent annual meeting of the society.

The committee points out that there is no need of standardizing construction details, since there is a wide legitimate field for individual preference or convenience here. With the proper rate of filtration the case is far different, since this depends on the laws of nature. Associated with this rate are some other matters deserving attention.

Capacity can best be expressed in gallons per square foot of filter surface per minute. The upper surface of the bed should be used even in the case of horizontal cylindrical filters. Ample capacity to meet maximum demand should be provided. The recommended depth of filter bed is 33 in., "of which at least 24 in. is sand or similar fine material of suitable size and grade." Minimum thicknesses of 27 and 18 in. respectively are named. Bed thickness is independent of the washing devices used. On the subject of filter medium the report says:

> The most desirable filter medium is a granular substance of a hard, nonporous, insoluble character, with grains substantially uniform in size and shape, the exact size and uniformity of the particles being open to some variation depending upon local conditions. If properly washed, such a filter bed will remain in efficient working condition for several years.

Bone charcoal or other porous material is sometimes of aid in the removal of iron, color, tastes or odors. But if they are used, it must be recognized that growths of bacteria in the effluent are very likely to occur, although there is no evidence to indicate that such growths include disease-producing germs.

Coming now to the main point of the report, the rate of filtration, the committee says:

The permissible rate of filtration in any instance depends upon the character of the water to be filtered and the purpose for which the water is used. If the water is for domestic purposes, whether the filters are installed in a municipal plant or otherwise, the rate of filtration should not exceed that which has been adopted for such service by universal consent of filtration engineers. We therefore recommend that:

a. Whenever the water is to be used for domestic purposes or to secure full bacterial purification, the capacity shall be based upon a rate of filtration not to exceed 2 gal. per min. per sq.ft. of filtering area, and a coagulant must be used.

b. Where a lesser degree of purification is required, either because the water is not to be used for domestic consumption or because the water to be filtered is already sufficiently free from bacteria, or where the filtered water is to be effectively sterilized, a higher rate of filtration may be used, but not to exceed 3 gal. per sq.ft. per min.

Double or series filtration, through material of the same character, is not good practice. Better results are secured by operating the filters in parallel, thus giving a lower rate. For some waters it may be advisable to use a secondary filter of fine material to remove fine suspended matters that pass the primary filter. Where iron, color, odor or taste is to be removed, a primary sand filter and a secondary filter of bone charcoal, or some other porous material may be employed, provided there is no objection to an increase in harmless water bacteria through growth in the porous medium. But in any case the rates for double filtration should not exceed those for single "unless warranted by the results of experiments" or advised by "a competent filtration engineer."

It should be understood that, with the rapid rates approved in the report, proper coagulation of the raw water is imperative, and in the case of very turbid water preliminary sedimentation must also be considered.

It has been found that sterilizing the filters with steam is of temporary advantage only, and sometimes results in the growth of water bacteria in the filter. Disinfection can best be secured by treating the filtered water by liquid chlorine, hypochlorite of lime or ultra-violet rays.

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Detroit Sewer Construction Severely Criticized*

Like many municipalities the inspectors in the Detroit sewer department are frequently political ward workers with or without qualifications. With a compensation of $4 per day, irregular time, many receive more than they possibly could elsewhere. A yearly salary of $1,000 to $1,200, and the position made a stepping stone to promotion are some of the recommendations. At present the inspectors, as a body, are not competent, the inspection service is not efficient, and good contract work is secured by chance.

The methods of undertaking sewer work by day labor are off-hand and informal. No estimate or bid of the probable cost of this work is made by the Sewer Department, nor are detailed cost data of work done. The general superintendent of the department examines the city engineer's estimates and all the contractors' bids submitted, and with this information and his own experience concludes whether or not he can do the work for less than the lowest bid. It is recommended that the superintendent submit sealed bids or estimates based on carefully kept cost data of past work.

The construction of storm sewers by the Sewer Department is usually done without stakes for either line or grade, nor is the completed sewer surveyed, nor is a record plan prepared or filed. The so-called "sight-arm" method of giving grades is in vogue. Long stretches of storm sewers have been constructed to connect with only one or two inlets. A more careful layout of street grades would reduce the work of storm sewer construction.

Seldom after sewers are designed and constructed is attention paid to their operation for the purpose of checking the accuracy of the methods of design. It is suggested that a careful study be made of the operation of existing sewers in connection with the compilation of rainfall records extending over a period of years, and that from these data the present method of design be checked by the so-called "rational method."

In general, the quality of construction work inspected was found to be poor and not in accordance with the specifications—with one exception. The pipe laying inspected was extremely poor. No attempt was made to build the sewers to a true line and there was only a rough attempt to obtain a true grade. Bell holes for the pipe were not excavated, and the pipe was improperly bedded. No mortar was placed at the bottom of the joints and very little in the joint below the springing line of the pipe. The only operation which seemed to be well done was the backfilling in open cuts.

In the performance of routine work over a period of years, the whole conduct of sewer construction has apparently slipped into a rut. The reasons for present conditions may be traced to two sources: Laxity of supervision and political influence in the selection of inspectors.

Little attention seems to be given to the quality of materials used on the work. The specifications are none too explicit as to terms under which various materials will be acceptable to the city, and laxity in inspection of materials is to be expected. Occasional, if not regular, testings of all materials accompanied by explanations to inspectors of results found would have a beneficial effect in improving not only the quality of materials used, but in raising the entire standard of construction work.

The specifications contain numerous "requirements" to which little or no attention is paid. Many important paragraphs can be analyzed and numerous requirements found which are not enforced. The contractor should be allowed to bid on specifications which mean what they read. Under the present practice in the construction of sewers it is difficult to see how an outside contractor can bid intelligently. Either the contractor must assume that the specifications will be ridgidly enforced and bid accordingly, or in order to compete with contractors who understand that various clauses will not be enforced, he must anticipate non-enforcement of the specifications. A superficial examination of published bids does not indicate, however, that the cost of sewers is excessive, were first-class work obtained.

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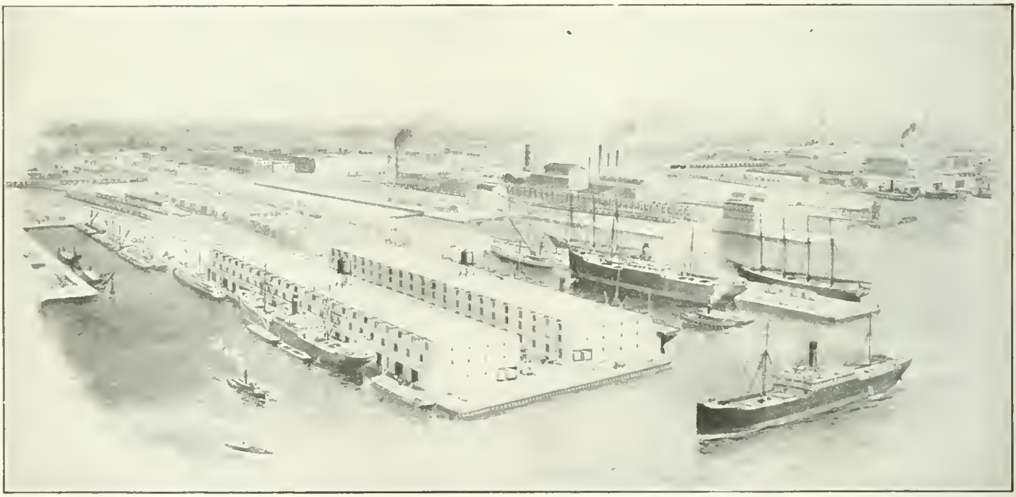
*From a report on the sewer construction work of the Detroit Department of Public Works, prepared by the Detroit Bureau of Governmental Research, of which H. S. Morse, formerly Engineer of Sewers of Cincinnati, is engineer. The paragraphs given are extracts from the report.

News of the Engineering World

Warehouses on Terminal Piers for Camden, N. J.

In a report to the Board of Harbor Commissioners of Camden, N. J., B. F. Cresson, Chief Engineer of New Jersey State Board of Commerce and Navigation advises the construction at that port of an innovation in American harbor practice: that is, the placing of large storage warehouses upon terminal piers, so that ships, trucks and railway cars can load directly one to the other or each to the warehouse.

The report, dated Dec. 4, 1916, recommends the development of the port of Camden, directly across the Delaware River from Philadelphia, by the construction at a cost of approximately $1,000,000 of two new piers, on one of which, shown at the left in the accompanying view, will be erected the warehouses, which are described in the report as follows:



PROPOSED DEVELOPMENT ON DELAWARE RIVER AT CAMDEN, N. J.

> The pier will be a wide solid filled structure with a timber bulkhead and a platform constructed outshore of the bulkhead to provide deep water wharfage. It will provide dockage for a 600-ft. ship on one side and a 480-ft. ship on the other. It will be 326 ft. wide over all and will be divided longitudinally into two separate operating parts, each with the same facilities except the driveway in the middle.
>
> There will be a three-story shed along the north and south sides of this pier. The lower floor will have a vertical clearance of about 22 ft.; this will be for the protection and handling of cargo in transit. The second and third floors, each of which is stepped back 5 ft. on the water-side to provide a landing and working platform for cargo, will have a vertical clearance of about 12 ft.
>
> The floor of the lower level will be 100 ft. wide back from the string-piece and there will be two railroad tracks in a pit immediately adjoining the floor and within the building. The elevation of the pier floor will be the same as that of the floor of the car and this will facilitate the handling of freight between the pier deck and the cars. Immediately to the rear of the shed will be a platform 10 ft. wide at the elevation of the car floor, and adjoining this will be a street or roadway 60 ft. in width. The second floor will have a width of 111 ft. exclusive of the landing platform, and the third floor will have a width of 106 ft. exclusive of the landing platform. The shed on the northerly side will have a length of 560 ft. and on the southerly side will have a length of 480 ft.
>
> With such an installation trucks may drive on to the lower deck of the pier where they may deliver or receive cargo to or from ships. Cargo which is coming from ships to railroad cars may be trucked directly across the floor of the pier and into the body of the cars at the same level as the pier floor, and a similar process for cargo going from railroad cars into ships. Cargo that is received from ships for storage or warehousing will be unloaded directly on to the platforms of the second or third floors to the warehouses by means of the ship's tackle and portable electric winches and cargo hoists. Cargo from the warehouses or storage houses going into ships will be unloaded from the platforms along the edge of the pier into the ships in similar manner. Cargo going from the warehouses to railroad cars will be lowered from the doors of the warehouses on the street side on to narrow platforms to the rear of the sheds and from these platforms into the body of the railroad cars on the level of the platforms. Cargo going from the warehouses into trucks will be lowered in a similar manner to the platform and directly into the trucks.

Quick Work Handicaps Bidder on Cleveland Filter Repair

Bids were received on Dec. 6, 1916, for the reconstruction of the clearwater basin in the Cleveland Division Ave. filtration plant which, as detailed in *Engineering News*, Dec. 7, 1916, p. 1099, is showing such serious settlement. The repair work comprises a complete relining of the basin by the construction of what amounts to an entirely new structure inside of the old. Bids were asked on itemized quantities and in addition an exact time limit had to be specified for two particular parts of the work, with a penalty of $250 per day for overtime on each section. In comparing bids the collected totals were added to an amount found by multiplying the mean number of days specified for the two parts of the work by a fixed sum of $500 per day.

Three bids were received, as follows: F. W. Mark Construction Co., Inc., Cleveland, Ohio, $331,708.50 plus $55,000 (110 average days) or $386,708.50 for a comparative total; John F. Casey Co., Pittsburgh, Penn., $328,317 plus $91,000 (182 average days) or $419,317; The Masters & Mullen Construction Co., Cleveland, Ohio, $330,457.15 plus $110,000 (220 average days) or $440,457.15.

It will be seen that the basic bids are remarkably close. Each bidder was asked to outline the program of his work, which must be prosecuted during the coming winter, under what is usually, in Cleveland, severe weather conditions. After considering the different programs the water commissioner recommended the letting of the contract to the J. F. Casey Co., who had the lowest bid but whose time limit was higher than that of the Mark company. In presenting this recommendation to the Board of Control, the commissioner said that the time specified by the Mark company seemed so short that it was to be feared that no matter how honest their intentions they would constantly be under pressure to put more effort into speed than into thoroughness. Furthermore the program of the Casey company seemed more possible of execution. The contract was thereupon awarded to the J. F. Casey Co.

Chicago Sewage Dilution Hit

Two opinions on the Chicago sewage-disposal system have been given out during the past week. They were published on the same day, and both are strongly adverse to the present policy of disposal by dilution. An extract from the annual report of the Chief of Engineers, United States Army (published in the local press), states the case as follows:

> Modern expert opinion is to the effect that the disposal of sewage by dilution in the manner practiced by the Chicago sanitary district is neither economical, efficient nor in keeping with the public spirit that should direct undertakings of this kind. The present practice is to apply some form of treatment to the sewage which shall remove its more offensive characteristics before it is released and permitted to flow past the waterfronts of near-by communities.

The report states that the Sanitary District of Chicago is drawing from Lake Michigan a much larger quantity of water than the 4,167 cu.ft. per sec. permitted by the Secretary of War, the average flow through the Chicago River to the drainage canal since 1910 being over 7,000 cu.ft. per sec. This represents a daily average of nearly 600,000,000 cu.ft. of water drawn from the lake, which is about equal to the entire low-water flow of the Mississippi River at St. Paul.

The report further states that the continuous withdrawal of such a volume of water will result in permanently lowering the water level about 5 in. in Lake Michigan and Lake Huron and nearly as much in Lake Erie. This would seriously affect river and harbor works as well as navigation and lake commerce. The International Waterway Commission has estimated that a 6-in. lowering of the water level would reduce the loading of large lake vessels by 300 to 550 tons, and thus cause an annual loss of about $1,500,000. Furthermore, the state authorities of Illinois are said to contemplate a still greater diversion, 10,000 cu.ft. per sec. or more.

The second adverse opinion, strange to say, comes from within the Sanitary District of Chicago. The new president of the district, Charles H. Sergel, who was elected by popular vote in November, in his inaugural address on Dec. 5 came out squarely in opposition to the dilution system, although this system has been the practice and policy of the Sanitary District since its earliest days. He also predicted restriction of the supply of water from the lake by the United States Government. Mr. Sergel has not been connected with the Sanitary District until now, and this expression of his attitude has met with strong objection on the part of the Board of Trustees, the principal argument being the great expense involved in any other system. The following is a quotation from Mr. Sergel's address:

> The most important work of the sanitary board in the next few years is the putting into active operation of modern methods of sewage treatment to supplement the dilution method of disposal now in use, so that eventually our rivers—the Chicago, the Calumet and the Des Plaines—will no longer be open sewers. Our great metropolis, which should march in the van, has been lagging in the rear.
>
> The work of experimentation that the sanitary board has been carrying on for many years must have supplied enough facts and principles and methods. If not, other investigations have. Let us now put these principles into operation by constructing treatment plants, and thus rescue our rivers from sewerdom. We then will be in no danger of having the entire sewage system paralyzed by the United States Government's reducing the supply of water from the lake, for even the minimum supply will be sufficient.

Free Consulting Engineering Services in Minnesota

It is reported that the regents of the University of Minnesota, in their budget for the next two years just formulated for submission to the legislature, have provided for the employment of a consulting civil engineer in the University Extension Department, whose services would be free to Minnesota cities and towns. This appears to be in line with a resolution adopted on Oct. 19, 1916, by the Minnesota League of Municipalities, as follows:

> We, your special committee appointed to consider the question of having an engineer in connection with the State University Extension Department who will be at the service of the members of the league in an advisory capacity, do recommend that steps be taken to have such an engineer of maturity and wide experience in municipal work added to the faculty. Respectfully submitted, William Ries, Shakopee; P. A. Hustad, Benson; Frank Lonergan, White Bear; Frank A. Bowman, Gilbert.

The names and addresses attached to the resolution seem to indicate that the demand for free consulting services comes from the smaller communities of Minnesota.

St. Louis May Spend $8,000,000 To Improve City Plan

Prevention of floods and of stream pollution, together with a remarkable opportunity for industrial development and a chance at the same time to provide a residential area and an interesting and useful circuit driveway, are the leading recommendations in a report entitled "River Des Peres Plan," just issued by the City Plan Commission of St. Louis, Mo. The reason for choosing this area for consideration in advance of making a plan for the whole city was in part the floods that occurred in the River Des Peres Valley on Aug. 20, 1915. Another reason was the unusual opportunity afforded for planning well in advance the utilization of an area instead of waiting until haphazard developments made a logical plan almost impossible. It may be mentioned in passing that the City Plan Commission is composed of nine members, with James C. Jones as Chairman, Walter B. Stevens as Secretary, and Harland Bartholomew, Engineer. Five city officials are ex-officio members of the commission, including E. R. Kinsey, President of the Board of Public Service, and Charles M. Talbert, Director of Streets and Sewers.

The four elements of the improvements recommended and their estimated cost are as follows:

Open channel, closed sewer and all other related construction	$5,815,450
Double-track industrial railroad, complete	526,000
Driveway from Kingshighway, Southwest, to McCausland Ave. and Manchester	1,277,668
Ivanhoe Ave.—McCausland viaduct (city's share)	400,000
Total	$8,019,118

The commission proposes that the entire cost of this project be made a charge upon the city, to be met by a 20-yr. bond issue. It advises that an item for this amount and purpose be included in the referendum on municipal bond issues likely to be held in April, 1917.

The main drainage canal contemplated would be an open channel 160 to 180 ft. wide and 18 ft. deep, built of reinforced concrete, extending from the Mississippi River to the several forks of the River Des Peres in Maplewood. This channel would carry both sewage and storm water. From its upper end to Macklind Ave. there would be a channel about 80 ft. wide and 16 ft. deep for surface water, beneath which there would be a sewer. From Macklind Ave. to Union Ave. in Forest Park there would be a double-section reinforced-concrete sewer, each section being 27 to 30 ft. wide by about 20 ft. high. From the upper end of this section to the city limits in Hodiamont, there would be a single reinforced-concrete conduit, about 30 ft. wide by 23 ft. high. Besides the channel and large conduits various sewers would be built and some existing sewers rebuilt.

The excavated material from the channel would be used for the proposed industrial railway, parallel thereto. Well toward a thousand acres of otherwise largely unusable land would be made available for industrial purposes.

Mechanical Engineers' Meeting Breaks a Record

At the 37th annual meeting of the American Society of Mechanical Engineers, held last week at the Engineering Societies' Building in New York City, the total registration was 1,786, the largest on record. The number of members registered was 924 and the number of guests, 862. In 1914 the registration at the annual meeting was 1,367.

At the opening session on Tuesday evening, the retiring president, Dr. D. S. Jacobus, gave the annual presidential address, taking as his subject "Education in Engineering." Speaking from twenty years' experience as a teacher at Stevens' Institute of Technology and over ten years' later experience in engineering work, Dr. Jacobus referred to the list of essential factors desirable in young engineers prepared by the Carnegie Foundation in its investigation of engineering education. He then described other qualities which he believed deserved special attention as follows: (1) Taking a personal interest in one's work; (2) amenability to discipline; (3) perseverance under adverse circumstances; (4) cheerfulness and amity—the human side.

Dr. Jacobus declared that the present entrance requirements to engineering schools do not accurately gage the ability of an applicant and he believed it a mistake to make the entrance requirements to an engineering college too high. He urged that some of the time in college now spent in specializing should be devoted to more thorough teaching of the fundamental branches. At the conclusion of the address, Dr. Jacobus introduced the newly-elected President, Dr. Ira N. Hollis, President of Worcester Polytechnic Institute. In a brief speech Dr. Hollis emphasized the idea that the efforts of the society should be directed toward rendering service to the nation.

At the annual business session on Wednesday morning, the annual reports of the Council and standing committees were presented. The total membership of the Society is now 7,244, a net gain of 667 during the year. The total is made up of 4,585 members, 1,553 juniors, and the balance in other grades. There are also 841 students in engineering colleges affiliated with the Society through membership in student branches. The Society is in a flourishing financial condition. It had a gross income last year of $167,141, and its expenses were $143,023. The last indebtedness on the Society's share in the purchase of the Engineering Building site was paid on July 1, and the Society's balance sheet shows total assets of $720,672, the chief item of which is the Society's one-third interest in the Engineering Societies' Building and the land on which it stands.

The prize for the best paper submitted by a junior was awarded to L. B. McMillan, Instructor in Steam and Gas Engineering, University of Wisconsin, for his paper entitled "The Heat Insulating Properties of Commercial Steam Pipe Coverings." Honorable mention was awarded to Victor J. Azbe, of St. Louis, and Herbert B. Reynolds, of New York City.

The report of the committee on the standardization of filters used to purify water for industrial purposes was presented by the Chairman, George W. Fuller. An abstract of the committee's report is printed elsewhere in this issue. At the close of the business session, the reading and discussion of technical papers was taken up and two simultaneous sessions were held, one considering various papers on steam boilers, the other proposed code of safety standards for cranes.

During the noon hour, exercises were held in honor of the memory of the late John E. Sweet, of Syracuse, a past-president and honorary member and the founder of the Society. Reminiscences concerning Professor Sweet were given by Worcester R. Warner, Capt. Robt. W. Hunt, and others. In the afternoon four simultaneous sessions were held, one devoted to power plant engineering, one to textile engineering, one to machine shop practice, and one to industrial management. In the evening a smoker was held at which the feature of attraction was an address by Frank B. Gilbreth recounting his experiences "somewhere in Germany" during the war.

The principal features on Thursday were two sessions on valuation, with special reference to methods of valuation for industrial plants. A session was also held of the gas power section. The principal social event of the meeting was the annual reunion held on Thursday evening. Instead of resorting to some of the large hotels, as has been the custom in previous years, involving a heavy expense, the reunion was held in the Engineering Societies' Building. The fifth floor of the Engineering

Societies' Building has been altered and redecorated to make it attractive for social gatherings, and it was used this week not only for the Thursday evening reunion, but for the reception on Tuesday evening and for luncheons Wednesday and Thursday noon. On Friday, the closing day, three simultaneous sessions were held. In the auditorium the development of naval construction in the United States was shown; and the other meetings were devoted to steam boilers and to railway engineering.

Highway Improvement in the Northwestern States

The definite and practical aspects of highway improvement and highway development were featured strongly in the third annual meeting of the Northwestern Road Congress, held at the Sherman Hotel, Chicago, on Dec. 7 and 8. The attendance was good, and the program was excellent, and as it had a relatively short list of papers, it was followed out pretty closely, most of the papers being presented and discussed in the time available. In addition, the papers were mainly of commendable brevity.

These papers covered the ground as follows: Earth roads, John H. Mullen (Minnesota); oiled earth roads, B. H. Piepmeier (Illinois State Highway Department); gravel roads, J. T. Donaghey (Wisconsin); macadam roads, H. G. Shirley (State Engineer of Maryland); concrete roads, A. N. Johnson (consulting engineer for the Portland Cement Association), and brick roads, E. B. Schmidt (Indiana). All these papers laid stress upon the importance of maintenance from an economic as well as a traffic point of view. Further, there was a paper on the maintenance problem of state roads, by W. D. Uhler, Chief Engineer of the Pennsylvania Highway Commission.

The gravel road construction employed by Mr. Donaghy is of the two-course type, dressed with a harrow and grader and well rolled. Clay may be added if necessary, care being taken that the quantity is only sufficient to act as a binder and not enough to make a muddy road in wet weather. Oiling may be done as required. He considered this as the best of the medium-priced roads, and figured the comparative cost of gravel and concrete as follows, these figures including maintenance and interest charges:

	Cost per Sq.Yd. at the End of		
	5 Years	10 Years	15 Years
Concrete road	$1.65	$2.11	$2.71
Gravel road	.93	1.70	2.60

The macadam roads now built in Maryland are all bituminous-bound, a light oil binder being used. Mr. Shirley described the patrol system of maintenance, and expressed his opinion that maintenance work should be of such character that after several years' service the road would be better than when it was built. Investigation is made as to the tonnage carried and the depth of wear, and he urged the ton-mile as the proper basis for repair costs.

In concrete road construction, Mr. Johnson emphasized the importance of thorough consolidation of the subgrade, and careful finishing of the concrete so as to remove surplus water and get a hard and dense surface. Hand floating destroys the even contour, but the finishing may be done by a roller, a belt or a machine-float. In the discussion Mr. Kuelling (Milwaukee, Wis.) advocated increasing the width of paved road on curves, and stated that he found concrete made with large-sized aggregate (1- to 2-in. stone) showed less wear than that made with the smaller size of coarse aggregate. Another paper dealt with bridges and culverts.

Subjects of an administrative character included state and interstate road systems, the coördination of the highway programs of various states, the new law providing for participation by the United States Government, in highway development, and the education of the public in regard to the bond-issue system of paying the cost of road improvement. During the meeting there were numerous moving-picture displays illustrative of road work, and the convention closed with an illustrated lecture on the great highways of America.

Minnesota State Health Board May Be Reorganized

A reorganization of the Minnesota State Board of Health has been recommended by a commission appointed by Governor Burnquist to recommend desirable legislation concerning public health. Dean E. P. Lyon, of the university medical college, is chairman of the commission.

The present state board of health consists of eight doctors and one civil engineer. Up to one year ago the board had always consisted of doctors. Governor Hammond was requested, by the Civil Engineers Society of St. Paul, to fill the next vacancy by appointing a sanitary engineer and did so.

The commission recommends:

That membership on the board be open to men in the different walks of life instead of physicians.

That the board consist of five members instead of nine.

That the board be granted broad, general powers, instead of specifying in detail the limit of its duties and activities.

That the board be empowered to appoint a commissioner of public health, who shall be a "field general directing an army" more than an officer charged with enforcement of law.

That industrial hygiene regulations be transferred to this new board from the State Department of Labor.

That the commissioner be a man trained in sanitary science and public health administration and devote his whole time to the work and be paid a salary high enough to secure an able man.

Concrete Arches Favored for Galveston Causeway

The Board of Arbitration appointed by the various interests involved in the reconstruction of the Galveston Causeway has recommended, under date of Dec. 4, 1916, that the part of the structure washed out in the storm of August, 1915, be replaced by the concrete-arch structure submitted by the Concrete-Steel Engineering Co., with certain modifications in detail. These changes relate to additional reinforcement, extension of the pier footings and use of a richer concrete. The estimated total cost of this scheme is $1,370,000 to which must be added $110,000 for the repair of the Galveston approach. The Board considered that the concrete girder plan submitted would cost more than the authorized expenditure.

The Board of Arbitration consisted of Prof. A. N. Talbot, named by the steam railroads, Prof. G. F. Swain, named by the interurban railway and the county and Lincoln Bush, selected by the other two arbitrators. The Board of Engineers which is to decide upon the proper structure is headed by Frank Merritt, Chief Engineer of the Gulf, Carolina & Santa Fe R.R. Mr. Merritt has authorized the publication of the report of the arbitration.

Navy Wants Contractors' Advice on Contract Provisions

The Navy Department, Bureau of Yards and Docks, Washington, D. C., is arranging for a conference with a number of building trades associations, contracting companies, and other parties interested, for the purpose of discussing its General Provisions, specifications and contract requirements. The Bureau is particularly desirous of receiving suggestions for improving its General Provisions and specifications with a view to making them conform with generally accepted commercial requirements of this character, having in mind that certain statutory requirements and accepted precedents bind Government procedure.

Upon application to the Bureau, interested parties may obtain current copies of the General Provisions and specifications for examination. Those contemplating attendance at the conference are requested to send their names to the Chief of Bureau of Yards and Docks, who will inform them as soon as practicable of the place and date of meeting.

* * *

The Engineering Association of the South will surrender its charter and disband, that being the decision of the membership announced by ballot, Dec. 1. Members of this organization feel that there is no place for a society between national and local. It is probable that the various sections of the Engineering Association of the South will continue their organizations as local societies. In the case of Nashville, this intention has already been announced and the new society will be called the Nashville Engineering Association, the committee considering the matter comprising M. A. Lightman, M. A. Rooney, and W. Harwell Allen, secretary of the old association. The Nashville Section has about 150 members.

Check Dams in the Mountain Cañons of Los Angeles County, Calif., are being constructed in accordance with the suggestions of the County Flood Control Commission, published in "Engineering News," Feb. 17, 1916. A flood control committee at Glendora, Calif., has expended $8,000 on channel protective work and the construction of check dams. Forty-two check dams were built in the Big Dalton Cañon; two with stone laid in cement mortar, and the balance of rock laid dry. In Easley Cañon 212 check dams have been constructed. Half of the money expended on this work was contributed by the County Board of Supervisors, and the other half was raised by an acreage assessment on the lands which will be benefited by the flood control work.

The World's Largest Simple Truss Span, the 720-ft. main span of the Metropolis Bridge across the Ohio, was successfully swung clear of its falsework on Dec. 11, 1916, at 3 p.m. This bridge, described in "Engineering News," July 27, 1916, connects Metropolis, Ill., with Paducah, Ky., and is part of a link connecting the C. B. & Q. R.R. in the north with the N. C. & St. L. R.R. in the south. It comprises a number of shorter spans leading up to the middle span, with its record length for a simple truss. Erection was carried on on falsework by means of derrick cars, the largest one of which had a 130-ft. boom. All top chord joints are now bolted and pinned and some web connections are riveted. Erection work was very quick, starting Aug. 26, and the top chord being closed Dec. 1. The American Bridge Co. is in charge of erection.

All the Concrete Pavements in the United States are being subjected to a maintenance survey by the field engineers of the Portland Cement Association. According to late reports, nearly 20,000,000 of the 70,000,000 sq.yd. of such pavements have been examined and reported upon, and it is expected the work will be completed during the course of the next month. Over 100 engineers stationed in various parts of the country are making this inspection. One of the objects of this survey is to secure data based on actual experience, so that methods of construction and maintenance that have produced the best results may be definitely determined with a view to raising the standards of practice in concrete-pavement construction generally. When this work is completed, the Portland Cement Association will have a complete history of all concrete pavement in the United States—roads, streets and alleys.

Bids for Four Battle Cruisers which will be far larger and more powerful than any vessels ever built for the United States Navy were opened by the Secretary of the Navy on Dec. 6. The Newport News, Wm. Cramp & Sons, Fore River, and Union Iron Works companies each offered to build one of the vessels on the basis of cost plus a percentage. Newport News and Cramp offered cost plus 10%, and the Fore River and Union Iron Works, which are controlled by the Bethlehem Steel Corporation, offered to build at cost plus 15% profit, "or such percentage of profit as the Federal Trade Commission may determine to be reasonable." The two latter companies offered to complete the vessels in 48 months, and the Newport News Co. in 51 months. In submitting its proposal, the Fore River Co. stated that in view of the enormous size and power of these vessels, having six times the horsepower of any existing vessel in the Navy, and 14 knots greater speed than any of the capital ships, there is a much greater element of risk and uncertainty in the construction than in other vessels previously contracted for. The Fore River Co. further submitted alternative designs involving the use of a turbine reduction-gear drive, and a rearrangement of the boilers, placing them all below the protective deck instead of half of them above it as in the department's design. These changes in design would save about 1,000 tons in the displacement of the vessel, while the number of smokestacks are reduced from seven to three. The department design was an electrical drive. It is estimated that the substitution of the turbine reduction-gear will save $1,300,000 in the cost.

PERSONALS

E. L. Cannon has been appointed Office Engineer of the Seaboard Air Line Ry., with office at Norfolk, Va.

Meyer Davis, formerly Chief Engineer of the Asbestos Protected Metal Co., Pittsburgh, Penn., has been made Manager of the San Francisco, Calif., office of the company.

Clarence E. Kinne, M. Am. Soc. M. E., of the Bagley & Sewall Co., Watertown, N. Y., has just started on a several months' trip through China and Japan for engineering exploitation work, especially in relation to paper mills.

John L. Howard, M. Am. Soc. C. E., recently Assistant Engineer for the Directors of the Port of Boston, has been appointed Assistant to the Chief Engineer of Water-Works, Metropolitan Water and Sewerage Board, Boston, Mass.

Raymond Baffrey, President of the Hennibique Construction Co., New York City, and an officer in the French Army who has been at the front since September, 1914, is home on furlough. He will resume his military duties soon.

Henry Welles Durham, M. Am. Soc. C. E., County Engineer of Bergen County, Hackensack, N. J., and Consulting Engineer, New York City, is again enabled to resume his practice by the return of the 7th New York Infantry from the Mexican border.

Earl F. Church has resigned as Computer, United States Coast and Geodetic Survey, in order to accompany the exploring expedition of Dr. Hamilton Rice to the upper branches of the Amazon River in Brazil. He will be astronomer and topographer of the party.

C. E. Denny, formerly Signal Engineer of the New York Central Lines West of Buffalo, has been appointed Special Engineer, to work on terminal problems, in the office of J. J. Bernet, President of the New York, Chicago & St. Louis Ry. (Nickel Plate), Chicago, Ill.

Sir Alfred M. Mond, Managing Director of several large corporations including the Mond Power and Heating Gas Co. and the Power Gas Corporation, Ltd., of London, England, has been appointed First Commissioner of Works in the new Cabinet of the British Empire.

J. P. Clarke, recently with the city engineering department of Richmond, Va., and **Thos. H. Powell,** recently with the engineering department of the Chesapeake & Ohio Ry., announce the formation of the firm of Powell & Clarke, Civil and Mining Engineers, Ashland, Ky.

Sir Albert Stanley, General Manager of the London Underground Rys., has been appointed President of the Board of Trade in the new Cabinet of the British Empire. He is an American technical graduate and was Manager of the street railways in Detroit, Mich., and Newark, N. J., before going to England.

Herbert Chase, recently Laboratory Engineer and Chief Engineer of the Automobile Club of America, has been made Assistant Secretary of the Society of Automobile Engineers. He is also Treasurer of the Society and a member of its council. He is a 1908 graduate in mechanical engineering of Cornell University.

J. S. Dennis, M. Am. Soc. C. E., recently Assistant to the Second Vice-president of the Canadian Pacific Ry., with office at Calgary, Alta., in charge of the railway's department of natural resources, has been made Assistant to Lord Shaughnessy, President of the Canadian Pacific Ry., with headquarters in Montreal, Que. He will have charge of colonization and the development of natural resources.

Dr. Ira N. Hollis, President of the Worcester Polytechnic Institute, who was recently elected President of the American Society of Mechanical Engineers, was the guest of honor at a banquet tendered him by the New York Alumni of the Worcester Polytechnic Institute, Dec. 8. The guests and speakers of the evening included two of Dr. Hollis' classmates (1878) at the United States Naval Academy—M. E. Cooley, Dean of the Departments of Engineering and Architecture, University of Michigan, and Rear-Admiral Robert S. Griffin, Engineer-in-Chief of the United States Navy.

OBITUARY

Charles H. Hersey, President of the Hersey Manufacturing Co., the well known water-meter makers, of Boston, Mass., died at his home in Roxbury, Dec. 9, aged 86 years.

W. W. Scranton, President of the Scranton Gas and Water Co., said to have been largely instrumental in introducing the Bessemer process of steel making into this country, died Dec. 3, at his home in Scranton, Penn., aged 72 years. He was a descendant of the Scranton who founded the Lackawanna Iron and Coal Co., and for whom the city was named.

Frederick C. Fisher, President of the Ferro-Construction Co., Chicago, Ill., died Dec. 6. He was born at Lake Linden, Mich., 45 years ago, and was a graduate in civil engineering of the University of Michigan. In his early structural engineering experience he was employed on the construction of the famous Thebes Bridge over the Mississippi River.

Drake Whitney, a retired civil engineer of Niagara Falls, N. Y., died Dec. 4, aged 74 years. He was born at Niagara Falls. He studied engineering at the German universities of Freiburg and Heidelberg and for several years was a member of the staff of engineers which planned and built the Canadian Pacific Ry. At one time he was Village Engineer of Niagara Falls.

Richard Relf, one of the civil engineers engaged in the construction of the Northern Pacific Ry., died recently at his home in St. Paul at the age of 83 years. He had been with the Northern Pacific since 1867. In the seventies he was incapacitated from active engineering work by an injury. He was then placed in charge of the engineering records of the company, where he remained until a few years ago.

Roger Tappan, a retired civil engineer and artist died Dec. 6, at his home in Natick, Mass. He was born in Marshfield, Mass., Nov. 27, 1848. He was graduated from the Massachusetts Institute of Technology and was engaged in early railway work in both the Eastern and Western States. As a young man he taught drawing in the public schools of Salem and Haverhill, and about 1890 he gave up engineering to devote his whole time to art.

Edward M. Bigelow, M. Am. Soc. C. E., whose appointment as Director of Public Works of Pittsburgh, Penn., was noted in the "personals" columns of Nov. 30, died Dec. 6, at the Allegheny General Hospital, where he had gone for an operation. He was born in Pittsburgh, Nov. 6, 1850. He was educated in the public schools of his native city and at the Western University of Pennsylvania, now the University of Pittsburgh. Soon after graduation he was appointed Engineer of Surveys of the city, and in 1880 was chosen City Engineer. Eight years later he was made the first Director of the Department of Public Works, which position he held until 1900. He returned to this office in 1903 and continued in it until 1906. From then until 1911, when he was appointed State Highway Commissioner, he was in private practice, also serving as Consulting Engineer for the county. During the period 1880 to 1900 Mr. Bigelow had an important part in the development of the city park system. The two parks which in particular represent his work are Highland and Schenley parks. He also planned and carried out the construction of the two great boulevards of the city.

Edmund Brownell Weston, M. Am. Soc. C. E., Consulting Engineer and President of the Jewell Export Filter Co., Providence, R. I., died Dec. 9, at a private hospital in Boston, Mass. He was born at Duxbury, Mass., Mar. 25, 1850. His early engineering education and experience was obtained in the office of the chief engineer of the Providence, R. I., water-works. In 1877 he was appointed Assistant City Engineer in direct charge of the Water-Works Department. During this period he published the book "Friction of Water in Pipes." During this period also (1893-94) he made experiments to determine the efficiency of mechanical filtration for potable water-supplies, which antedated the now famous Louisville (Ky.) experiments. In 1897 he resigned from the city service and shortly after became Engineer, Manager and President of the Jewell Export Filter Co. As consulting engineer of this company he designed mechanical filter plants for many cities in this country and in Austria, India, Egypt, Germany, Japan, France, Finland, China, Korea, Siam, Italy and Ceylon. He devoted much time to original research in hydraulics and water purification, and his foreign travels and studies of water-supply and sanitary engineering were extensive. He was a member of the Institution of Civil Engineers and of the Royal Society of Great Britain. He was a bachelor and is survived by two brothers and a sister.

ENGINEERING SOCIETIES

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

American Water-Works Association—Leonard Metcalf, President, announces that the 1917 convention at Richmond, Va., will be held on May 7 to 11, with headquarters at The Jefferson.

The St. Louis Association of Members of the American Society of Civil Engineers held its annual dinner Nov. 27. Col. J. A. Ockerson was reëlected President, F. G. Jonah, vice-president, and Gurdon G. Black, secretary. The election of officers was followed by several interesting addresses.

Washington Society of Engineers—A most successful annual dinner, attended by nearly 400 members and guests was held on Dec. 6. The speaking, aside from a short talk by Secretary of War Baker, was in the nature of a symposium by the professions, the lawyer, the journalist, the clergyman and the engineer being represented.

The Calgary Branch of the Canadian Society of Civil Engineers at its annual meeting on Dec. 2, elected A. Scott Dawson, chief engineer Department of Natural Resources, Canadian Pacific Ry., chairman for the ensuing year, and Sam G. Porter, assistant chief engineer, Irrigation Branch, Department of the Interior, Canada, was reëlected secretary.

The Engineers' Society of Western Pennsylvania held its annual banquet, Dec. 11, at the William Penn Hotel, Pittsburgh. The attendance was 900. The applications were 1,200 and 300 had to be turned away. The speakers were Major-General Goethals, William L. Saunders, and George Ade. The toastmaster was Edwin M. Herr, President of the Westinghouse Electric & Mfg. Co.

The American Association of State Highway Officials opened its annual meeting Dec. 5, in St. Louis at the Hotel Jefferson. The first day of the three-day meeting was devoted almost entirely to discussing the act of Congress last year appropriating $75,000,000 to aid the states in the construction of through highways. The second day was given over to addresses and papers.

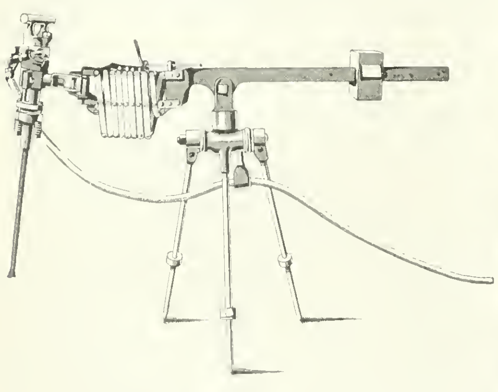
The Brooklyn Engineers' Club will hold its annual meeting Dec. 14 at 8.30. The nominations are as follows: For president, Bernt Berger; vice-president, Harry E. Funk; secretary, Joseph Strachan; treasurer, Carroll S. Dunphe; directors, Wm. J. Conway and Michael J. Shugrue; auditing committee, Carleton A. Graves, Carlos Lobo, and Howard P. Quick. The fifth presentation of the Alfred T. White Prize will be made.

New Jersey Sanitary Association—The 42nd annual meeting was held at Lakewood, Dec. 8 and 9. In the course of his annual address, Dr. Geo. E. McLaughlin, Jersey City, mentioned the reduction in the typhoid fever death rate per 100,000 in the United States from 34 in 1900 to 19 in 1914, or 44%. Geo. A. Johnson, consulting engineer, New York City, reviewed the mortality from various preventable diseases throughout the country and presented figures to show that with more liberal expenditures for health-protective work thousands of lives could be saved. Dr. John F. Anderson, late president of the American Public Health Association, sent a paper on "The Protective Use of Vaccines and Serums," in the course of which the value of anti-typhoid inoculation was illustrated by the fact that from May to November, 1916, there were only 24 cases and no deaths from typhoid fever in the regular army and mobilized National Guard, compared with some 20,000 cases and 2,192 deaths in eight months during the Spanish-American War of 1898. The water-supply problem in Northern New Jersey was sketched by Morris R. Sherrerd, consulting engineer, North Jersey Water-Supply Commission. The ultimate capacity of the Passaic River—700,000,000 gal. a day—will be reached about 1960 at the present rate of increase of demand upon that source of supply. This fact did not worry Mr. Sherrerd so much as the long delays experienced in securing the right to take water from the Wanaque River as an additional supply for Newark and other communities. This delay was attributed to the Public Utilities Commission and to the opposition of private water interests. In addition, jurisdiction is vested in the Conservation Commission. The election of officers resulted in the choice of Calvin N. Kendall, Trenton, as president, and Chester H. Wells, Montclair, chairman executive committee. Edward Guion, Atlantic City, was reëlected secretary.

Appliances and Materials

Balanced Tool Holder

An extensible balanced tool frame, intended to hold all sorts of portable tools like pneumatic riveters, chippers, busters, hand drills, tampers, grinders, etc., in their various operations, has been made by Jackson, Schmitz & Shanks Engineering Co., 15 South Desplaines St., Chicago. The device consists of a tripod supporting, through a swivel joint and horizontal pivot, a beam made up of the tool holder and the counterbalance arm. The tool holder consists of a pair of lazytongs with a socket at the back and a grip at the front. The tool arm has a range of 16 ft. Tools weighing from 20 to 100 lb. are best accommodated.



JACKSON BALANCED TOOL HOLDER

* * *

New-Type Electric Soldering Iron

An electric soldering iron of new design has been developed by the Clemens Electrical Corporation, of Buffalo, N. Y. The wires from the supply line come to two high-resistance soldering points that are close together, but not in contact. The circuit is closed only when the iron is placed on the work to be soldered, and then the points glow, concentrating the developed heat at the point of application. A low voltage (5 to 15 volts) is needed for this type of tool, so that a step-down transformer would ordinarily be required. Another design working on the same principle has two separate tools on the ends of the soldering circuit; one makes contact with the work and the other feeds solder at the desired point.

* * *

New Insulating Material

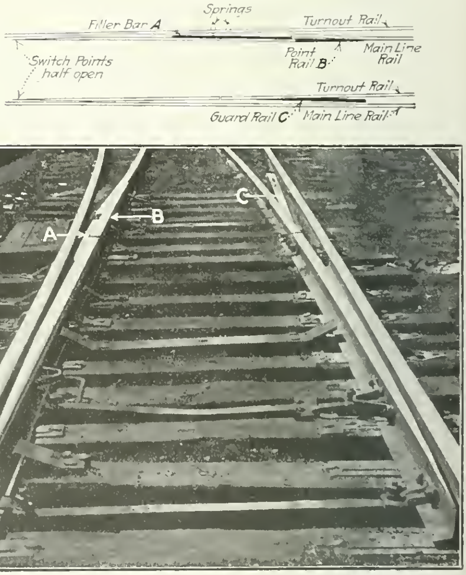
A new electric insulating material, called "Condensite-Cellulac," has been developed and patented by the Diamond State Fiber Co., of Bridgeport, Penn. As the name indicates, it is made in part of a proprietary phenol-formaldehyde synthetic resin; it has the properties of this material in that it can be supplied in the soft unformed state for use where it is advisable to cure in place. The fully cured material is supplied in sheets, rods, tubes, etc. It is claimed to have properties different from any other insulating material, combining the physical, chemical and electrical properties of "Condensite" with the mechanical condition of vulcanized fiber. It is anhydrous and nonhygroscopic and is unaffected by weather, steam, acids or oils.

* * *

New Design of Split Switch

A new split switch for railway track has the special feature of providing against derailment in the event of a train heading into it when the point rails are misplaced so that the switch is not set for either track, as shown in the accompanying view. This condition may occur owing to breakage of a rod connection or to some obstruction preventing the point rail from being closed against the stock rail. In such case the wheels would follow the diverging unbroken stock rails, with the result of derailment.

The switch has three auxiliary parts: On the turnout side are the filler bar, A, level with the underside of the head of the point rail; and the emergency trailing point, B. On the main-track side is the guard point, C. With a switch in the position shown, the flanges of the wheels on the turnout side will ride up on the filler bar and be guided into the heel of the emergency point, forcing this point open as the wheels return to the main-track rail. Normally this point rail is held closed (as shown) by a spring, like that of a spring-rail frog. The guard point holds the wheels over sufficiently to insure that those on the turnout side will trail through the emergency point. The view shows switch installed in the approach to wheels on one side upon their flanges will tend to carry them through the emergency point without the action of the guard point. The view shows switch installed in the approach to the union passenger station at St. Paul, Minn. The switch is designed under the Dunn patents and an early type was described in "Engineering News," in 1890. It is known as the Perfection Safety Switch, and is built by the Twin City Frog and Switch Co., 1003 Germania Life Building, St. Paul, Minn.



PLAN AND VIEW OF DUNN SAFETY SPLIT SWITCH

Engineering News

VOLUME 76 DECEMBER 21, 1916 NUMBER 25

New Multiple-Arch Dams in the Sierra Nevadas

In the upper levels of the Sierra Nevada Range numerous depressions in the granite formation act as storage areas for a portion of the runoff from the adjacent watersheds. Many of the small natural lakes thus formed occupy reservoir sites admirably adapted to economical development for hydro-electric enterprises. Gem Lake and Agnew Lake, two adjoining basins of this character, located in Mono County, California, have been developed this year by the Pacific Power Corporation as an additional unit in the system that supplies current to the larger southern California cities, Imperial Valley and many of the Nevada mining camps.

With a tributary area of 22 sq.mi., yielding an annual runoff of approximately 2 sec.-ft. per sq.mi., Gem Lake has been converted into a reservoir of 17,000 acre-feet capacity, with a surface elevation of 9,050 ft., by the construction of a multiple-arch dam of the Jorgensen type. Agnew Lake, below and immediately adjoining Gem reservoir, with an additional watershed area of 1.65 sq.mi., will be enlarged to a capacity of 400 acre-feet by the construction of a smaller multiple-arch dam of similar design.

Gem Lake dam is approximately 700 ft. along the crest, has 16 arches, each with a 40-ft. span, and a fractional arch at each end. Its highest arch is 112 ft. above the foundation and 84 ft. above ground surface. The maximum thickness of concrete at the base of the arch is 3.6 ft., and at the crest is 1 ft. Buttresses are 5 ft. long in plan on top and tapered. In the buttresses the mix is approximately 1 : 2½ : 5 and in the arches 1 : 2 : 4. A total of 8,500 cu.yd. of concrete was used in this structure, and 90 tons of reinforcing steel.

Reinforcing bars are spaced as shown in Fig. 2. Their function is to withstand contraction stresses due to excessive cold, which will produce tension at the center of the

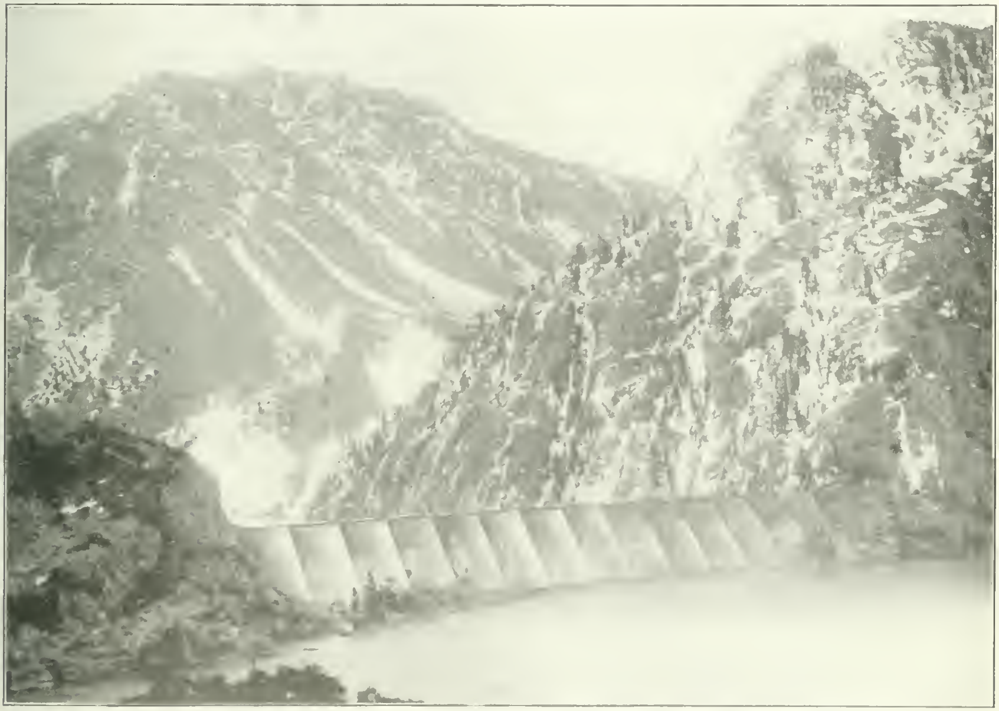


FIG. 1. THE COMPLETED GEM LAKE DAM IN THE SIERRA NEVADA MOUNTAINS

intrados and near the buttresses on the extrados surface. The arches are cylindrical on a portion of the upstream face, but from El. 15 to the crest, unlike the Eastwood multiple arch, they are elliptical, to keep the center line of pressure and the center line of the arch as near coinciding as possible. The deviation of the two is due to the fact that the water pressure at the crown on any arch slice is 7 ft. less than at the corresponding point at the abutments; and the effect of this has to be compensated for in logical manner, which is accomplished by the elliptical section.

On Gem Lake dam, as well as on the smaller structure at the lower dam site, the crest of the eight spillway openings per arch is 3 ft. below the true crest elevation. These openings will discharge 100 cu.ft. per sec. of water each. Two arches on each dam are provided with these openings.

Agnew Lake dam is nearly 280 ft. along the crest, has seven arches and a maximum height of 30 ft. The arches are 2 ft. in thickness at the base and 1 ft. at the crest, the total volume being 661 cu.yd. The surface of the reservoir that it will impound will be about 550 ft. below the surface of Gem Lake reservoir. Its function will be to furnish an auxiliary supply for peak loads at the power house, which will be located at Silver Lake, 1 mi. east of Agnew Lake, at an elevation of 7,242 ft. above sea level.

Water is taken from Gem reservoir through a 48-in. steel pipe, which is concreted in an outlet tunnel about 300 ft. in length, whose intake is 20 ft. below the natural level of the lake. Below Agnew Lake this pipe branches into two 30-in. pipes, reduced in diameter at the power house to 26 in. Both pipes can be supplied from either reservoir. In the tunnel the pipe is of $\frac{3}{16}$-in. riveted steel. Below the Agnew dam, lap-welded steel pipe of American manufacture is used, varying in thickness from $\frac{1}{4}$ in. to $\frac{7}{8}$ in., according to head. A series of tests of the strength of the weld was made to determine the strength of the joint, since before the war much of this type was imported from Germany, and some doubts existed as to the efficiency of the American product. The strength of the joint, as shown by these tests, varied from 96% to 105% of the strength of the unwelded metal.

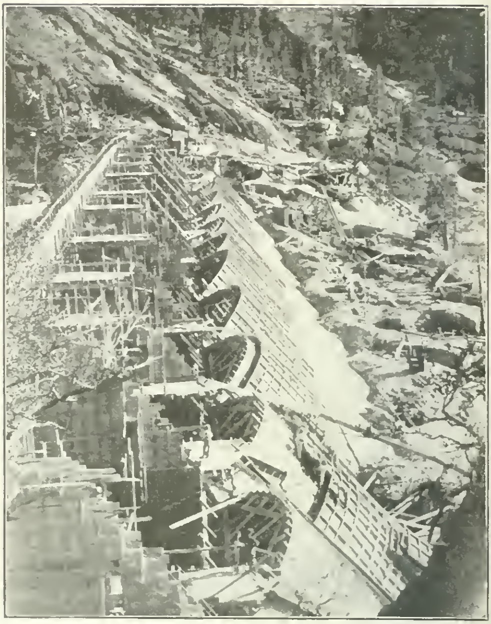


FIG. 3 GEM LAKE DAM UNDER CONSTRUCTION

Pipes lead direct from the reservoirs to two Pelton-Doble 5,000-kw. units in the power house, of which one is now in operation. These will give a total production

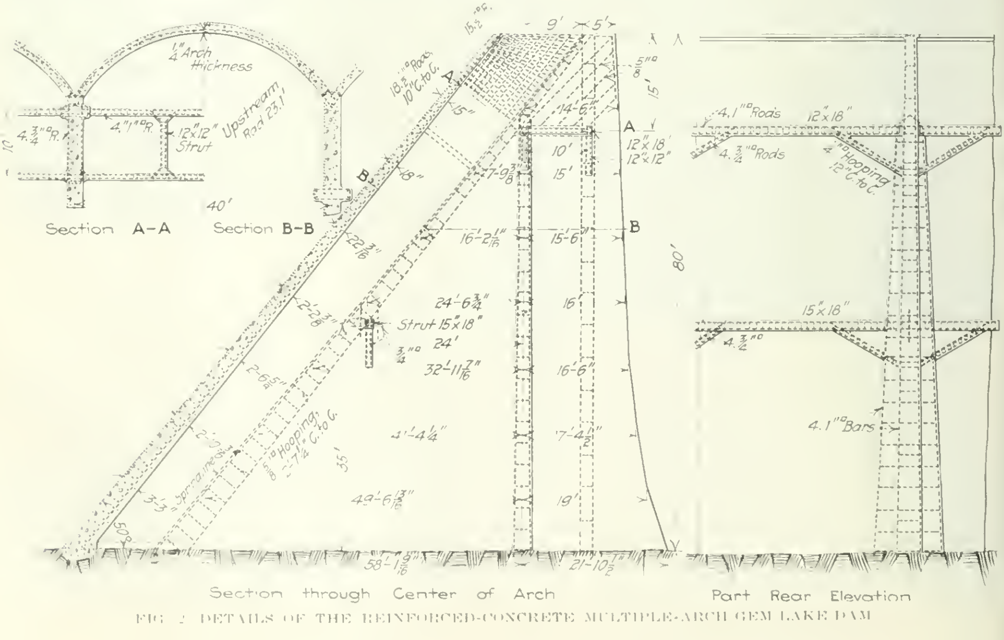


FIG. 2 DETAILS OF THE REINFORCED-CONCRETE MULTIPLE-ARCH GEM LAKE DAM

of 13,400 hp. from the station, which will operate under a static head of slightly over 1,800 ft. from Gem Lake and 1,250 ft. from Agnew Lake. Current will be transmitted at 60,000 volts for the present. Later it will be stepped up to 140,000 volts.

MATERIAL HAULED FAR TO THE SITE

Cement for the work was hauled 60 mi. by six 75-hp. gasoline caterpillar tractors, from Benton, a station on the Southern Pacific, in Mono County. The tractors were unloaded at the upper end on Silver Lake and their contents brought to Agnew Lake on a tramway, then ferried across on barges and then loaded on another tramway that terminates at the mixer house. The total cost of transportation from the railroad to the upper dam site was so high that the cement on the job cost $7.50 per bbl.

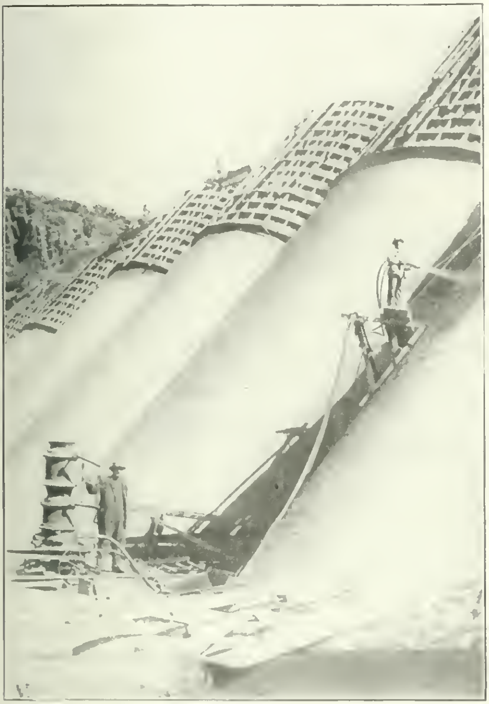


FIG. 4. WATERPROOFING THE UPSTREAM FACE OF GEM LAKE DAM WITH CEMENT GUN

Rock was obtained from the tunnel dump and from an adjacent slide. It was crushed and segregated into three sizes by means of revolving screens. All screenings below ¼ in. in size were classified as sand, about 25% of the total amount required being obtained from this source. The remainder was excavated from the lake shore.

The largest-size rock used in the concrete was 2 in., and very few plum stones were deposited in the aggregate when it was in place. One ½-yd. concrete mixer discharged into buggies in which the concrete was conveyed to the forms.

Timber for forms, camp buildings and tramways was cut by a sawmill near the dam site. In all, 930,000 ft. b.m. was required. Work was finished on Nov. 18 of this year, except for some plastering of the upstream face, which is being done by means of a cement gun (Fig. 4).

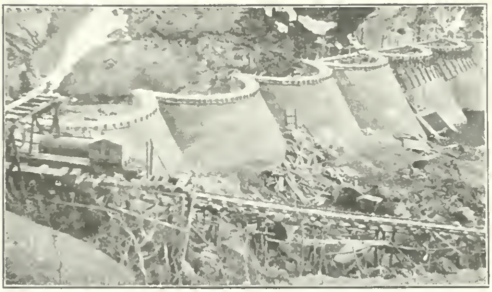


FIG [illegible] THE NEARLY COMPLETED AGNEW LAKE DAM JUST BELOW GEM LAKE

L. Jorgensen was the designer and Supervising Engineer of the dams, and C. O. Poole was Chief Engineer of the entire development. E. J. Waugh was Resident Engineer; L. B. Curtis, Field Engineer; and R. S. Manifold, Civil Engineer; F. O. Dobson, Superintendent of Construction. The contract was performed by the Duncanson-Harrelson Co., of San Francisco.

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Speedy Precise Leveling

In *Engineering News*, Nov. 30, 1916, p. 1011, there was published a brief note on the record progress made by John H. Peters, in charge of a precise-leveling party of the United States Coast and Geodetic Survey working in Michigan. Mr. Peter's party, for instance, ran a double line over a distance of 159.6 mi. in the month of September, 1916.

How this kind of work impresses the uninitiated engineer is well set forth in the following extract from *The Holcad*, the publication of Michigan Agricultural College:

> Watching the Geodetic Survey men run levels along the Michigan Central tracks from Holt to Lansing was an interesting sight. There was a time when these men walked, as the common or garden variety of surveyor does, now, however, the Government men are considerably more efficient and speedy. The level they use is mounted on a gasoline "go-devil" which one-lungs its way along a railroad track at about 15 mi. an hour, and a second gas car has mounted on it an adding machine for the use of the recorder. The rods are graduated to the metric system and the readings are taken by the very accurate three-reading system. Some idea of the speed with which these Geodetic Survey men work may be had when the fact is known that they ran a mile of levels in a few minutes less than half an hour.
>
> If some of the underclassmen had witnessed the interesting episodes that happened along the Michigan Central tracks, the title "dignified senior" would soon be as extinct as the dodo. The senior civils and a few juniors, headed by Professor Cade, met the geodetic men about two miles this side of Holt and undertook to watch them work. Vain hopes! The only glimpses of the work the seniors had, after the first greetings were over, were few and fleeting. The gas car started up the track to a new set-up while the seniors started to walk leisurely beside it. Soon that walk developed into a trot; then into a dead run. In a few short moments a bunch of about 40 men were strung out behind that gas car like a comet's tail, each and every man throwing cinders 30 ft. in the air in a desperate endeavor to keep within seeing distance of the survey party. Then, just as the first panting, gasping senior arrived at the scene of action, the level men would leave rapidly and with much noise for a point a few hundred yards farther up the track, leaving the seniors to repeat the performance. After a mile or so of marathon work most of the class came to the conclusion that there was too much speed in that job for them and so they left for the street car line [illegible] to the [illegible].

Rectangular Wooden Flumes

By J. C. Stevens*

The object of this article is to touch briefly on a few important points connected with the design and construction of wooden flumes for irrigation and power purposes, that have not been treated either in textbooks or in technical articles, so far as the author is aware.

The author will preface his remarks with this advice: Do not build wooden flumes for permanent institutions if funds are available for more lasting types of construction. He hastens to add that where circumstances demand, good wooden flumes can be built that under careful management will last in serviceable condition for many years.

The life of wooden flume under Western irrigation practice may be taken as 10 yr., while that of steel flume with wooden substructure on masonry footings may be taken as 20 yr. It is easy to figure that it will be cheaper to construct and maintain two sets of wooden flume, during a 20-yr. period, than one of steel. Nevertheless the sense of security felt by the management and the confidence it will inspire in prospective settlers under a system where steel flumes are in use will more than offset the difference in cost.

In the majority of cases, however, the funds available for a proposed development make it necessary to construct wooden flumes or none at all. Under such circumstances a type of flume must be adopted that is simple and cheap, and that can be maintained and repaired at minimum cost.

Choice of Lumber—Seasoned vs. Green

For the flume box, redwood will probably give the best results, but it is expensive and often out of the question. In the Northwest the next best cheap material is Western yellow pine. Douglas fir will probably outlast the yellow pine, but it checks so badly that it is very difficult to keep fir flumes tight, especially under the intermittent use for irrigation. Douglas fir is probably the best material for the substructure, although yellow pine, spruce and hemlock are extensively used.

The condition of lumber as to seasoning is a very important feature, and on it largely depends the type of joint to be used. For tongue-and-groove joints, spline joints, or shiplap it is very important to use well-seasoned lumber placed dry. Even well-seasoned lumber placed in damp weather will afterward shrink enough to open any of these joints. Subsequent warping will prevent complete closure when water is next turned in, and permanent leaks will develop.

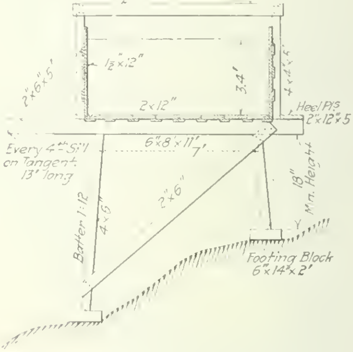
Many flumes have been built of green lumber, fresh from the saw and often floated to the point of use after milling. Such practice, especially for irrigation flumes, cannot be too strongly condemned. Where this method is used, however, a simple butt joint with battens on the outside should be adopted, and under no circumstances a tongue-and-groove, spline or shiplap joint.

The drier the lumber used the tighter will be the flume, hence it is important always to use well-seasoned lumber laid in dry weather. If possible, lumber should be air-seasoned in the rough for at least a year in properly stuck piles or kiln dried. Just before construction the flume plank should be milled to dimensions. If this is done, the plank will be found to have nearly uniform dimensions, the construction will be greatly faciltated, and a much tighter and better flume will be obtained. No buckling of plank from subsequent saturation will result if they are properly nailed in place.

A year's air seasoning is often out of the question, however, and in such cases as long a time as possible should be given. Even the drying received in as short a time as two weeks in well stuck piles will be well worth the extra cost of piling.

Milled vs. Rough Lumber

The substructure and especially the battens are best made of rough lumber. The flume box is generally made of milled lumber for two reasons: One side of the planks are often dressed and placed with the planed surface inside to reduce friction; planks are often sized one side and one edge or sized one side and two edges to secure uniformity of dimensions.



TYPICAL WESTERN IRRIGATION FLUME

Bents 4 ft. c. to c. Battens to be 1x6 in., cut long, sprung in between posts and sills, and nailed with 10d nails 6 in. c. to c., staggered and clinched.

Experiments on the flow of water in flumes show, for the stretches selected, a slightly lower coefficient for dressed than for rough lumber. In practice, however, the capacity is often governed by the amount of dirt or gravel in the bottom of the flume, or by a slimy growth that will attach itself to either planed or rough lumber. As far as carrying capacity is concerned there is not a great deal to be gained by planing the flume plank.

There is no doubt but that a far better flume can be built of uniformly sized planks. On the other hand the rough edges of planks will hold silt better than planed edges and thus will produce tighter flumes.

It is practically useless to size flume lumber when it is green, because, in drying, the shrinkage is not uniform and considerable variations will be found in width of planks after they have had a few weeks of air drying. Sizing of lumber also reduces its strength as well as dimensions for which due allowances must be made in the design.

If lumber is well seasoned, the best practice is to use plank sized one side and one edge to facilitate construction and to insure tight joints. In laying place a rough edge and a smooth edge together. An alternative plan, if there is a saving in cost, would be to use plank sized one edge only, since it is desirable to secure plank of uniform width if possible.

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*Consulting Hydraulic Engineer, Spalding Building, Portland, Ore.

If the lumber is green, use the flume planks in the rough—that is, without sizing. In constructing do not break joints but build the flume in 16-ft. lengths. Then trim the wide end of the last panel (usually 4 ft.) of the bottom to meet the width of the narrow one at the joint. Sides need not be trimmed. A variation of an inch or so in the width of the flume will thus result, but it is not a serious matter.

The most practicable longitudinal joint for flume plank, considering cost, ease of repair, calking and rapidity of closure, is a simple butt joint with a batten on the outside. Battens should never be placed on the inside of a flume. It is a waste of lumber, for they serve no useful purpose in this position. Unless they are placed on the outside it is better to omit them altogether. This applies equally to the flume proper and to the transition section that is buried in the earth.

Typical Western Irrigation Flume

The accompanying illustration shows the type of flume that has been gradually evolved in Western irrigation practice. It has no bolts, no mortise joints, no dapping. Nearly all sticks can be cut to size at the mill, thus reducing field carpentry to a minimum.

Flume planks should be drawn to as close a fit as possible at all longitudinal joints. Battens are cut to fit snugly between side posts and sills and are driven into place. They should be securely nailed to the planks and the nails clinched on the inside of the flume. Both flume planks and battens should be of well-seasoned yellow pine, white pine, sugar pine, cedar or redwood. Fir is not desirable, but all other timbers may be of fir.

If there is sufficient money available, footings should be of masonry built high enough to keep the ends of the posts above the soil. This, however, is quite expensive, and the use of wooden footing blocks is quite general in the West. The life of the flume will be materially lengthened if footing blocks are of timber treated with creosote or other preservative. The bearing surface on soils must be for that soil in a saturated condition, and generally should not exceed one ton per square foot. Posts should be cut to exact length, and the use of shims should never be allowed.

Bench flumes on steep side hill should always be avoided, as soil will collect against the flume box on the upper side and cause early decay. A much better plan is to set the flume on posts free from the hillside, burying the footing blocks and post in the soil and back filling so as not to disturb the original slope of the material.

Importance of Extension Joints

If flumes are built of seasoned lumber, it is very important to provide extension joints. If this is not done, subsequent saturation will lengthen the flume enough to lift it clear of its supports on the inside of curves. On sharp bends around rocky points the flume may even be pushed off its footings altogether. This is particularly true of the smaller sizes. The author observed a flume 2 ft. in width without extension joints wrecked at a sharp curve when water was first turned into it. The extension was sufficient to tip the flume so that water poured over the side on the outside of the curve and washed out the footings.

Experiments by D. C. Henny on kiln-dried lumber measured before and after saturation in tanks shows the following percentages of extension:

	Range	Average
Sinker redwood	0.04 to 0.09	0.087
Soft redwood	0.02 to 0.18	0.143
Hard redwood	0.08 to 0.21	
Sap redwood		0.097
Yellow fir		0.117
Red fir		0.073

Experiments by the author on yellow pine air-seasoned for 6 months, measured before and after saturation, gave the following average percentages of extension: Yellow pine (*Pinus ponderosa*) series 1, 0.064; series 2, 0.051.

On constructed flumes some of this extension is taken up by crushing at the joints so that the extension to be provided for is somewhat less than that shown above. On a flume constructed of yellow pine air-seasoned for 60 days an extension of 3¾ in. in 735 ft., or 0.043%, was observed following a few days of rainy weather. The flume was practically on tangent with one end free.

A questionable practice has been to leave about ½ in. space between ends of planks at panel points. If the flume is empty, and extension results from wet weather, the nails will give but little and the flume will be lifted at critical points. Moreover, to take up the extension the nails must bend, and this induces leakage. If the flume has battens on the outside, the joint is useless since the battens will prevent the extension being taken up in this manner.

The location of extension joints is largely a matter of judgment and experience, as they must be placed with reference to the alignment of the flume and height of posts.

Perhaps the best type of extension joint is a V-joint of galvanized-iron sheets joining two collars spaced about 4 in. apart. This forms a sort of bellows between adjacent panels and can be made practically water-tight. Another type can be made entirely of wood by ending one panel on a false collar that slides on a larger collar fastened to the other panel.

Where green lumber is used extension joints are not so imperative, particularly on large flumes. During construction, however, an occasional open panel should be left at curve points until just prior to the time of filling. This will prevent the footings being lifted due to extension from rains or snow until the flume receives its load. Under its load much of the extension will be taken up by tightening and crushing at the joints. The subsequent drying in the nonirrigating season may pull the joints slightly, but it is not likely to lift the footings.

In the design overturning can rarely be provided for by the batter of the posts. For example, a 5x3-ft. flume on 16-ft. posts will require a batter of 2.6 in 12, and on a 31-ft. trestle posts with a batter of 3.75 in 12 will be required to resist a wind pressure of only 15 lb. per sq.ft. on exposed surfaces with flume empty. For a 2x2-ft. flume the required battter is 7.8 in 12 for 16-ft. posts.

Such batters are of course impracticable and some other means of resisting wind loads must be provided. The simplest plan is to build all flumes with the same batter to the posts, say 1 or 1½ in 12, then provide guys at critical points. Only the exposed portion of flume need be anchored in this manner.

The author has successfully used [illegible]/8-in. galvanized-iron messenger cable anchored to creosoted dead timbers buried in the ground. A constant batter of 3 to 5 was given the cables, but the spacing of anchors was varied from 32 to 96 ft. or greater, depending on the size of flume, height of posts and exposure to winds.

The wind pressure above cited—15 lb. per sq.ft. of exposed surfaces—is about half that usually adopted for bridge and building designs, but if flumes are built to withstand a wind load of 15 lb. per sq.ft. they are amply safe.

IMPORTANCE OF CAREFUL PRIMING BEFORE USE

By this term is meant the first filling with water. If there is a point of weakness anywhere in the flume, the water will soon discover it. The secret of successful operation is to detect incipient trouble and make repairs before damage occurs.

On most soils the leakage that inevitably occurs between the time water is first turned in and the joints have closed by swelling of the flume plank cannot be permitted. On rocky foundations, where leakage can do no property damage or endanger the footings, the flumes may be allowed to close of themselves.

The only sure method of preventing this leakage is to calk all side joints with oakum prior to turning in the water. During construction it is best to leave a ⅛-in. calking space between butt joints of the side plank. The most important joint to be closed is the butt joint of the bottom side plank. Oakum should be forced below the top of the bottom plank, onto the sill in this joint, or leakage will occur here ever afterward and cause early decay of the supporting timbers. The joints of the bottom will rarely give trouble and are quickly closed.

A simple effective method of priming is as follows: Throw in a wheelbarrow of fine soil about every 20 ft. for a large flume. At the upper end of the flume throw in a wagon load of sawdust. The first water turned in should not be over 3 or 4 in. deep in the flume, and as it advances workmen with rubber boots and shovels should stir the silt and sawdust into the water. Almost instantaneous closure of the bottom joints will result. If any of the butt joints of the bottom side plank have not been calked it will be evident at once, and they must be calked before the water is raised.

Water should then be raised slowly, about 2 in. per day or less, until the required depth is secured. Oftentimes the water is held for a day or more at the height of one of the side joints or just over it until closure by swelling and calking is secured. If settlement occurs, the flume should be immediately raised to grade and the footings enlarged or other means adopted to prevent a recurrence. Oftentimes leakage water can be led away from footings on treacherous soil by means of wooden V-troughs, or canvas sheets may be spread over the soil to collect the water, from which it is readily conducted by ditching.

After the flumes have become thoroughly soaked they will become practically water-tight. The author has seen stretches of a mile or more of this type of flume carrying a good head of water, but with hardly a drop escaping, all supporting timbers and the soil underneath being absolutely dry. Such a condition tends to longer life of the flume, and to secure it should be the aim of design and construction.

Slipperiness Test Pavements

The State Highway Commission of Massachusetts under a special appropriation of the legislature has recently completed the construction of ten sections of test pavement, the purpose of the experiment being ostensibly to determine the relative slipperiness of the various types of construction and to develop a pavement least objectionable to the horse owners of the state. Incidentally, it is expected that the experiments will demonstrate other things of interest.

The test sections are on Washington St., Boston, Mass., near the city line, adjoining Dedham. The sections are 500 ft. long and are on 4% grades. Alongside the pavements is a waterbound macadam shoulder 6 ft. wide, the test for slipperiness being the readiness with which horse-drawn vehicles seek the shoulders of the various strips of pavement.

Section No. 1 is a "rough" tar penetration pavement—that is, constructed of a 3-in. layer of rolled No. 1 stone covered with 3 gal. of hot tar per square yard, spread in a single application. This differs from the regulation tar penetration macadam in that the tar is added in one application instead of two, the second application being generally known as the seal coat. Section No. 2 is a "smooth" tar penetration pavement that was built with the two applications of tar—that is, sealed.

The next section, No. 3, is concrete laid in the usual manner. Section No. 4 is a "smooth" asphalt penetration pavement, exactly like No. 2 except that a standard asphalt instead of tar was used as a binder. Section No. 5 is a "rough" tar mixture pavement. The paving mixture consisted of No. 1 stone, sand and tar in the following proportions by weight respectively—750 : 150 : 10. Section No. 6 is a "rough" asphalt penetration macadam, like No. 1 except that asphalt instead of tar was used for the binder.

For the following section, No. 7, a "rough" asphalt mixture was used, exactly like No. 5 except that asphalt was used instead of tar. Section No. 8 is a tar-sand grouted layer of No. 1 stone. The tar-sand grout was a 1 : 1 mixture and was poured hot over the rolled stones. The sand used was very fine. Afterward ½ gal. of tar per square yard was added as a seal coat. The tar grout filling required about 2.15 gal. of tar per square yard. Section No. 9 is a "Ma-Drite" tar macadam pavement, constructed after the manner described in *Engineering News*, July 8, 1915, p. 81 (hand-mixed tar and stone). Section No. 10 is a Topeka mix asphaltic concrete pavement. This section was put down by special contract, and it is not the equal of ordinary Topeka specifications pavements.

The only noteworthy points yet developed are that the asphalt mix, with coarse aggregates, tar mix and the rough penetration pavements have already required a seal coat to keep them from raveling under only two or three months' wear and that the macadam shoulders are next to impossible to maintain. The same kinds of asphalt, tar, stone and sand were used in all the sections, so that the variables are reduced to only the methods of construction.

The chairman of the Massachusetts State Highway Commission is William D. Sohier; A. W. Dean is chief engineer, and F. C. Pillsbury is division engineer of the third division, including Boston and vicinity, in which the above experiment is being tried.

Wayne Sewage-Disposal Works After Nine Years' Use

By G. Everett Hill*

SYNOPSIS—To economize space in a highly developed residence section and to save pumping the sewage, the broad irrigation works designed and built by Colonel Waring a quarter-century ago have given way to septic tanks, coke roughing and intermittent sand filters and hypochlorite treatment. The plant is described and some operating results are given.

Wayne is a residential community of about 4,000 population, on the main line of the Pennsylvania R.R., 14 mi. west of Philadelphia. Its natural drainage outlet is a small stream (normal dry-weather flow 0.69 to 0.87 sec.-ft.) known as Ithan Creek, which runs 4 mi. through a well-populated district—and for part of its course through large parked estates—to Darby Creek.

A system of sewers and sewage treatment was installed by the late Col. George E. Waring, Jr., in 1891.[1] Disposal was effected by irrigation upon 11 acres of land, divided into five tracts for use in rotation. Four acres of the field, divided into two tracts, was open meadow land, fed by gravity and used to treat the night flow. The day flow was pumped intermittently from a gravity-fed receiving tank to seven acres of wooded hillside, divided into three tracts. Before application to the soil the sewage stored in the receiving tank was thoroughly aërated by starting the pumps and opening a bypass that discharged the sewage, in a strong jet, back into the tank. In the light of recent activated-sludge developments it is interesting to note that the effluent was better when the tank seemed most in need of cleaning—that is, when the aërating jet mingled with the water the greatest amount of old sludge. This system of disposal operated—on the whole, satisfactorily—for 15 years.

In 1906 the writer advised the owners that developments in the art made it possible to reduce the size of the plant and to operate it entirely by gravity. Reconstruction was ordered, and the system now in use was completed and put in operation in September, 1907, under the writer's direction. It occupies the space formerly used for the treatment of the night sewage. During construction the entire flow was diverted to the hillside beds, which are now idle.

In a shallow chamber, built in the course of the main 12-in. sewer, the sewage passes through a screen (normal wetted area, 7.5 sq.ft.) made of bars with $2\frac{1}{4}$ in. clear spacing. This inclines 40° from the vertical, so that the operator, standing on the ground at the outlet end of the chamber, can rake the accumulated deposits up the screen to a perforated sheet iron plate, suspended over and draining into the outlet channel. Adjoining this drain plate is a small chamber, in which the drained material, sprinkled with a little lime, is stored until a convenient time for removal. This screen chamber is intended to retain nothing but the bulky and resistant solids that are foreign to true sewage but which every sewer carries. Some paper is removed; but most of it, if it does not pass the coarse screen immediately, is ultimately shredded and carried away by the flow.

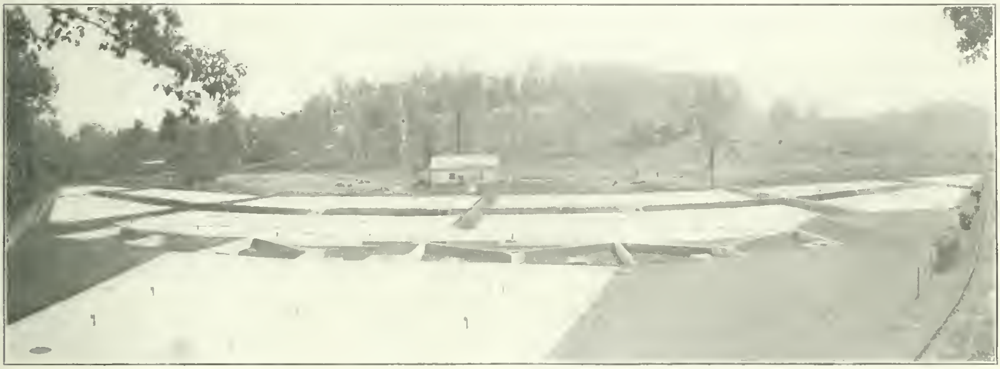

FIG. 1. GENERAL VIEW OF SEPTIC TANKS, ROUGHING AND SAND FILTERS, WAYNE, PENN.

Digestion or One-Story Septic Tanks

From the screen chamber the sewage passes to the digestion tanks. These are three one-story concrete chambers, roofed with reinforced concrete, lying in the foreground of the general view of the plant, Fig. 1.

The inlet feeds (Fig. 2) have three right-angle turns that check the speed of the incoming sewage, and the last bend delivers horizontally, below the scum and above the sludge, backward *against* the wall of the tank, which acts as a diffusion plate and spreads the liquid (like cigar smoke blown gently against a wall) in all directions—securing immediate loss of velocity, good distribution and uniform displacement of older sewage. This form of inlet was determined after experimental study of many types in glass tanks filled with clear water and fed with varying mixtures of water, sand, finely powdered clay and aniline dye. The flow to each inlet is regulated by an adjustable diaphragm consisting of a set of nested concentric iron choke rings.

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*Vice-President and Chief Engineer, City-Wastes Disposal Co., Consulting Engineers, New York.

[1] See "Engineering News," Nov. 3, 1892, pp. 422-424, for illustrated description; also Jan. 1, 1891, p. 16, for remarks in an article by Colonel Waring.

The outflow from each tank (Fig. 2) is over a smooth dead-level weir wall (protected by a scum-retaining apron wall) that extends across the whole outlet end. This type of outlet insures the escape of the sewage without the increase of velocity that would be induced by the use of a point or points of outlet. It maintains a uniform cross-section flow from wall to wall, and because of its great relative length the liquid creeps over it in a film so thin that it cannot float even the smallest masses of digested sludge. When these rise beyond the apron wall, they strike and stop at the weir wall, until they are disintegrated and carried away by the flow in subdivided form so fine that no individual particles can be distinguished, and faint momentary discoloration—such as might be made by a drop of ink—is all that is apparent.

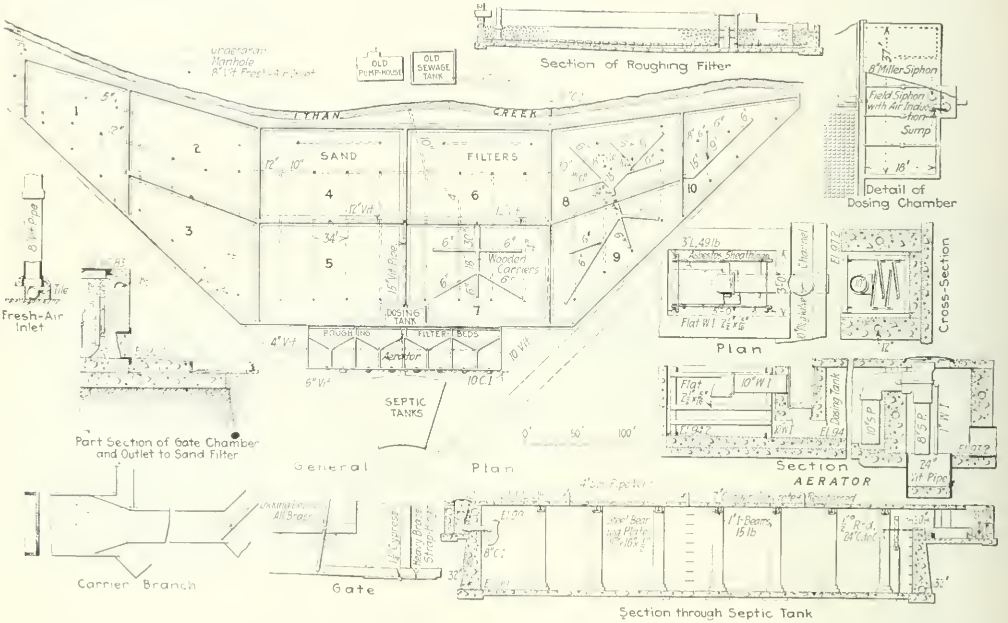


FIG. 2. PLAN AND DETAILS OF SEWAGE-TREATMENT WORKS, WAYNE, PENN.

Each tank has an area of 1,260 sq.ft., a working depth of 9 ft. and a capacity of 85,000 gal. In plan, the tanks form a sector of an annulus with a short radius of 86.11 and a long radius of 146.11 ft. Partitions as well as side walls are radial. Sewage enters at the narrow end and escapes at the broad end of each chamber, and the ratio of these ends is practically as 10 to 17.

Studies of Sedimentation and Sludge Digestion

Experimental study of a tank of this form, in conjunction with another tank of the same depth and capacity, but built with parallel side walls, showed about 18% superiority in sedimentation efficiency and a distinct advantage in digestive power. The former is doubtless due to the fact that light flocculent particles, which would be carried out of the tank by the *average* velocity of flow through it, settle in the less-than-average velocity of the wider outlet end. The gain in digestive ability may perhaps be due to the elimination or reduction of bacterial organisms by the deposition in different zones (due to diminishing velocity) of the heavier and the lighter solids and the resultant tendency toward segregation of the many different kinds of reducing organisms, each preferring some special food.

Experiments in anaërobic decomposition, made by the writer in 1900, showed more complete digestion of *total* organic matter when three successive withdrawings of settling sewage sludge were rotted in three separate vessels than when an equal amount of the same sewage was settled and septicized in one tank. The marked advantage of the segregation of the different kinds of *aërobic* bacteria was recognized as early as 1890 and was brilliantly demonstrated by Scott-Moncrieff. Rideal in his "Sewage and Its Purification" (p. 100, third edition) wrote, "The best conditions are attained when a sewage plant is so arranged as to afford separate areas favorable to groups of organisms which work similarly." Like results have since been noted by Dr. Schmeitzner, who in his book, "Clarification of Sewage," calls attention to the 49.3% removal efficiency of a tank at Sheffield with parallel sides and uniform velocity, as compared with 82% removal efficiency of a tank at Viersen, similar save in that it has diverging side walls. The performance of the Wayne tanks, cited later, seems to justify the construction.

The outlet channel of each digestion tank is fitted with a slate knife-edge measuring weir. Two tanks are devoted to the treatment of normal dry-weather sewage. One is used at a time. When sludge ebullition becomes marked, the flow is diverted to the other tank, in which, during its period of rest, ebullition has usually subsided. The third tank is held in reserve, to act as an equalizer when heavy rains (which find their way into the main sewer in spite of careful construction) increase the volume to an extent that would agitate the sludge or impair sedimentation in the dry-weather tanks. When the abnormal flow has ceased, the storage tank is bled slowly to a sand filter.

Down-and-Up Flow Primary Filters

From the digestion tanks the clarified sewage passes to coke-filled primary filters of the down-and-up-flow type. Their function is merely to withhold mechanically the finely divided or the semiliquid gelatinous substances not detained by the digestion tanks, which, if allowed to pass to the sand beds beyond, would cause unnecessary clogging and raking. As the downflow side of the primary filter collects by far the greater part of the sediment, eight downflow beds are provided and only four upflow beds. The septum walls, separating the down and up compartments, are so arranged (see section) that an up bed can be used in conjunction with either of its two tributary down-beds without any setback of liquid into the other down-bed. The average depth of the beds is 2.75 ft., and the total primary area is 0.1676 acre. Ordinarily two down-and-up units are in use at once, while six down and two up beds are draining (to a special sand sludge bed), aërating and reducing their accumulation of fine sediment. The effluent from the upflow beds passes over a weir wall into a channel that leads to a dosing tank, either directly (in winter) or (in warm weather) over a vertical series of sloping perforated aërating plates of asbestos board.

The dosing tank holds 10,000 gal., and it feeds the sand beds through either one of two 8-in. siphons—the first, a Miller, for use in cold weather, when it is desirable to conserve whatever heat the sewage has; and the second, for summer use, a Field-Waring fitted with a special air-induction device that sends the whole flow to the sand beds bubbling and foaming like soda water.

Ten sand beds are provided, with a combined area of 2.33 acres. They are 3 ft. deep and filled with clean quartz sand, brought from Cape May, N. J. The effective size of this sand ranged from 0.25 to 0.35 mm., and the uniformity coefficient never exceeded 2.5. The arrangement of distributing gates and carriers is shown in portions of Fig. 2. All beds are amply underdrained. Two systems of tile were installed, each collecting the flow from five beds and discharging through a separate outlet into Ithan Creek. Normally two sand beds are flooded daily, while eight are draining and aërating. No bypass to the creek exists. It is structurally impossible for sewage to reach the stream without passing at least through the sand. The structural cost of the plant, including engineering, was $81,335.

The present dry-weather flow is from 150,000 to 500,000 gal. a day. The average periods of detention are: In digestion tank, 1.3 hr.; in primary filters, 33 min.; in dosing tank, 30 min. The average horizontal velocity in the digestion tank is very low, only 0.001 ft. per sec. The rate of application to the sand beds—whole area—has averaged a little over 200,000 gal. per acre per day; to the beds in use, something more than 1,000,000 gal. per acre per day. This is a good index of the thorough clarification of the sewage before application to the sand. No sludge was removed from the digestion tanks between September, 1907, when they received their first sewage, and May, 1915, over 7½ yr. A conservative estimate of the amount of actual suspended matter received in this time is 1,200 tons. Of course, not all of this was destroyed. Much of it passed out in comminuted form and was caught by the primary filters, and some of it was detained and sent to the sludge bed (with the primary drainings) by a primary that was emptied of its coke and used for a time experimentally as a secondary settling basin. But the total mechanical removal of solids from any part of the system has been the rakings from the sand beds, averaging 2½ wheelbarrow loads a day, a small indeterminate amount washed at long intervals from the coke of the primary filters, and the deposit taken from the tanks in 1915, which was 617 tons of *wet* sludge, containing from 30 to 60 tons of actual solids. The rest has disappeared.

The primary filters have been cleaned by washing the coke about once in two years. The cost of washing each filter is about $60. Neither coke nor sand has ever been renewed.

Hypochlorite treatment of the effluent was added, after the plant had been running for some years, as another factor of safety. Thirty-five pounds of chemical is used per day, and the time spent in mixing, adjusting feeds, etc., averages about one labor-hour. The solution is fed directly into the eastern effluent drain, just above its outlet into the creek. The western (the upstream) drain receives no individual treatment, but it and the entire creek benefit by the treatment after mingling with the lower effluent, as is clearly shown by the following average of 11 weekly representative bacterial analyses:

	Bacteria Per c.c.
Creek above the plant	324
Upper effluent (not treated)	17,337
Lower effluent (chemical just introduced, no time for contact)	343
Creek below plant	243

Weekly chemical analyses show that the effluent is uniformly stable in character, with an excellent degree of nitrification and containing abundant dissolved oxygen. The plant is regularly inspected by the Pennsylvania State Department of Health.

The disposal field, which is flanked by handsome residences and golf links, has been parked and is kept in beautiful condition. Three men are employed constantly in caring for the sewers and disposal plant, but more than half of their time is spent in maintaining lawns, trimming hedges and in other gardening operations. An extra man is occasionally needed. The total cost of operation (not including interest and overhead charges) is about $3,000 a year.

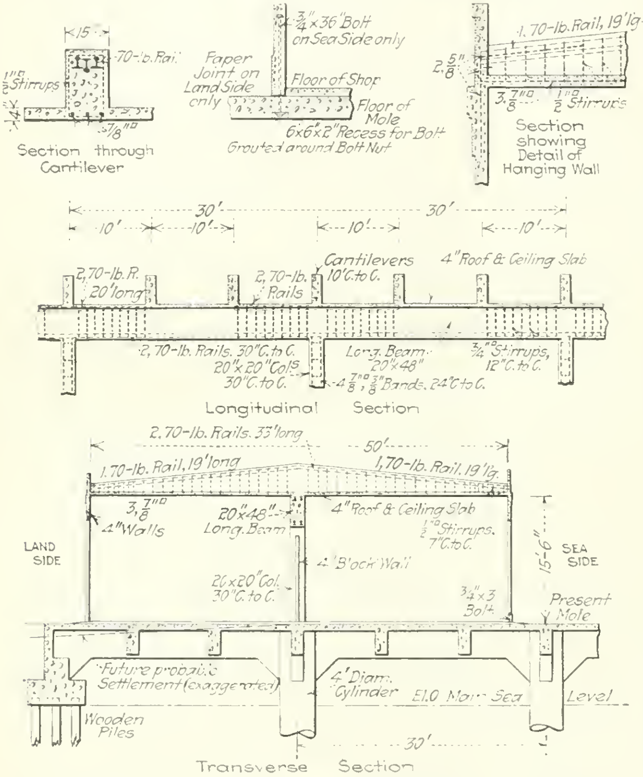
* * *

Engineers and Salesmanship—At the recent organization of the Salesmanship Club at Kansas City, Mo., Malcolm Lowry, of Hemiesi Kent & Lowry, engineers, said in part: "The engineer needs salesmanship as well as the merchant or manufacturer. The act of selling is just as essential a feature of the business whether the thing to be sold is a tangible piece of goods, or an intangible service. The engineer with the best equipment and organization in the world, the best potential service, is helpless without the sale of his service—just as useless a barnacle as the merchant with an unsold stock of goods. Life insurance men want to see the selling of insurance put on a higher plane, for the lasting benefit of their profession. And it is just as necessary that the selling of engineering service be done by competent men, that the buying public may be kept properly informed as to what engineering service is, and what is offered."

Concrete Building Balanced on Middle Line of Columns

By R. C. Hardman*

A reinforced-concrete repair shop and electric charging station now under construction at Cristobal, Canal Zone, has some unique features of design to meet unusual conditions. The building, which is being erected upon the mole between piers 8 and 9, is 51 ft. 4 in. by 271 ft. 8 in. in plan and one story in height. The mole, constructed in 1913, as will be seen in the accompanying plan, is founded upon piles and cylinders. The piles are of wood and the cylinders of steel filled with concrete. Since being put into use the wooden piles, which are under the inner or land side of the mole, have shown a small amount of settlement, while the steel cylinders have remained at their original elevation. Although this settlement was very slight and not sufficient to cause damage to the mole structure, its presence and the possibility of its future increase were subjects for consideration in the design of any structure to be built upon the mole. The new building is so placed upon the mole decking that one of its longitudinal walls is nearly over the line of piling on the land side. As it was not desired to place any additional load on this side of the mole, it was decided to suspend the walls from the roof. In addition to relieving the mole from the extra load, any possible damage to the building due to further settlement of the piles was also obviated.



BUILDING ON MOLE AT PANAMA IN WHICH SIDE WALLS HUNG FROM ROOF BEAMS

The type of structure selected is shown in the accompanying drawing. A single row of columns spaced 30 ft. on centers and located directly over one of the rows of cylinders supporting the mole establishes the longitudinal center line of the building. A large continuous beam connecting the tops of the columns carries transverse cantilever beams, which are spaced on 10-ft. centers. From the ends of these cantilevers are suspended the light 4-in. reinforced walls, which rest directly upon the mole deck, although their weight is carried, theoretically, by the cantilevers. Thus, it will be seen that the entire building (except the floor) is carried by a single row of columns on the center line of the building. While this is true under normal conditions and from a theoretical standpoint, practically the entire weight of the building is carried as would be the case in a structure of ordinary design—namely, by walls and columns. The designed action of the cantilevers will be secured only in case of further settlement of the wooden piles without corresponding settlement of the steel cylinders. Even with such further settlement the building would be in equilibrium about the row of columns unless it received wind pressure or other lateral force, in which case the tendency would be for the whole structure to move about the base of columns. To obviate the overturning result of the two stated conditions, the wall on the sea side is anchored firmly to the deck of the mole, so that under settlement and wind no damage would occur. It is not expected, however, that these anchor bolts will be called upon to serve their purpose, as settlement will be followed by the grouting-up between building wall and mole deck. Details are also shown of the various sections of beams, methods of wall suspension and roof and ceiling slab. The ceiling slab, it will be noticed, by being pitched for drainage also serves as a roof. Attention is called to the use of 70-lb. steel rails as reinforcing material. Since the watering of the canal prism enormous quantities of these rails have been scrapped and are being extensively used wherever possible because of their relative cheapness.

The building has been designed and is being constructed by the Building Division of the Panama Canal.

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*Balboa Heights, Canal Zone

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Linking Up British Power Stations—A joint committee of the associations of electric power companies and municipal electric undertakings has been formed to study the general interconnection of power stations throughout England, Wales and Scotland. This is urged to save fuel, increase security of supply, future economy of investment, etc. The country has been divided into 16 districts in each of which a local sub-committee of engineers is studying (or will shortly) particular problems of the locality.

Side Lights on Depreciation Problems of Utilities—I*

By Harry Barker†

SYNOPSIS—A review of the many meanings applied to the word "depreciation" and a proposed system of definitions to remove existing confusion. A new term is offered, "retirance"—annual repayment to compensate for depreciation. A subsequent article will deal with plans for computing annual depreciation and retirance.

"Depreciation" is a term that has been too loosely employed. The meanings given to it are seen to fall into two general classes: (A) Losses in value of physical property, and (B) sums secured from earnings to offset loss in value of property.

The first group of definitions of "depreciation" is further divided into: (1) Aggregate actual or estimated loss in value from all causes, (2) the loss of value due to wear- and age-deterioration as distinguished from the loss of value from liability of obsoletion or inadequacy, (3) the loss in value due to loss of ability to render full service or to decreased efficiency.

The second group of definitions is seen to be split into: (4) An annual accounting figure representing the depreciation for the year, or any other given period, deducted from gross earnings in computing probable true net earnings; (5) an annual sum used in making up the amount of necessary income to be secured by the rates. This last is often an annual amount to be set aside out of the earnings to help create a reserve which will equal the cost of the several items of plant when they are retired from service, and will pay for the renewals to the extent of the cost of the items retired. It might well be a direct repayment out of earnings of investment, equal to the annual loss in value of property due to depreciation. There is a final observable definition of depreciation as (6) various aggregates of the annual sums secured from time to time to compensate for loss in value through depreciation.

The various shades of meaning indicated in these definitions explain the extreme confusion which has been introduced into discussions of depreciation and the need of greatly restricting the use of the term. Language is not so impoverished that it is necessary to use the single word in so many senses.

"Depreciation" Properly Used

The first definition—as the aggregate loss in value from wear-deterioration, inadequacy, supersession, antiquation, dilapidation, etc.—is probably the most used and the original one. This can well be adhered to, and a few available terms employed to carry the other meanings given.

The idea involved in the second definition makes a most useful distinction which should be preserved, but it is more definitely indicated by "wear-deterioration," "age-deterioration" or "wear- and age-deterioration," according to the precise shade of meaning needed.

The third definition—loss in value due to diminished power to function or to decreased efficiency—has no real place in depreciation discussions, for mere ability to render the original service does not indicate lack of depreciation, and percentage of service ability (which is not the "serviceability" of the dictionary) alone does not measure value. (It indicates relative value only when the duration of that percentage of service ability is considered; if one machine can yield certain service for 10 years and a second machine can yield the same service for 20 years, their real values are not equal.) Instead of speaking of this loss of service ability as depreciation it should be called "service-ability drop" or some equivalent.

The fourth definition has sprung up to give a short expression equivalent to "deductions for depreciation expense," or something like that. If there were not so many definitions in the field needing weeding out, its abbreviation to "depreciation" would be excusable. But, because of the confusion induced, the longer phrase should be reverted to.

Similarly in the case of the fifth definition it is advisable to say "allowance for depreciation expense," or more briefly "depreciation allowance," and not merely "depreciation." Between speed of speech and accuracy of expression there should be no question of choice. Depreciation allowances correspond to what some engineers call a "theoretical depreciation" in contrast with what they designate as "actual depreciation" (meaning wear-deterioration) found by examination.

A New Term Offered

Definition five conveniently reduces to "renewal allowance" and for further simplicity to the coined word "renewance," which the author has found generally understandable. The first and the fifth definitions are perhaps the ones most used, so that it is a great advance to agree to speak of "depreciation" as the actual lost value, and "renewance" as one year's part of the compensation therefor.

However, it is little more than a convenient fiction to speak of building up reserves for renewals, since those funds have no relation to the amounts spent for the new equipments. Electric railways have been known to scrap generating equipment and purchase power from central-station companies, notable examples being the Cleveland (Ohio) Railway Co. and the Third Avenue Railway Co., in New York City. In general, replacements are made with radically different apparatus. What the business must be made to yield, in line with the Supreme Court's dictum, is full compensation to the utility concern for the loss in value of property from all the various causes already outlined. That is to say, *the rates must cover the liability for retiring plant rather than the cost of renewing it.* "Retirance" therefore has been substituted for "renewance." Retirance then is the annual amount to be repaid the corporation to compensate it for each year's depreciation. Retirance is a definite factor in rates and in its nature is a repayment of invested capital. Unit retirance may be spoken of as a subdivision of retirance as it has been apportioned over rates. Wear-retirance, age-retirance, obsoletion-retirance, etc., become useful special terms which can be accurately employed. The place of aggregate retirance is obvious.

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*Advance publication of parts of a chapter from a forthcoming book, "Public Utility Rates," to be published by the McGraw-Hill Book Co. Copyright, rights reserved. In part based on the author's discussions at the Philadelphia Valuation Conference, November, 1915, and American Society of Mechanical Engineers, December, 1916.

†Associate Editor "Engineering News," New York City.

By such a restriction as outlined on the employment of the terms "depreciation," "wear-deterioration," "depreciation-allowance," "retirance," etc., discussion is not appreciably encumbered and a fundamental cause of exasperating confusion is removed.

Retirance a Repayment of Lost Investment

Whether or not the retirance money secured out of rates can be regarded as a repayment of investment is one of the most debated points that has arisen. Careful consideration of the question (keeping in mind the fundamental idea that loss of investment, impairment of capital or assumption of liability for renewal must be compensated by the customers in whose service the loss, impairment or assumption arose) will seemingly leave little doubt that the retirance collected is a restoration of balance between physical assets and incurred liabilities (including stocks and bonds). That looks like repayment.

However retirance cannot be a direct repayment when it is purposely made smaller than the annual depreciation with a view to placing it in a sinking fund and obtaining the normal amount through accumulations of interest. In this case the retirance is not free capital which the owner of the property may put in service to swell his income; all the earnings must be retained to complete the retirance fund, which can be drawn on only when an item has reached its assumed length of life.

Appraised Value, Depreciation and Retirance

It is the actual depreciation which in the long run affects real profits—considering actual values preserved as well as net earnings secured. But it is retirance which determines the computed, and approximated, profits and possible dividends from quarter to quarter or year to year. The annual increment in actual depreciation is not necessarily the same as the annual retirance sum which is intended to cover it, though that is the ideal sought. The most that can be said is that the aggregate of retirance accumulated on an item of property plus the scrap value should equal the total first cost when the item is discarded—no sooner, no later. Few can estimate so happily as to have their first estimate of retirance continue to the end without readjustment. If an examination of a piece of apparatus showed that the aggregate of contributions made against its retirement is going to be too large, then they might be decreased to such an amount as will probably complete the return of cost at the end of the useful life of the item, except that the rates should be held steady rather than fluctuating. The reverse adjustment would be necessary if the aggregate of allowances for a number of years proved to be less than the actual decrease in worth shown by examination. This adjustment affects dividends and surplus rather than stable rate schedules.

The exact eventual return of cost through retirances can be simply secured with the sort of accounting required by the Interstate Commerce Commission. In following its rules, monthly charges against depreciation are made, based on expectation of life. If an item lasts longer than anticipated, the retirance charges stop when 100% of its cost has been reached. If the life for any reason is shorter than expected, the unreturned balance is used to swell the depreciation-expense account for the year, or for large sums the balance is put into a suspense account and spread over several years.

It must not be expected that the valuation figures of a property, even though based on a good appraisal, plus the aggregate of all retirance moneys secured out of rates, will any more than roughly approximate the reproduction cost of the property or the legitimate investment historically established. The reasons are fairly obvious. Among other things, the value may be based on changing unit prices; appreciation of property may enter. The retirement allowances, as assessed on customers, are weighted composites for the various items that make up the whole plant. With uniformity and stability of rates over a given short period of time, the annual retirance at first would usually accumulate faster than *observable* composite depreciation would accrue. The deterioration of machinery seems to become more obvious in the last years of its service that in the earliest; and part of the retirance covers an antiquation which descends swiftly and, though impending, may not be seen by the superficial appraiser.

Failure to Collect Retirance

Where retirance money has not been collected, through the error and oversight of officials or neglect to charge sufficient rates, then according to the Knoxville case decision the company still is entitled to earn only on its depreciated value of property. This view has been assailed by many prominent engineers, and the hope has been cherished by them that the Supreme Court would reverse itself. It is of interest therefore to examine this part of the decision in question (City of Knoxville vs. Knoxville Water Co., 1909; 29, Sup. Ct. Rep. 148) to find its basis in law and economics.

> The company's original case was based on an elaborate analysis of the cost of construction. To arrive at the present value of the plant large deductions were made on account of the depreciation. This depreciation was divided into complete depreciation and incomplete depreciation. The complete depreciation represented that part of the original plant which through destruction or obsolescence had actually perished as useful property. The incomplete depreciation represented the impairment in value of the parts of the plant which remained in existence and were continued in use. It was urgently contended that, in fixing upon the value of the plant upon which the company was entitled to earn a reasonable return, the amounts of complete and incomplete depreciation should be added to the present value of the surviving parts. The court refused to approve this method, and we think properly refused.
>
> A water plant with all its additions begins to depreciate in value from the moment of its use. Before coming to the question of profits, the company is entitled to earn a sufficient sum annually to provide not only for current repairs, but for making good the depreciation and replacing the parts of the property when they come to the end of their life. The company is not bound to see its property gradually waste without making provision out of earnings for its replacement. It is entitled to see that from earnings the value of the property invested is kept unimpaired, so that at the end of any given term of years the original investment remains as it was at the beginning. It is not only the right of the company to make such a provision, but it is its duty to its bond and stockholders, and in the case of a public-service corporation, at least, its plain duty to the public. If a different course were pursued, the only method of providing for replacement of property which had ceased to be useful would be the investment of new capital and the issue of new bonds or stocks. This course would lead to a constantly increasing variance between present value and bond and stock capital-

> ization—a tendency which would inevitably lead to disaster either to the stockholders or to the public, or both. If, however, a company fails to perform this plain duty and to exact sufficient returns to keep the investment unimpaired, whether this is the result of unwarranted dividends upon over-issues of securities or of omission to exact proper prices for the output, the fault is its own. When, therefore, a public regulation of its prices comes under question, the true value of the property then employed for the purpose of earning a return cannot be enhanced by a consideration of the errors in management which have been committed in the past.

This statement is seen to be based on the proposition that for every dollar by which the property has depreciated, the company is entitled to earn a dollar above interest and profits. When this is done, each item is repaid as it is retired and existing depreciation is made good each year. If it should not be done, in the course of time replacements would have to be made out of entirely new capital and that would be an economic sin against the next generation.

This is a statement of general principle evidently intended as broadly applicable—since there are no references to the effect of peculiar conditions disclosed by the evidence in this case. So it must have been well considered before given that form and stated without exceptions. It is hard to find grounds therein for expecting its reversal *except* for those cases where the company has been constrained by local government or regulating commission to make rates that did not fully provide "for the replacement of its property out of earnings." Requiring a company to base rates on depreciated value of property in such cases would seem to constitute confiscation.

The same unfortunate result would be attained if the regulating authority had applied and continued to use the sinking-fund annuity in determining rates together with depreciated value of property. The sinking fund is not free capital; it brings the company no dividends by its investment and the concern gets no return on part of its investment where the equivalent of full value is not retained in the rate basis.

If rates have been based on full value and retirance has been secured by sinking-fund annuities, the regulating authority could follow two courses. First, they could continue as before to use the sinking-fund annuity for retirance and full value of property on which to figure return; or they could follow the Knoxville dictum and use depreciated value provided retirance was made fully equal to computed annual depreciation henceforth; the accumulated sinking fund properly handled would equal the depreciation up to that time and would then become free capital.

The last sentence quoted from the opinion lays stress on the errors of management which cause or permit insufficient rates. It is not to be assumed that the same interdiction applies to the many cases where the business could not have struggled along in its earlier stages had the charges been large enough to satisfy this demand—customers would have been driven away instead of being encouraged to increase to the point when the same rates yielded all the proper sums without being burdensome. Error and incompetency, not mere force of circumstances, are to be penalized, if a strict sense of equity is to be preserved—and that surely was what the court sought. Therefore, the inclusion of deficits between the actual and what would be proper returns to cover depreciation may be retained in development expense—or what some call "going value."

Some Items Affecting Cost of Structural-Steel Work

Views of structural-shop engineers on the factors affecting costs of shopwork were given the Engineers Society of Western Pennsylvania on Oct. 31 by E. W. Pittman, Manager of the Rankin Plant of the McClintic-Marshall Co., and George H. Danforth, Structural Engineer for Jones & Laughlin Steel Co. One of those discussing the papers later thought that Mr. Pittman was venturing into fields of humor when the statement was made that the designing engineer "has a creditable ambition to produce something original and to specify the best of materials and workmanship and at the same time is conscious of an obligation to his client to keep the cost of the structure within reasonable limits." Mr. Danforth was a little more blunt in stating that "some designers seem to think more of building a monument or of establishing a reputation for a wonderful design than they do of making a simple piece of work that can be readily built of easily available material."

Simple Details Desirable

In Mr. Pittman's judgment the design of a structure is the largest single factor in determining the cost per pound of structural steel, rather than any special or unusual requirement as to workmanship. The use of simple sections and few members in the place of complicated work often makes for a reduction in cost, even though the total weight may be somewhat increased. Both speakers emphasized the importance of using as few sections as possible in one job, and those to be sections frequently rolled, as both time for fabrication and the shop costs are reduced thereby. Both also referred to the disadvantages arising from the use of two sizes of punched holes in a single member.

The sequence of operations in putting work through a modern shop was outlined and the influence of design and specifications on the cost of these steps pointed out. In the discussion some difference of opinion developed as to how much in detail the engineers' drawings should be. Samuel E. Duff held that simple general drawings with good specifications were best, leaving details to the contractor, who could make them to suit his shops and tools. Paul S. Whitman, on the other hand, advocated complete design drawings, showing the number of rivets, even, in all important connections, on the grounds that the "average draftsman is a good spacer of rivets, but nothing more" and has little conception of the elements of design or the number of rivets required for good connections.

Design Drawings Should Be Complete

Another engineer with fabricating-shop experience, G. W. Nichols, agreed that design drawings should be complete, as this avoided the necessity for the fabricator to add a percentage to cover what the engineer might require and made all bids on a comparative basis. R. A. Pendergrass referred to the annoyance and expense often caused the drafting room by incomplete general drawings, from which essential information as to what the designer desired was lacking. He also mentioned an interesting case of shop drafting-room revision of a design where Bethlehem H-columns spliced at every floor were changed to three-story columns with but a slight increase in weight and a marked economy in shop operations and final cost.

Altering the Columns in a 21-Story Skyscraper

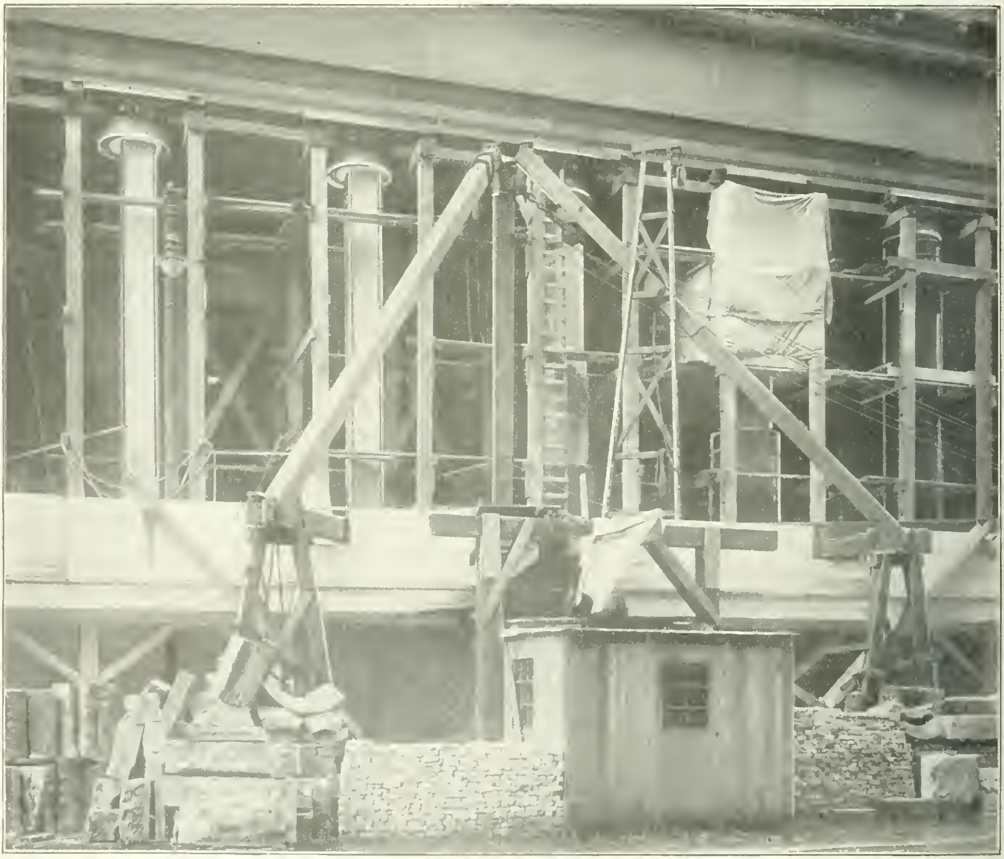
The 21-story Continental and Commercial National Bank building, one of the largest office buildings in Chicago (324x166 ft. in plan), has had interesting alterations made in the lower stories to obtain additional floor space at the sacrifice of the original architectural treatment. The building was described in *Engineering News*, Nov. 13, 1913.

The main front on La Salle St. was built originally with a loggia extending to a height of 45 ft. (nearly four stories) and with a depth of about 15 ft. (or the spacing between the outer columns and the first row of interior columns). In the front of this loggia the steel columns were concealed in red granite pillars, 41 ft. high, with capitals supporting the outer wall at the building line. These steel columns are of very heavy construction, owing to the great unsupported length and the loads carried.

To meet the requirements for additional space on the bank floors, it was decided to eliminate the loggia, and extend the floors and front wall to the building line in the lower stories. The red granite columns have been replaced with gray granite fluted pilasters built into the new wall and fitted to the original capitals. The entrance to the building is now less significant architecturally, consisting simply of rectangular doorways opening upon the sidewalk.

The most interesting work was in regard to the change in the treatment of the columns. In the construction of the building the exterior steel columns in this side were erected to the height of the loggia, and then each was inclosed in a series of red granite rings slipped over the column and built up to form a pillar. These rings were 35 in. high, 4 ft. 9 in. to 5 ft. 4 in. exterior diameter, varying with the entasis of the pillar. The thickness was 5 to 8 in., the pillar being placed eccentrically to the inclosed column.

These pillars gave considerable trouble, as noted in *Engineering News*, March 11, 1915. They did not take a good polish, and an attempt was made to repolish them in place with a machine rigged up so as to slide vertically and also travel around the column. This apparatus was only used experimentally. More trouble developed after a winter's exposure, several of the granite rings being split. This was considered due to excess of moisture in the granite shell and the concrete packing.



ALTERING THE STREET-FRONT COLUMNS OF A CHICAGO 21-STORY OFFICE BUILDING

The old granite rings, now being removed, split soon after they were placed

The specifications called for each drum or ring to be filled with concrete as it was set, before setting the next drum. Owing to delay in delivery of the granite and to the fact that the beds of the drums were not in accordance with the specifications, there was considerable delay in the work, and the superstructure for the entire La Salle St. front was held up until the drums could be placed over the steel columns. As a result the drums were all set in place and then concreted instead of being filled separately. Shortly after erection, it was found that some of the drums were not in perfect alignment, and the contractor started to recut and repolish the surfaces. This process kept the drums wet until late in the fall, and consequently the amount of moisture in the stone and the concrete was increased rather than decreased after the erection. Some of the pillars which had not been recut or repolished showed no cracks.

Repair would have been difficult and expensive, as the rings could not be removed without cutting them apart. The adoption of the alterations, however, made it necessary to remove these pillars entirely. For this work a staging was erected over the sidewalk, and an electrically operated stiff-leg derrick was installed. Vertical cuts were made in each ring with pneumatic tools and hand chisels, and the segments were removed by the derrick. The concrete packing was then broken away, exposing the steel columns, so that the new framing could be attached to them. The work was completed by the building of the new exterior wall and the granite columns, the latter being formed by segments on the street side only (the other sides being incased in fireproofing and masonry).

This work is shown in the accompanying view. The column at the right is in its original state. The next one has the rings removed to a point below the staging on which men are at work (inside the canvas screen) cutting away the concrete filling. The middle column has this filling in place to just below the staging. The two columns at the left have been stripped, except for the concrete filling between the flanges. The original front wall is behind these columns. The new wall is between the columns, and in line with the wall above. In the street are piled segments of the granite rings.

The new granite was furnished by the Stanstead Granite Quarries Co., and placed by the Steven & Son Co. The alterations were planned by Graham, Burnham & Co., who were the architects for the building as originally constructed.

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Slides in a Deep Street Cut

The deep cut made at Kansas City, Mo., to extend Main St. from 24th St. to Grand Ave. is at last being used, but only by street cars, after eight years of planning and grading. The cut is 2,400 ft. long, with a maximum depth of about 82 ft. and a bottom width of 90 ft. The magnitude and difficulties of this work, which is known locally as the "Culebra Cut," have been explained by articles in *Engineering News* of Dec. 10, 1914, and Feb. 21, 1916. The great trouble has been the serious and continual caving of the side slopes.

The contractor for the grading brought the street to the established grade and the full 90-ft. width, removing all slides as they occurred during the progress of the work and then removing all remaining ledges that appeared dangerous. His work was finally accepted, May 12, 1915. A sewer with catchbasins, manholes, etc., was then constructed up the center of the street, followed by telephone conduits and a double-track car line, completed in the fall of 1915. Bids were also asked for paving, but none were received, due to the risk involved in estimating the amount of subgrading.

During this time small slides were constantly occurring, and the shale under the rock ledge disintegrated, leaving large overhanging rocks. At about the time the car track was completed, there were several very heavy slides, bending the rails and breaking trolley poles. The car company refused to operate cars through the cut, and the city spent the winter in trying to compel the property owners to make the cut safe and remove the slides. The ordinary legal-notice procedure, which was effective where small amounts of dirt caved onto the sidewalk on other streets, failed of results. The only course left open, if the street was to be improved, was for the city to remove the rock and earth at an estimated cost of $60,000 and test the validity of its action by a court suit to recover from the property owners. It is an established point in Missouri law that a street cannot be graded twice to the same grade and tax bills issued against abutting property for it, but it is also law that a property owner cannot maintain a menace to public safety.

The $60,000 not being available, the city has spent about $1,200 in the past three months, lightly blasting and prying the overhanging ledges down into the cut. The street-railway company removed that which fell between its rails and began the operation of street cars. Only one building has been built on the street since it was graded, which is at the intersection of Main St., Grand Ave. and 27th St. Only two other lots (next to 24th St.) have been graded down. A small rock-crusher plant is located on the east side, and the Park Board is planning to spend a $100,000 bond issue in grading and terracing the 8½ acres of Station Park, which fronts the plaza in front of the new Terminal Station and abuts on Main St. between 24th and 25th St. No other improvements are planned at present.

The cost, to date, for the opening and grading of this exceptional street cut is as follows:

Damages paid to abutting property in a special benefit district on account of cuts made in first grading	$49,117
259,963 cu yd. removed under first contract	193,347
Damages allowed on account of second cut	32,350
Cost of property acquired in widening street from 60 to 90 ft., assessed against a special benefit district	41,265
165,981 cu yd. removed under second contract	178,642
Cost to city for breaking down dangerous ledges	1,200
Total	$495,921

We are informed that the city will probably bring suit to recover the $1,200 from the abutting property owners, and that if successful it will proceed with the removal of the slid dirt in the same manner. The court action is based on the usual notice that is served on property owners or their agents, setting forth that a menace to public safety and obstruction of the street exists and giving a reasonable time to have conditions corrected. The city threatens that otherwise it will do the work and assess the cost against the property.

A change has recently been made by Kansas City in the form of ordinance and proceedings in grading, by which it is expected to avoid not only extreme cases of slipping, like the Main St. cut, but also the minor ones that occur where cuts of more than 5 ft. are made. An easement has previously been condemned on private abutting property in the proceedings for the grading of streets where embankments come, allowing the necessary 1 to 1½ slope to fall on private property. Now an easement, or privilege, is also condemned at the same time, allowing the city the right in grading the banks and including this cost in the cost of grading the street. Several grading cases under these new proceedings have gone through without opposition.

The fact remains that after an expenditure of nearly $500,000 and eight years' time this cut is being used only by a few street cars. If completed and improved, it will be one of the arterial streets between the residence and business sections of the city. Cuts and fills of over 30 ft. are common in Kansas City, and little difficulty has been experienced heretofore with slides, the soil (or soil and rock) standing nearly vertical indefinitely, as shown by numerous pieces on unimproved lots close to the business district. But the Main St. cut is of unusual depth and length and has the disintegrating shale ledge beneath the rock ledges.

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Locomotive Crane for Heavy Concrete-Bridge Work

Massive concrete slabs are being used for the decks of bridges over streets on the Chicago track-elevation work of the Rock Island Lines. They are also replacing, to some extent, the through bridges that were used extensively throughout Chicago in the earlier track-elevation work. To handle these slabs and set them in place, a locomotive crane has proved to be very economical, both in facility of operation and low cost of erecting. A heavy crane of this type, purchased recently by the Rock Island Lines, is shown in the accompanying view. It combines the features found in the heavier type of locomotive wrecking cranes, together with special features that were introduced to adapt it to this particular purpose.

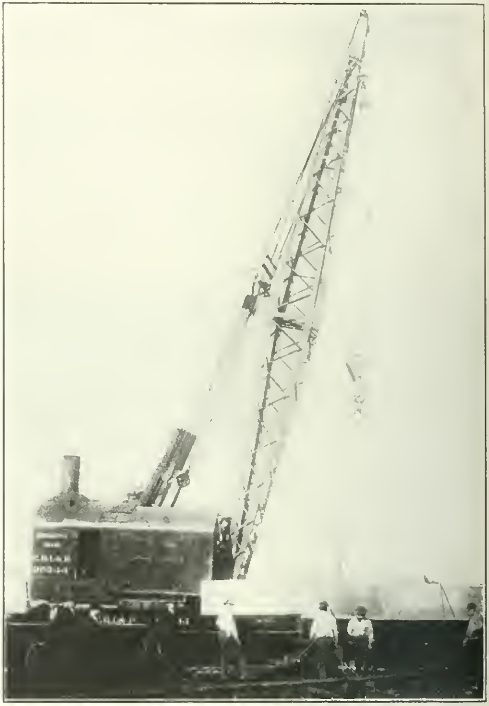
DESIGN OF THE CRANE

The crane is of steel construction throughout, mounted on extra-heavy trucks, similar to those used on the railway's 100-ton wreckers. Heavy outriggers or jacking beams provide excess stability when making side lifts at long reach. The boom is of the box-lattice type, with a bolted splice at the middle, so that the normal 50-ft. length can be increased to 70 ft. by inserting a 20-ft. extension. With the 50-ft. boom the hoisting capacity is about 50 tons at 20-ft. radius, or 13 tons at 50-ft. radius. The heaviest bridge slabs weigh about 50 tons.

Provision is made for attaching piledriver leads at the head of the boom, with a strut running from the foot of the leads to the base of the boom. This permits the machine to be adapted for piledriving on short notice and without the use of guys. The machine is also arranged so that it can operate a grab-bucket for excavating or unloading purposes.

This crane is designed primarily for high-speed erection, the intention being to provide the greatest possible capacity at long radii and to keep the weight of the machine as low as practicable and at the same time enable it to be used on other classes of work when not employed on the track-elevation bridges. To facilitate handling, air-operated clutches are provided, as well as a slewing motion of the selective type, having a slow speed for heavy loads and a fast speed for lighter loads. As much of the work of the crane is with light loads, this feature is of particular value. In addition to the boom hoist motion, there are four independent hoisting lines—the main hoist, auxiliary hoist and two winch heads. All these can be used for either hoisting or holding loads.

The machine is equipped with an electric turbo-generator with a capacity for running two 100-watt lights on the end of the boom and two 60-watt lights part way out on the boom, with sufficient provision for lights in the cab for the benefit of the operator. There are also two plugs on the outside of the cab, to which can be attached a flexible cord for operating a 1,000-cp. flood light on a tripod, in order to permit the machine to work to advantage during the evening or night hours. An equalizer on the topping lift distributes any strains on the boom cables that raise and lower it. The machine is self-propelling and is so designed as to be used economically on construction and erection work.



LOCOMOTIVE CRANE SETTING CONCRETE BRIDGE SLABS; ROCK ISLAND LINES

The work on which this machine is used is under the direction of Robert H. Ford, Engineer of Track Elevation, Rock Island Lines. The crane was built by the Industrial Works, Bay City, Mich.

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Artificial Gas made and sold in the United States in 1915 amounted to 266 billion cu.ft., according to statistics collected by the U. S. Geological Survey. The total value was $174,000,000. These figures represent an increase of 25% in quantity and 17% in value compared with 1912, the last preceding year for which statistics of this industry were collected. Of the total output, 13% was coal gas, 17% carbureted water gas and 13% oil gas.

Roof Slabs of 10-Ft. Span

A roof covering composed of gypsum T-beam slabs 10 ft. long, having a clear span of 9 ft. 8 in., is a feature of a steel-frame building 190x200 ft. recently erected for the Walker Manufacturing Co. at Racine, Wis. These long slabs have been designed as the outcome of numerous tests made at the University of Illinois by Willis A. Slater.

The slabs are of T-section, 15 in. wide and 8 in. deep, with a thickness of 1¼ in. for the top, or flange, and 2¼ in. for the rib. The ends are closed by diaphragms 15 in. wide and 2 in. thick. Each beam has two ⅜-in. rods in the bottom of the rib, one of these being bent up at the ends as a shear rod and looped so as to increase the value of the bond stress. In the top flange is embedded a steel-wire mat of No. 14 gage and 4-in. mesh. The weight is 16 to 17 lb. per sq.ft. The joints are plastered on the outer surface.

These beams were made at the site, in wood forms, at the rate of about 300 sq.ft. per hr. They only required 15 min. to set, from the time the mold was poured until the forms were knocked down. These beams were erected in place and walked upon within three hours after being poured. They were designed (upon the same principles as reinforced concrete) to carry a uniformly distributed live-load of 50 lb. per sq.ft. with a safety factor of 4. Tests of five sample beams 24 hr. old were made with loads of 2,200 and 2,400 lb., or 200 to 218 lb. per sq. ft., with respective deflections of 0.034 and 0.070 in. The total loads were then increased to 3,500 lb., causing slight horizontal shear cracks to appear, but without other signs of failure.

ROOF OF GYPSUM SLABS 10 FT. LONG ON STEEL FRAMING

In the roof construction these slabs, or beams, are carried by light steel trusses for the saw-tooth portions and by steel purlins, etc., for the flat portions, all of the supporting steel being spaced 10 ft. c. to c. In general the flat roof portion has a pitch of 1½ in 12, while the saw-tooth construction pitches about 7½ in 12. The architect for the building was P. L. Batty, Chief Engineer of the Arnold Co., consulting engineers, Chicago. The Arnold Construction Co. had the contract. The slabs were made under the direction of the United States Gypsum Co., of Chicago.

When a flat ceiling effect is desired, instead of the ribbed, or beam, ceiling formed by these T-beams, the slabs may be of H-section, with the top and bottom flanges of equal width. These weigh from 22 to 24 lb. per sq.ft. for the live-load noted above. In such a roof now being erected the beams weigh 22 lb. per sq.ft.

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Power Loss in Screw Propellers Due to Rough Surface

In a paper read at the recent annual meeting of the Society of Naval Architects and Marine Engineers, Naval Constructor William McEntee, U. S. N., described a test made at the model basin of the Washington navy yard to determine the effect of the rough surface of a propeller on its efficiency.

These experiments indicate the great saving in power resulting where ship propellers are made of some noncorrodible metal like bronze and are carefully machined and polished, as compared with the ordinary practice of using propeller castings as they come from the foundry. It is likely that these experiments teach a valuable lesson, also, to the designers and builders of centrifugal pumps. The skin friction of a rapidly moving impeller in a centrifugal pump must be very great, especially in pumps working at high heads; and it seems all but certain that this skin friction must be greatly increased if the impeller is a rought casting.

The screw propellers used on naval vessels are customarily carefully finished by machining the rear surface of the blade to a true helicoidal surface and finishing by hand the front face so that it will be perfectly smooth. The propellers of merchant vessels, however, usually have blades of cast iron or cast steel and are given no finish whatever, except trimming off the rough places with a chisel or rough file. In addition, as is well known, iron and steel propellers often suffer by pitting, so that they present an extremely rough surface to the water.

In order to test the relative efficiency of a smooth finished propeller and a propeller left with the rough surfaces of the original casting, four 16-in. diameter propellers were made and tested at a uniform speed of 5 knots. Two of the propellers were of bronze, one of cast iron and one of cast steel. One of the bronze propellers was finished perfectly smooth; the other propellers were left as they came from the molds, with only the ordinary cleaning. The test showed that the propellers with a rough surface had a maximum efficiency of about 63%, whereas the polished propeller had an efficiency of about 72%.

In order to test the effect on propeller efficiency of a still rougher surface, such as exists on a propeller that becomes badly pitted or on which barnacles and other sea growths accumulate, the bronze propeller that had been polished was varnished, and to the sticky varnish there was applied a layer of granulated cork, such as is used for cork paint in ship work. The same tests were repeated with the propeller surface thus artificially roughened, and the maximum efficiency of the propeller, which had been about 72% in its polished condition, was reduced to 36%.

Engineering Literature

Dr. Waddell Makes Notable Addition to Bridge Books

An Illuminating Review by Gustav Lindenthal*

BRIDGE ENGINEERING—By J. A. L. Waddell, M. Am. Soc. C. E., Senior Partner of Waddell & Son, Consulting Engineers, Kansas City, Mo. In Two Volumes. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. lxxv + 2,177; profusely illustrated. $10.

The latest addition to the literature of bridge construction is a work in two volumes by Dr. J. A. L. Waddell under the title "Bridge Engineering." In his preface the author describes the work as an expansion of his pocket-book "De Pontibus," first published about 18 years ago and followed five years later by a second, somewhat enlarged, edition. The new work is estimated by the author to contain about seven times as much matter and 30 times as many illustrations as "De Pontibus." Each of the two new volumes contains over 1,000 pages. The author states that the expense of getting out the book was $22,000 and that it contains the results of his 40 years of professional experience; the book is thus somewhat biographical in character.

The particular value of the work is derived from the fact that it comes from a practicing bridge engineer of wide experience and established high reputation. We all know how rare it is that a busy engineer can spare the time, effort and expense to incorporate his valuable practical knowledge in book form for the instruction and benefit of other engineers.

The scope of the work may be judged from the number of chapters. There are, in the two volumes, not less than 80 chapters, many of them being voluminous essays on their particular subjects.

The author does not profess to go to any extent into the theory of stresses in steel structures; instead he refers his readers to the standard works on bridges. In the long chapter on reinforced-concrete bridges (XXXVII), on the other hand, there is presented, along with well-known theories on beams, a method of computation of reinforced-concrete arches with fixed ends. Parenthetically it may be observed that most theorizing on concrete design pretends to greater refinement and accuracy of stresses than it seems reasonable to use with the coarse and variable character of the material as it occurs in practice.

New Book on Bridge Engineering Justified

The usual questions about a new book are: (1) Does it contain new matter not found elsewhere? (2) Does it contain old matter, but treated more extensively? In this case both questions can be answered in the affirmative.

Some chapters comprise subjects not treated, or not as completely treated, in any previous works on bridges. For instance, Chapter I deals with the Evolution of Bridge Engineering, from the origin of bridge building to the present time, ending with a prognostication of future development. Chapter II is on the Bridge Specialist, with a definition of his duties and the necessity of retaining him. There are also chapters on Determination of Waterways; Requirements of the United States Government for Bridging Navigable Waters; Hydrographic Surveys; Expedients in Design and Construction; Office Practice; Triangulation, Erection and Falsework; Examination of Bridges; Bridge Failures and Their Lessons. There is a valuable chapter on True Economy in Design and one on Determination of Layouts. Then there is a chapter on Specifications in General and another on Contract Forms; one on Arbitration for Settling Disputes; one on the Promotion of Bridge Projects; and one on Business Features of Bridge Engineering. Engineers will derive satisfaction from a chapter on Fees, and for those who desire to practice what is preached there is a chapter on the Ethics of Bridge Engineering.

Of old and well-known subjects brought together and more extensively treated by the author, mostly from his own viewpoint, may be mentioned the chapters on Alloy Steels, Dead- and Live-Loads, Impact Loads, First Principles of Designing, Shop Work, Elevated Railroads, Cantilever Bridges, etc. A large number of tables taken from the author's office practice are included. There are also several chapters on Foundations, Piers, etc.

The two volumes comprise a vast amount of material brought together for practical information. At the end of the second volume is a comprehensive glossary of technical terms as they occur in bridge engineering, and a rather too scanty index. The book would have been more convenient for reference if a complete table of contents and index had been given in each volume so that any particular subject could more easily be found.

Its use for reference would have been facilitated also by subdividing the chapters into numbered articles or paragraphs with their particular titles printed in heavier type. These headings might also be placed at the top of the page instead of the senseless repetition of the general title of the book on every other page. This is a defect of makeup which is quite general in technical books and for which the printers are largely to blame. In the present work there are whole chapters without a single subhead, so that the finding of any desired subject is made unnecessarily troublesome and time-consuming. This is further aggravated by the manner of reference to articles published elsewhere, by number of volume of periodical or journal instead of by date of publication, a sort of pedantry found also in the transactions and journals of engineering and other scientific societies.

The book is profusely illustrated, but the selection of the subjects is not always fortunate. Some of the line drawings are rather elementary, and many of the views are of little value. A few more good typical detail drawings, representative of best modern practice, would have been more instructive.

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*Consulting Engineer, 68 William St., New York City.

The book is too large to have its character and scope adequately discussed in any brief review. It appears to be valuable and authoritative only in so far as it deals with the engineering of bridges of ordinary span and type, that have already become more or less standardized. When the author ventures outside of this field into the domain of long-span and indeterminate structures, his insufficiency of knowledge and experience are betrayed (pp. 217, 272, 474, 482, 586, 594, 621, etc.), and his lack of grasp of the big questions in this field becomes evident. This may sound like harsh criticism, but it appears justified in view of some of the author's pretentious but erroneous judgments on higher-class structures.

Prejudices and Mannerisms

In this work, as well as in its forerunner, "De Pontibus," the author's attitude toward the general question of using indeterminate structures is one of unfounded prejudice, which may find too readily believers among novices in bridge engineering. He goes too far when he presumes to represent in this respect the best opinion of American bridge engineers. There may have been some justification for the avoidance of such structures in the early days before the theories for their design had been developed, but in the present day of advanced structural theory the prejudice has no justification. The greater amount of labor in the computations cannot be admitted as an objection in large and costly structures, when there is a gain in stiffness and economy, as well as in æsthetics. The legitimacy of these types denounced by the author should be considered past discussion among bridge engineers.

On certain other peculiarities of the work, the author himself touches in his preface, as when he mentions the characteristically personal style of his writing. He explains this by stating that "the book is intended to be, in a certain sense, a record of the author's life work, prepared after a ripe experience"; and he trusts that it will win the recognition of his fellow engineers, so they may find him worthy of that famous Colorado epitaph: "He done his level damnedest; no angel could do no more." The reader can hardly escape the impression that, true to this aim, the author tries his level best throughout both volumes not to hide his light under a bushel and to always first inform the reader of his own personal preferences and opinions (which, it is evident, he considers, though others may not, of leading importance) on the thousand and one questions that occur in the designing, laying out, contracting, fabrication, erection and maintenance of bridge structures.

While the breezy and often gossipy narrative form of presentation in many places may have merit for attracting the attention of inexperienced readers to an otherwise dry subject, it can hardly be recommended for imitation, as it swells the bulk of the reading matter far beyond what is necessary to give the really essential and valuable information.

It would have been more fortunate and in better taste, had the author omitted the bestowing of various degrees of eminence, excellence, notableness, leadership, etc., upon engineers, most of them still living. This glorification does not appear consistent with some of the criticisms that the author passes in other parts of the book upon the methods and work of the same engineers, although then they are not named. The text is also marred by an affected, though innocuous, punctiliousness in attaching to names inconsequential titles, as Esquire, C. E., member of, etc., as if marking some for social or professional distinction while others, not less distinguished, go without it.

Along with these mannerisms, the style lacks uniformity. Some chapters are examples of restrained and concise reasoning on a high plane, while others are written in an assertive and self-complacent jargon quite unusual in scientific literature. The difference in style and presentation is probably explained by the fact that parts of the book were prepared by different assistants, to whose helpful labor the author gives proper credit in the preface. It may also explain the lack of balance and proportion between the fullness of treatment of different topics in the book.

A considerable amount of trivial matter could have been omitted without detriment to the work. Thus (p. 1385), the author explains in elaborate detail the use of an erasing shield for making changes on drawings; this seems out of place in a book on bridge engineering.

Busy engineers, as a rule, prefer specific data and information in more condensed and matter-of-fact form in order that it may be more convenient for reference when a number of authorities have to be consulted. The judgment and views of other experienced engineers will probably not always agree with those of the author, as he himself anticipates. His reference to some bridge structures, designed by engineers not less able than the author, as hybrid, archaic or unscientific, betrays, perhaps unwittingly, an assumption of superiority for which there is no apparent warrant.

A Book of High Intrinsic Merit

These peculiarities of the so-called personal style are mentioned merely to indicate the undesirableness of vanities in engineering literature; it is done in the kindest spirit and with high personal regard for the author. Nor should the foregoing remarks be taken as deprecating the high intrinsic merit of the book as a whole, for it must be acknowledged to be an important contribution to bridge-engineering literature.

Among the special features of the work is the chapter on Alloy Steels, particularly nickel steel, for bridge construction. On this subject, of great interest to bridge engineers, the author has had special opportunities of investigation, although he has not had an opportunity to build a structure of any alloy steel himself. The author's paper on Alloy Steels, contributed to the International Engineering Congress at San Francisco in 1915, is here incorporated with additional information since collected. The intimation in one place that nickel steel was used in bridges only after his experiments had been made is not quite correct. Nickel steel was used in the Queensboro Bridge before the author's experiments with nickel steel were made known.

The suggestion, that alloy steels, if cheap enough, should also be used for short and for ordinary lengths of span, can hardly be indorsed. The greater unit stresses, which go with alloy steels, produce greater deflections and vibrations, hence less rigid and poorer structures, than with the usual structural steel. Alloy steels are justified only for long and heavy spans, and then only when not more expensive than those of structural steel. It is a good rule to follow, that of several designs of equal strength that bridge is the best which has the largest bulk and weight for the same money. A bridge of structural steel at the same cost as of alloy steel is thus preferable, because stiffer and promising greater durability.

In Chapter VI, on Live-Loads, the author's computation of live-loads for railroad bridges is carried up to the E70 loading, which he considers as closely approaching the practicable limit for locomotives. He also mentions that in a recent design this limit has already been considerably exceeded, going up to the E90 limit for locomotives, but with the lower impact and higher unit stresses allowed, this loading is not more severe than an E60 loading with the usual impact and unit stresses. Heavy coal cars that, when fully loaded, exceed 7,000 lb. per lin.ft. and have axle loads of 64,000 lb. will, however, soon come into use on one of the eastern trunk lines.

American Impact Practice

In Chapter VII, on Impact, the author gives the history of the American practice and the various empirical formulas, including his own, used for railway spans of ordinary length with the usual open tie floor; also the modifications for highway bridges. He cites the few but as yet inconclusive experiments on bridge impact so far made. Professor Robinson's theory of maximum impact based on the coincidence of impulse from unbalanced drivers at certain speeds with period of vibration is elaborated. Formulas that take account of the important minimizing effect of dead-load upon impact, such as have been used in important heavy structures like the Beaver Bridge over the Ohio River or in the Hell Gate Bridge over the East River, or as contained in the bridge specifications of the Pennsylvania R.R., are not mentioned. Lindenthal's formula on bridge impact, which he deduced from observed facts and which is applicable alike to steel and masonry bridges of any length of span up to the longest, is not given. The author mentions Lindenthal's article on that formula in *Engineering News* of Aug. 1, 1912, but in his comments uses a quotation which, separated from its context, is entirely misleading.

The method of providing for impact by halving for live-load the unit stresses for dead-load is mentioned in another chapter (on Intensities of Working Stresses) and there properly condemned as an irrational practice, notwithstanding its continued use by some bridge engineers.

The subject of secondary stresses is very fully explained. In the chapter on Intensities of Working Stresses the author convincingly discusses the great and unnecessary variety of unit stresses obtaining in American practice.

Two of the best chapters are those on First Principles of Designing (XV) and Detailing (XVI). These are very comprehensive, including with well-known elementary matter the more refined newer methods of detailing.

Especially good also are the chapters on Floors and Floor Systems, Laterals, Sway-Bracing, Plate-Girder and Rolled I-Beam Bridges, Trestles, Viaducts and Elevated Railroads, Erection and Falsework.

The chapter on Deflections includes a lucid account of the Williot-Mohr graphical method of determining truss deflections.

The chapter on Simple Truss Bridges treats of the various kinds and forms of trusses, and the finesse of their design and detailing is fully elaborated. Yet the author's reasoning on the economy or wastefulness of certain truss types is not always convincing, nor supported by facts as judged by other practitioners. Too much is made of trivial economies of metal between one type and another and of the danger from secondary stresses on mere theoretical grounds. Multiple-intersection trusses and the small-mesh lattice trusses are not as bad as painted by the author. The slight ambiguity in the web stresses and the secondary stresses at the intersection of the web members are of little practical importance when compared with the advantage of dividing up large web stresses among a greater number of web members, which at their intersections are connected and strongly bracing each other. Mere theoretical prejudice is keeping this rigid and cheaply manufactured type from more frequent use in riveted heavier and longer span trusses. The fact cannot be gainsaid that they have proved themselves very durable, and many of them over 40 years old are safely carrying loads twice as large as those for which they were designed. The author admits that very few bridges of the small-mesh riveted type have collapsed when derailed cars ran into end posts or into the middle of the web, as the theoretically immaculate truss with single web system invariably does.

Years ago it was the fashion to laud the virtues of the American pin-connected type as against the riveted European type. An engineer not falling in with the procession was tabooed. Nevertheless, the general wabbliness of the pin-connected truss bridge has led to its gradual abandonment even on longer spans. On the other hand, it needs to be pointed out that the American eye-bar and pin connections are eminently fitted for use in heavy structures of the lenticular and parabolic types, which are condemned without any good reason by the author.

For heavy or long spans crossing over railroad tracks or steamboat channels, where it would be a great advantage to have the bottom chord high above the floor as a protection against the corroding smoke underneath, the lenticular type is specially well suited. In this type the floor system is independent of the trusses and is not affected by the stresses in the bottom chord. Moreover, the wind truss in the plane of the floor can be provided with independent chords, and it can have a much greater width than the distance between the trusses, which offers an important advantage in long spans. The lenticular truss is one of the most accessible forms for painting and maintenance, and its supposed higher cost over the standard form of truss with curved top chord is a mere myth. The above is mentioned merely to illustrate how opinions of bridge designers on the merit of different plans may legitimately differ, and to emphasize the fact that dogmatic views are out of place.

Cantilever Bridges

In the chapter on Cantilever Bridges the subject is very extensively discussed, with numerous tables intended to be helpful in the laying out of designs. The author assumes, correctly, that this type is commendable only for long spans. Different forms of cantilever bridges are discussed and their merits and demerits analyzed from the author's point of view, which is not free from some of the prejudices held by less informed engineers.

It is a narrow view which holds that the great Forth Bridge could have been better designed with pin connections and by American engineers. They had the chance at the Quebec Bridge, and what a mess they made of it! The gigantic structure in Scotland was built without a precedent to go by, and it was completed without a collapse or catastrophe such as marked the Quebec project. The Forth Bridge was required by the authorities to be dimensioned for the enormous wind pressure of 56 lb. per sq.ft., nearly double that assumed in American practice, and this added greatly to its weight. The structure is very rigid under trains at 60 mi. per hr., and considering the given abnormal conditions of dimensioning, erection and fabrication, it is a fine example of economic design with well-worked out details. A personal inspection of the bridge is convincing to any engineer who can appreciate the difficult problems in a long-span bridge of this type, that these problems had been skillfully solved.

As regards rules for length of suspended span, which the author discusses extensively, a variation of conditions not always in the control of the engineer will give different results from those advised by the author.

The great defect of cantilever bridges, unless heavy and of very long span, is their jerky vibration, especially disagreeable under highway traffic. This can be largely obviated by leaving out the suspended span and providing for a middle hinge. Such arrangement will prevent the vibrations from becoming cumulative, as is proved by the freedom from vibration of the Mirabeau Bridge in Paris (which is a shallow arch cantilever) and of the Queensboro Bridge (also named the Blackwell's Island Bridge) over the East River in New York, bungled as it is by gross errors and changes during construction.

Both types are statically determinate for dead-load and require no extra metal for erection stresses. The stresses from live-load, which are smaller than those from dead-load, are the only ones that require computations based upon the laws of elasticity of the metal. The methods for these have been so perfected, as already mentioned, that the same degree of accuracy can be obtained by careful designers as in the statically determinate types. Only the labor of computation is greater, but that labor is what the engineer and computer are for. To make the work easier for himself is a poor reason for an engineer to advocate and choose a shaky type for a bridge.

THE QUEENSBORO BRIDGE

The author indulges in certain witticisms on the Queensboro Bridge, but these are equally applicable to numerous other bridges. There are few structures, even of those designed by the author, about which some amusing things could not be written, but such do not furnish instruction to engineers.

The selection of the type for the Queensboro Bridge was thoroughly justified on structural and æsthetic grounds, which will be recognized by advanced designers when they know the reasons for the selection.

Several erroneous impressions about this structure have found currency among engineers and are incorporated in the author's book, which need correction. The type selected has nothing to do with the present weakness of the bridge, as the author asserts. That would have happened with any type whatever. The trouble was brought about by a change of city administration and a consequent change in the engineering direction of the work. That structure is a monument to the vicious system of frequent political changes in the administration of our public works. In this system engineers are as often abettors as victims.

In the case of the Queensboro Bridge the plans for the superstructure were changed after the contract had been let. The reasons and the manner of that change will not bear daylight. Not only were errors committed in dimensioning through irresponsible changes, but the detailing of the trusses and bracing is clumsy, as though designed by blacksmiths rather than engineers. The author's effort to ascribe the bungling and bad work in that bridge to the omission of suspended spans (p. 586), and his echoing of extravagant statements of the waste of millions of money in sole consequence thereof, are not creditable to his perspicacity. His credulity could not have been imposed upon to that extent, if he had a better acquaintance with designs of the statically indeterminate order for long spans.

LACK OF CORRECT INFORMATION

The author's neglect to get correct information is further shown by this criticism of ties to carry the web forces to the top of the tower posts (p. 591) instead of using inclined end posts for carrying them directly to bearings on the piers. The distance between the truss planes is less than the distance between the tower bearings on the piers. The existing tower posts spread out to the bearings and are outside the planes of the trusses, as any visitor to the bridge can see. Inclined end posts in the plane of the trusses would therefore have rested on the masonry arch between tower bearings, a dangerous arrangement. For that reason the web forces are carried through inclined ties to the tops of the towers.

Moreover, the expedient left, on each side of the tower post, room for passageways from the roadway to wagon elevators to be placed in stone towers to be attached to both ends of the island piers and forming an important part of the stone architecture of these piers. These elevator towers were also contracted for and work thereon commenced. But the contract for them was canceled by a stupid, if not corrupt, administration, so that Blackwell's Island is left to this day without the urgently needed connection with the bridge.

The chapter on Arch Bridges is not so full as that on Cantilever Bridges, and it is evident that the author flounders here in deep water. He brings forth some very curious statements. On p. 621, for example, the author, admitting his total lack of experience in this field of design, nevertheless asserts, without any foundation and "upon general principles only," his belief and confidence that hingeless arches are less economical than the three-hinged type. He

> feels quite confident that if he should ever figure one, he would find that a proper provision for excessive temperature stresses, possible large indeterminate stresses, unusual detailing, heavy anchor bolts and an inherent sense of fitness in proportioning sections would so increase the weight of metal as to absorb all of the theoretical economy over the three-hinged arch involved by the average direct stresses as shown on the stress sheets. Were it not for the immense amount of labor required and for the lack of time at his disposal for the finishing of the manuscript of this book, the author would settle this question finally by making several complete detailed designs and computing the resulting total weights of metal. A correct comparison could be obtained in no other way—moreover, it would have to be made by an expert bridge designer, who would know how to care properly for all the unusual stresses and conditions.

The author really seems to believe that the engineering profession is waiting for him to acquaint himself with the theory of these types, so that he may do the "figuring" and show up the ignorance of all previous investigators in this field! It would be difficult to find in engineering literature a parallel to this; it may be entertaining, but it certainly is not instructive.

The chapter on Suspension Bridges, with which the author confessedly has had less experience than with other types, is still shorter than that on Arch Bridges. It would have been worth while, however, to point out the existence in this country of very satisfactory examples of rigid suspension bridges aside from the heavy structures of long span over the East River. Among these are the stiffened chain bridges in St. Louis and (Point Bridge) Pittsburgh, the stiffened wire-cable bridges over the Ohio River at East Liverpool, Ohio, and at Parkersburg, W. Va., and the Cincinnati Suspension Bridge (although this latter is not a good type), all carrying heavy electric cars. The Ohio suspension bridges, of about 700- to 800-ft. span, are much stiffer and also much cheaper than equivalent cantilever bridges.

These and other examples of stiffened suspension bridges prove that the author's statement (p. 569) that "compared with a suspension bridge, a cantilever bridge is rigidity itself" is not based on fact, and that a rigid suspension bridge of rational design can very well compete with the cantilever system for length of span much below 1,600 ft., the limit which theoreticians on insufficient data have assigned. This applies to railroad as well as to highway bridges.

SAFETY OF SUSPENSION BRIDGES

The absolute greater safety and dependableness of the suspension type may be recognized from the example of the old Brooklyn Suspension Bridge. This bridge, as is well known, has very inadequate stiffening, yet is remarkably free from noticeable vibration. It is notoriously overloaded every day (that is, the moving loads on it are much greater, sometimes by 100%, than anticipated in the original plans), yet the bridge is safe and stiff under a traffic that is denser than on any other existing bridge. It is like a basket; it cannot collapse. A cantilever bridge from the same overloading would be highly unsafe. The failure of a single overstressed truss member would bring the structure down, as in the Quebec Bridge. These qualities are not disclosed by strain sheets; a rational comparison of the two types cannot be made that way.

For the longest feasible bridge spans all engineers have now long agreed that the suspension type is the only practicable one. But such bridges will be very few, and for their best design the engineer will need more searching studies than the author's book can afford.

The subject of Movable, Swinging and Bascule Bridges is fully treated in a descriptive manner. A more detailed treatment of the subject is promised to come later from Mr. Harrington, Mr. Waddell's former partner.

The chapters on Riveted vs. Pin-Connected Trusses, on Camber, on Protection of Metal Work against Rusting, will be found by the reader to be full of useful instruction.

The chapter on Reinforced-Concrete Bridges sets forth the precautions and methods to be observed with this brittle and variable material, for which, however, any calculations based upon elastic properties should always be made with a large margin of safety.

Welcome information to most railroad engineers will be the sections on the United States Laws for Bridges over Navigable Waters, the rules governing applications to the War Department for permission to bridge navigable waters, the preparation of drawings to submit to the authorities, etc.

Chapter LII treats of Aesthetics in Design, a subject which the author seems to have particularly at heart. But one cannot say that his taste will always be shared by other designers. *De gustibus non est disputandum.*

This is illustrated (p. 1178) in the author's plans for two bridges over the Danube at Budapest, submitted in an international competition for prizes in 1894, in which architectural merit was to be determining.

The Hungarian engineers, than whom more cultured ones are rarely met, must have wondered not a little that anybody could seriously propose trusses of the ordinary stock design with curved top chords stretched out to spans of over 1,000 ft. as works of art and as fit neighbors to Tierney Clarke's famous chain suspension bridge of classic beauty. Many readers will marvel also at the strange-looking ornaments planted at the ends of the spans in the author's designs, and their wonder will grow when they read his complacent statement that he publishes these views to show his conception of the proper artistic design of bridge approaches.

The author's criticism on the architecture of the Tower Bridge in London, with a quotation from the writings of H. Heathcote Stratham, is not shared by educated architects. To many, the ensemble and articulation of the structure appear striking and picturesque and in harmony with the historic surroundings and background of the old tower group architecture, though some of the details may be objectionable.

The author's repeated reference to æsthetic appearances based on nothing more than curves in the top or bottom chords will appear to others rather naïve. This chapter on architecture is well meant as an earnest plea to bridge engineers to show themselves in their work as cultured men. The author, however, in undertaking to furnish instruction and guidance to seekers of the æsthetic in bridge construction, has set himself a task that is evidently beyond his scope. For any bridge structure requiring architectural consideration the bridge engineer will do well to consult a competent architect; and experience has shown that not every architect is competent here.

The next two chapters, on Economy in Design and Determination of Layouts, very ably discuss the conditions of true expertness in designing. The following chapter, on Weights of Steel Superstructures, is among the best in the book. A very instructive and useful chapter is the one on Business Features of Bridge Engineering. The sage advice given therein by the author is well worth heeding.

As already stated, it is impossible in a mere review to more than hint at the contents, peculiarities and merit of the two volumes on "Bridge Engineering" produced by Dr. Waddell. Notwithstanding the idiosyncrasies that it has seemed needful and proper to point out, too much credit and praise cannot be given the author for his assiduous labor of many years, which the preparation and compilation of the immense amount of material for his book involved. Financial profit there will be none, rather a loss, as is well known to engineers who have tried to write books at their own expense. The compensation to the author will be the satisfaction of having contributed his share to the progress of bridge engineering, and a most valuable share it is, for which the grateful appreciation of his fellow engineers is due him.

Railway Passenger Terminals

PASSENGER TERMINALS AND TRAINS—By John A Droege, General Superintendent, New York, New Haven & Hartford R.R. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. v + 410; 220 illustrations. $5.

A book on the principles and practice involved in the design and operation of railway passenger terminals has long been needed, and Mr. Droege's work is a valuable addition to railway and engineering literature. It is comprehensive and systematic in scope, covering the design or planning of terminal layouts, the design of station buildings, the facilities requisite for train and station service, and the operation of trains and general station traffic. It shows clearly the need of active coöperation between different departments and officials in order to secure results satisfactory to the railways and the public.

The book opens with a review of the high degree of service rendered in the passenger traffic of American railways as compared with those of other countries. It points out also that this results in the very undesirable condition that passenger traffic as a whole is not profitable to our railways.

As to the terminal stations themselves, the too-frequent unsatisfactory architectural design is noted, and interesting comparison is made between the very large area of waiting-room space provided in American stations and the relatively small area in European stations. Thus while two modern American stations provide 25,000 and 33,000 sq.ft. for this purpose, one of the largest stations in London (handling much greater traffic than either of the others mentioned) provides only 3,000 sq.ft.

It could be wished that the details of individual terminals had been treated somewhat more critically (instead of being mainly descriptive). One real omission is that there is no general discussion of the principles and requirements in station planning, although different phases of the subject are dealt with in regard to individual stations. Nor is there any reference to the methods and diagrams employed in determining the traffic capacity of terminals. This matter has been discussed somewhat fully in reports of the yards and terminals committee of the American Railway Engineering Association.

The consideration of terminal layouts includes through or side stations, stub or headhouse stations, waterfront terminals, and the passenger terminals of New York, while one chapter deals with trains and terminals of foreign countries. Approaches, interlocking and electrification are dealt with, from both the engineering and operating points of view. The chapter on small stations is interesting, though a little foreign to the main subject of the book, and incidentally it discusses the different methods of operating trains and locating way stations on four-track lines.

Platforms and trainsheds are important features. The old style of long-span arched trainshed is obsolete, preference being given to the Bush type of low multiple-span trainshed or to individual platform shelters. No reference is made, however, to the trainshed design in which the columns are placed between the tracks instead of upon the platforms, the latter practice being almost universal. It is singular that the author classes the platform shelter as a type of trainshed, though the two are essentially different.

Station design must include adequate facilities in the way of waiting, rest, dining and lunch rooms, ticket and baggage offices, hospital and immigrant rooms, and the numerous conveniences required to meet the conditions of modern service. Some of the various other subjects covered are the illumination of platforms and stations, the use of stairs and inclines, handling mail by belt conveyors and baggage by small motor trucks and inclined elevators, the removal of snow in terminal yards, the provision of train bulletin boards and announcers, and the methods of communicating between the dispatcher (or signal tower) and the crews of trains in the station.

Subjects of particular interest to the operating official are trackage and terminal agreements, passenger terminal operation and train operation, the station master, the ticket office and baggage room, car cleaning, and timetables and train schedules. Supplementary matters dealt with include accidents, the commissary department, and statistics of passenger service. The numerous illustrations include terminal plans and a variety of halftone engravings.

Written by a man of long experience in railway service, this book is of distinct and practical value to the engineer, the architect, the operating official and the student of railway affairs and problems. The engineer finds grouped here matters relating to the general layout and design of terminals. The architect will find numerous points of importance in regard to the interior plan and facilities of the buildings, points which none but a "railway man" would think of or suggest. For the operating official there is a wealth of information on matters important in general and in detail. A notable feature of the book is the interesting and readable style in which it is written. It is a worthy companion to the author's earlier book on "Freight Terminals and Trains."

Bitumen Analyses and Tests

REVIEWED BY J. E. MYERS*

LABORATORY MANUAL OF BITUMINOUS MATERIALS—For the Use of Students in Highway Engineering—By Prévost Hubbard, Assoc., Am. Soc. C. E.; Chemical Engineer; Chief, Division of Road Material Tests and Research, Office of Public Roads and Rural Engineering, United States Department of Agriculture. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xi + 153; 7 tables and 39 illustrations. $1.50 net.

The author states that this manual is intended "as a laboratory guide for students of highway engineering and not as a treatise on methods of analyses and tests of bituminous materials," also that the manual deals with "the interpretation of results of tests" and with "the identification, suitability for specific purposes and control of uniformity of materials tested."

The subject matter is divided into three parts: (1) Description of materials; (2) tests and methods; (3) application or results.

The description of the materials in Part I is so arranged as to place briefly before the student a working knowledge of the subject. Five general group headings are given: (1) "Fluid Petroleum Products and Emulsions"; (2) "Semi-Solid and Solid Petroleum and Asphalt Products"; (3) "Refined Tars and Tar Pitches"; (4) "Creosoting Oils"; (5) "Bituminous Aggregates." Under these headings may be grouped all bituminous road materials in common use.

In addition to the general group headings there is a detailed classification of the crude bituminous materials based on the source of the material. Following this classification is a brief description of the refining processes used to produce road materials from the crude bitumens. By arranging these refined products according to their use for surface treatment or for incorporation in the pavement structure, together with a brief description of the desirable characteristics of these materials and their method of application, the author covers the subject of bituminous materials and their place in road construction in a clear and concise manner.

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*Chemist, New York Highway Commission, Albany, N. Y.

In Part II is a description of those tests which have been adopted as standard, together with other tests which are in common use but have not as yet been accepted as standard. The author gives a detailed description of the methods of performing the tests and a brief explanation of the results or value of the test.

Since the book is written with the primary object of being a laboratory manual, it would seem that the author could well have devoted more space to detail in the description or manipulation of a number of the tests described. For instance, in the distillation test, the student is instructed to pour 100 c.c. into the distillation flask. This quantity must be measured exactly, since the results are to be reported by volume as well as by weight. The exact volume measurement of a given quantity of a viscous liquid presents a considerable problem for a student beginning the study of bitumens.

The author has also neglected to harmonize detail in a number of the methods described. In the distillation test already mentioned, two methods are given—the generally accepted method for the distillation of tars; and the method usually followed in the distillation of creosote oils. In the description of the apparatus to be employed the student is instructed to use a carbon-dioxide-filled thermometer in one case and a nitrogen-filled thermometer in the other.

The author has illustrated the practical value of testing bituminous road materials in Part III by giving the ordinary tests made on those materials which are in common use together with typical results obtained from these tests. These results are explained or interpreted, and the characteristics of the material as indicated by the tests are discussed with reference to the use of the material in road building.

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Pocket-Book for Engineers

HANDBOOK OF FORMULAS AND TABLES FOR ENGINEERS —Compiled by Clarence A. Peirce, Assistant Professor in Power Engineering, with Mathematical Sections by Walter B. Carver, Assistant Professor of Mathematics, Cornell University. Second edition, revised and enlarged. New York: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. xii 188; illustrated $1.50 net.

The first edition of this handy little compendium of mathematical notes and tables was favorably noticed on p. 264 of *Engineering News*, Feb. 11, 1915. In the present edition a small amount of material has been added, consisting mainly of a paragraph on the laws of exponents, the formulas of hydraulics, tables of natural logarithms and hyperbolic functions, a reproduction of the Ellenwood steam chart and a table of steam properties made up from the Marks and Davis tables. The authors point out that it was their original purpose to produce a small book of really convenient pocket size; and that inasmuch as excellent handbooks of larger size are available, they have felt it wise in producing this second edition to adhere to the policy of the first.

Contractors' Cost Keeping

PRACTICAL COST KEEPING FOR CONTRACTORS. A Book Giving a System of Accurate Cost Keeping and the Methods Used for Adapting It to All Classes of Construction Work—By Frank R. Walker, Author of "The Building Estimator's Reference Book." Chicago (30 North Michigan Ave.): The Author. Cloth; 4x7 in.; pp. 273; 159 illustrations. $2.

On different methods of cost keeping there are many opinions, but the practical necessity of keeping a record of costs will not be denied by more than one contractor in a hundred. It is not a simple task to prepare a *useful* book on this subject, because the various kinds of contractors' organizations make any one system inapplicable to more than a limited number of firms. The prime requisite in systems designed for contractors is simplicity. If the system is not simple, it is not workable. Mr. Walker in his book recognizes this principle on page 1 of Chapter 1. This in itself suggests that the book is worth reading by anyone seeking to inform himself on the subject.

The classes of construction considered chapter by chapter are numerous, as they need be, and include such operations as "Driving Piles," "Foundation Work," "Water and Damp Proofing," "Cement and Composition Floors and Base," "Hollow-Tile Fireproofing," "Roofing," "Painting and Varnishing" and the various classes of interior fitting.

The forms required to keep labor costs in Mr. Walker's system and those for recording material costs are given in separate chapters. The daily construction report is explained, and illustrations are given of Mr. Walker's conception of what such a report should embrace. In the back part of the book are given samples of estimate sheets, weekly progress reports, order blanks and requests-for-bid cards.

As the author says, while the average building contractor will not find use for all the forms submitted, he is given a fairly wide choice. It should be noted, too, that many contractors, with numerous and varied wants, are required to make up the average contractor, so forms not needed by some will be prized by others.

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Oregon's Water Code Explained

CONTROL, DISTRIBUTION AND USE OF THE WATER RESOURCES OF OREGON. November, 1916: Rules, Regulations, Forms and Practice—Compiled under direction of John H. Lewis, State Engineer, by Percy A. Cupper, Assistant State Engineer. Salem, Ore.: Office of the State Engineer. Paper; 6x9 in.; pp. 70.

The Oregon Water Code, enacted by the State Legislature in 1909 to secure simplicity, directness and economy in recording water rights, both old and new, and in providing administrative machinery for proper distribution of water, has recently been upheld by the United States Supreme Court (as noted at length in *Engineering News*, June 29, 1916). This decision is of the greatest importance to the various states of the Union, as it establishes the legality of such boards of engineers and other experts and makes it possible for these bodies to plan their efforts comprehensively. Therefore this bulletin, giving detailed information about the administration of the Oregon Code, is of importance and interest. It fully describes the principles and procedure of initiating new water rights and of determining old rights. A third part, on distribution of water, describes the organization of water districts under water masters who oversee the taking of appropriated flow, inspect gates, prevent waste and regularly report on their districts' needs and supply. This section of the pamphlet describes the construction and use of trapezoidal weirs. A fourth section reviews court decisions on the Code, and an appendix shows the 27 forms for letters, certificates, notices, etc., mentioned in the body of the bulletin.

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Mason's Water-Supply Revised

WATER-SUPPLY, Considered Principally from a Sanitary Standpoint—By William P. Mason, Professor of Chemistry, Rensselaer Polytechnic Institute; M. Am. Soc. C. E. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. x + 528; illustrated. $3.75 net.

By omission, revision and the addition of uptodate matter Professor Mason has enlarged his "Water-Supply" by 80 pages net. The plan and general character of the book have not been changed. It still deals chiefly with water, its natural fitness for human use and the ways of making unfit water more fit. In addition, there are chapters on per capita water consumption and the action of water on metals. The first edition, published 20 years ago, was noted in *Engineering News* of Oct. 1, 1896, p. 224, and the third edition, July 17, 1902, p. 52.

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More on Activated Sludge

AMERICAN SEWERAGE PRACTICE: Vol. III, Disposal of Sewage—By Leonard Metcalf and Harrison P. Eddy. Second edition, with appendix on Activated Sludge and minor revisions. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 877; 234 illustrations and 190 tables. $6.

The authors of this book are to be congratulated for an opportunity to revise and extend it within a year of first publication. Aside from slight revisions the body of the volume remains unchanged, but the 12-page account of activated sludge in the first edition has now been extended and brought well down through 1916 by an appendix of 25 pages. The first edition was favorably reviewed, as it deserved to be, by John H. Gregory in *Engineering News* of Dec. 16, 1915, p. 1168.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ACCURACY OF STEAM-FLOW DATA—By N. C. Grover and J. C. Hoyt. Washington, D. C.: United States Geological Survey. Water-Supply Paper 400-D. Contributions to the Hydrology of the United States, 1916. Paper; 6x9 in.; pp. 53-59.

ALTERNATING CURRENTS—By Carl Edward Magnusson, M S., Ph. D., E. E., Professor of Electrical Engineering, University of Washington; Fellow, Am. Inst. E. E. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xv + 525; 475 illustrations. $4 net.

THE AMERICAN CITY: An Outline of Its Development and Functions—By Henry C. Wright, First Deputy Commissioner, Department of Public Charities, New York City. New York: A. C. McClurg & Co. Cloth; 4x7 in.; pp. 178. 50c. net.

AMERICAN RAILWAY ENGINEERING ASSOCIATION: Proceedings, 1916 Convention. Chicago, Ill.: The Association. Cloth; 6x9 in.; pp. 1391; illustrated. $5.

ANATOMY OF A STEEL HOPPER-BOTTOM COAL CAR—By George L. Fowler. New York: Norman W. Henley Publishing Co. Broadside; 24x18 in. 25c.

Isometric view and details, with printed list of parts.

CITY RESIDENTIAL LAND DEVELOPMENT: Competitive Plans for Subdividing a Typical Quarter-Section of Land in the Outskirts of Chicago—Edited by Alfred B. Yeomans, Landscape Architect. Chicago, Ill.: University of Chicago Press. Cloth; 9x12 in.; pp. 138; illustrated. $3 net; postage extra; weight, 3 lb.

COST ACCOUNTING AND BURDEN APPLICATION—By Clinton H. Scovell, C. P. A., Assoc. Am. Soc. M. E. New York: D. Appleton & Co. Cloth; 6x8 in.; pp. xiv + 328. $2 net.

THE ELEMENTS OF REFRIGERATION: A Textbook for Students, Engineers and Warehousemen—By Arthur M. Greene, Jr., Professor of Mechanical Engineering, Russell Sage Foundation, Rensselaer Polytechnic Institute. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. vi + 472; 192 illustrations. $4 net.

ENGINEERING CHEMISTRY: A Manual of Qualitative Chemical Analysis for the Use of Students, Chemists and Engineers. By Thomas B. Stillman, M. Sc., Ph. D., Member, American Electro-Chemical Society. Easton, Penn.: Chemical Publishing Co. Cloth; 6x9 in.; pp. viii + 760; 150 illustrations. $5.

ENGINEERING OF POWER PLANTS—By Robert H. Fernald, M. E., A. M., Ph. D., Whitney Professor of Dynamical Engineering, University of Pennsylvania, and George A. Orrok, M. E., Consulting Engineer, New York. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. ix + 586; 309 illustrations. $4 net.

FLOODS IN THE EAST GULF AND SOUTH ATLANTIC STATES, JULY, 1916—By Alfred J. Henry. Reprinted from Monthly Weather Review, August, 1916. Washington, D. C.: United States Department of Agriculture. Paper; 10x12 in.

An abstract of this interesting and valuable report appeared in "Engineering News" for Nov. 9, 1916, p. 886.

FLOW OF WATER UNDER PRESSURE THROUGH CLEAN CLOSED PIPES: Tabulated Data with Explanatory Notes—By George T. Prince, C. E., M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 4x7 in.; pp. v + 149; illustrated. $2.

GENERAL PHYSICS: An Elementary Treatise on Natural Philosophy—By William S. Franklin and Barry MacNutt. New York: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. viii + 604; 479 illustrations. $2.75 net.

GUIDA PRACTICA DEL MECCANICO MODERNO—By A. Massenz. Milano: Ulrico Hoepli, editore. Cloth; 4x6 in.; p. xxiv + 351; 331 illustrations. L. 4.50.

HANDBOOK FOR MACHINE DESIGNERS, SHOPMEN AND DRAFTSMEN—By Frederick A. Halsey, B. M. E., M. Am. Soc. M. E. New York: McGraw-Hill Book Co., Inc. Second edition. Cloth; 9x11 in.; pp. xii + 561; illustrated. $5 net.

HOW OTHER CITIES IN THE UNITED STATES ARE DISPOSING OF THEIR SEWAGE: An Investigation Made for the Cities of Pasadena, South Pasadena and Alhambra, in May and June, 1916—By T. D. Allin, Commissioner of Public Works and R. V. Orbison, City Engineer, Pasadena, Calif. Paper; 6x9 in.; pp. 8.

A LABORATORY COURSE OF PRACTICAL ELECTRICITY, for Vocational Schools and Shop Classes—By Maurice J. Archbold, Instructor in Vocational Electricity, Wendell Phillips High School, Chicago, Ill. New York: The Macmillan Co. Paper; 8x10 in.; pp. ix + 222; illustrated. $1.10.

LUBRICATING ENGINEERS' HANDBOOK: A Reference Book of Data, Tables and General Information for the Use of Lubricating Engineers, Oil Salesmen, Operating Engineers, Mill and Power-Plant Superintendents and Machinery Designers—By John Rome Battle, B. S. in M. E. Philadelphia, Penn.; J. B. Lippincott Co. Cloth; 6x9 in.; pp. 333; 114 illustrations. $4 net.

MEDIATION, INVESTIGATION AND ARBITRATION IN INDUSTRIAL DISPUTES—By George E. Barnett, Ph. D., Professor of Statistics, Johns Hopkins University, and David A. McCabe, Ph. D., Assistant Professor of Economics, Princeton University. New York: D. Appleton Co. Cloth; 5x8 in.; pp. viii + 209. $1.25.

MUNICIPAL ENGINEERING PRACTICE—By A. Prescott Folwell. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. xi + 422; 113 illustrations. $3.50 net.

NATIONAL ELECTRICAL SAFETY CODE: for Examination, Trial and Constructive Criticism. Second edition. Washington, D. C.: Bureau of Standards. Paper; 7x10 in.; pp. 323; illustrated. 40c. per copy from Superintendent of Documents.

NEW YORK STATE COMMISSIONER OF HIGHWAYS: State of New York Report—Albany, N. Y. Cloth; 6x9 in.; pp. 939; illustrations.

RAILWAY TRACK ECONOMICS: A Tabloid Treatise Upon Railroad Problems—By August G. Liebmann, Chicago, Ill.: The Author (7433 Emerald Ave.) Leather; 5x9 in.; pp. 66. $3.

The main purpose of this book is to advocate the use of the European type of chairs for supporting track rails. This is done in a few words at the end of many pages of miscellaneous notes on railway finance, traffic, equipment and track. No description of the proposed construction is given.

SURFACE WATERS OF MASSACHUSETTS—By C. H. Pierce and H. J. Dean. Washington, D. C.: United States Geological Survey. Water-Supply Paper 415. Paper; 6x9 in.; pp. 433; illustrated. 45c. a copy from Superintendent of Documents.

TEMPERA E CEMENTAZIONE DELL' ACCIAIO—By Mario Levi-Malvana. Milano: Ulrico Hoepli, editore. Cloth; 4x6 in.; pp. xii + 261; 66 illustrations. L. 4.

TRANSACTIONS OF THE AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, Vol. 8, 1915—New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. iii + 309; illustrated. $6.

TREATISE ON HYDRAULICS—By Mansfield Merriman, M. Am. Soc. C. E., with the assistance of Thaddeus Merriman, M. Am. Soc. C. E. Tenth edition, revised. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. x + 565; illustrated. $4 net.

WATER PENETRATION IN THE GUMBO SOILS OF THE BELLE FOURCHE RECLAMATION PROJECT—By O. R. Mathews, Assistant, Dry-Land Agriculture Investigations. Washington, D. C.: United States Department of Agriculture. Bulletin No. 447. Paper; 6x9 in.; pp. 12; illustrated. 5c. a copy from Superintendent of Documents.

WATER-SUPPLY COMMISSION OF PENNSYLVANIA: Report for 1915—Harrisburg, Penn. Cloth; 6x10 in.; pp. 403.

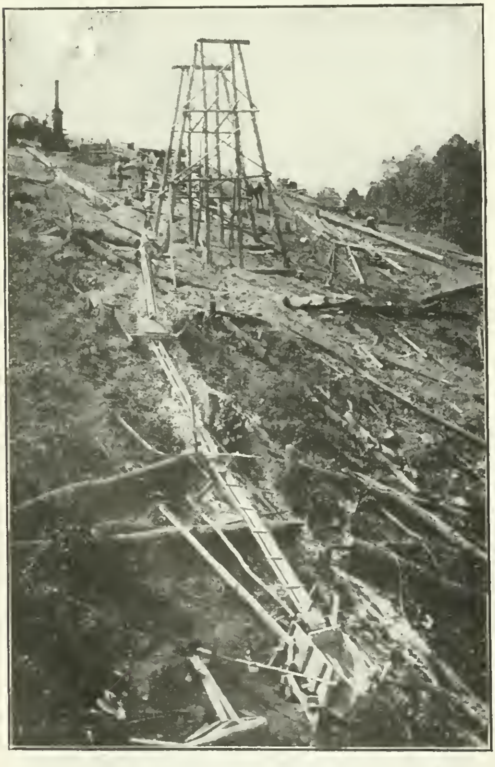
Notes from Field and Office

Steep chuting of concrete—Improvised dump car—Air chamber protects venturi meter from pulsations—Safe grade crossings in California—Steadying the suction pipe—Calculating four-sided areas

Chuting Concrete Down Steep Slopes from Mixer

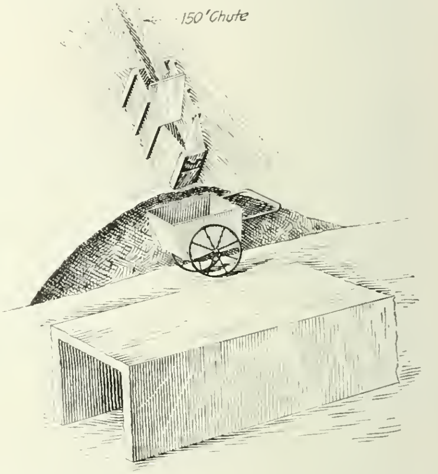
Concreting methods on the bridges and culverts on the 50-mi. Southern Ry. relocation in Georgia and South Carolina vary from hand mixing and placing to placing by elaborate cableways. Two jobs of special interest that differ widely as regards their relative importance but agree in the general method of concrete placing are described herewith. One is a rather small (about 4x4 ft.) culvert about 2 mi. south of Toccoa, Ga.; the other is a double-track concrete bridge consisting of four 80-ft. arches. In both cases Smith mixers discharged into chutes laid down a steep slope.

The chuting arrangement from mixer to receiving hopper at the culvert site is shown in the view and sketch. The chute is about 150 ft. long and its half-dozen sections are strung together down a slope of about 45°. First of all the timber was cleared from the slope, for use in building the filling trestles, of which there are two as shown.



CHUTING ARRANGEMENT FOR BUILDING A SMALL CONCRETE CULVERT

Teams bring the concrete materials to the mixer at the top of the hill. The mixer discharges directly into the chute. Just below the receiving hopper the slope has been cut down by spade and flattened to the culvert forms, so that the concrete can easily be transported to the forms by a buggy, shown in the sketch.



SKETCH SHOWING MIXER CHUTE, RECEIVING HOPPER, BUGGY AND DUMPING TRESTLE

The new line of the railway will cross Coneross Creek in South Carolina on a concrete bridge now building alongside the existing truss bridge. Two concreting plants are employed, one on each side of the stream. The south bank is steep and the mixer is installed on the top, discharging into a chute running into one of the pier-foundation forms.

The other chuting outfit was installed some time later with bins under the old bridge, so that the work train could stop over the bins and discharge directly into them. Under the bins is a platform carrying the mixer, discharging into small cars, which are pushed by hand to the north abutment nearby. There the concrete is delivered into closed chutes.

In the first part of October concreting was starting at Pier 1 on the south side and at the north abutment. Water in the excavations was kept down by a centrifugal pump in the pier pit and pulsometer in the abutment excavation. In excavating, the soil was removed by dump buckets loaded by a gang of a half-dozen men in the pits.

The wood sheetpiling was put down by a piledriver, the lower line of sheeting being driven by maul. The bridge is being built by Hickey Bros., of St. Louis; J. O. Smith is assistant engineer in general charge of the work for the Southern Ry.

⁂

Safe Loads on Rope Slings

By F. W. Salmon*

The attached condensed tables should prove very useful to engineers and contractors, particularly if they will cut them out and paste them in their notebooks.

By holding the diagram up at arms' length with the cut of the slings about in line with a sling in use, the approximate angle of the sling in use can be estimated, and the appropriate column used, to find the probable safe load on new, treated manila-rope 4-part slings.

Of course one will have to exercise judgment as to the present condition of the sling or tackle he may be using, and take a lighter load if the rope is old, worn, cut, or if the conditions of service make it necessary, as for example the damage that might result from an accident, wind, jerks, etc.

In using tackles the strength of the hooks should be considered as well as the rope, remembering that in hoisting, the hook of the upper block must carry the load on the lower block plus the rope pull plus the weight of the tackle; thus with a double and single $\frac{3}{4}$-in. tackle, the maximum load is given as 1,700 lb. on the rope, three parts at the lower single blocks; but the safe load on the hook of a single block (factor of safety 3) is only 1,320 lb. If the load is reduced in that proportion the result will be a pull in the hauling part of $\frac{1{,}320 \times 670}{1{,}770} = 500$ lb. Now 1,320 + 500 + 75 = 1,896 lb. at the hook of the upper double block, which is not materially above the rope load given as 1,800 lb. Of course moving the hooks will somewhat increase their safe capacity.

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*326 North 20th St., Birmingham, Ala.

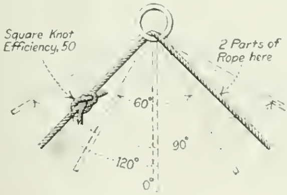
⁂

Range Finder and Clinometer

Maj. C. R. Young, of the Canadian School of Infantry, Toronto, Ont., has devised a simple instrument for roughly determining distances. It is based on the conclusion that it is easier to judge the size of familiar objects on the landscape than to judge their distance from the eye. With a little practice, it is claimed, an observer can make very close estimates of such dimensions as heights of buildings to the eaves, heights of common trees, telephone and telegraph poles, etc., while the heights of many things such as doors, cars, fences, horses and men are matters of common knowledge; and from these the ranges or distances are easily determined.

The instrument has been used successfully on military reconnoissance surveys and field sketching. The designer and Maj. H. H. Madill made extensive use of it in the plotting of a new 4-in. = 1 mi. maneuver map of Camp Borden. Apparently, it could be used with equal advantage in any reconnoissance survey work. The unit used on the instrument illustrated is the yard, but the same scales can be used for feet or inches if desired.

The accompanying illustration shows the instrument, which consists of a heavy, opaque piece of white celluloid 3x6 in. A small cord is attached to the card at C, on the left-hand border of the diagram. The length of the



Working Loads on new Manila Rope Looped Slings, Knotted, Gentle Lifting

Rope Diameter Inches	Angle of Sling Opening 0	60	90	120
	Load in Lb. Avoird			
½	1,350	1,160	943	675
⅝	2,100	1,800	1,470	1,050
¾	3,040	2,610	2,125	1,520
⅞	4,120	3,540	2,880	2,060
1	5,400	4,630	3,780	2,700
1⅛	6,830	5,870	4,770	3,420
1¼	8,450	7,250	5,900	4,230

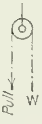
A short splice sling will carry 50% more

Sharp bends (such as the edge of a box) will reduce the safe load.

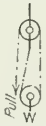
The table is for new rope of good quality not chaffed, worn, cut or in any way injured, dry, carrying the load on 4 parts, all parts free to divide the load equally, made up with a square knot.

Strength of a rope with a knot in it to the strength of the body of new rope in % by careful tests made

Kind of Knot	%
Eye spliced over an iron thimble	90
Short splice	80
Timber hitch Round turn Half hitch	65
Bowline loop Slip knot Clove hitch	60
Square knot Weavers knot Sheet bend	50
Flemish loop Overhand knot	45



A



B

MANILA ROPE HOISTING TACKLE

Maximum loads for use in erecting under careful supervision, new dry rope, at slow speed, with commercially perfect blocks fair lead to all ropes, no chafing

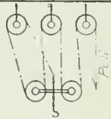


FIG. E

Diam. of manila rope	In.		½	⅝	¾	⅞	1	1⅛	1¼
Max. pull lb. on hauling part			296	402	670	900	1,185	1,490	1,850
Fig.			Lb. lifted by tackle with above rope pull = W						
A	Number of parts	1	272	370	615	828	1,080	1,370	1,700
B	of rope at the	2	553	752	1,250	1,680	2,210	2,790	3,460
C	lower or moving	3	750	1,020	1,700	2,280	3,000	3,780	4,700
D	block	4	955	1,300	2,170	2,910	3,840	4,820	5,980
E		5	1,130	1,535	2,560	3,440	4,530	5,700	7,070
Breaking load on 1 rope, lb.			1,775	2,770	4,000	5,440	7,100	8,930	11,100
Safe load on hook at ⅓ breaking load of steel hook	Single block		738	990	1,320	1,800	2,125	4,570	5,430
	Double block		990	1,325	1,800	2,125	3,120	5,350	6,240
	Triple block		1,325	1,800	2,125	3,120	4,570	6,240	6,780
Size of block shell, inches			4	5	6	7	8	9	10

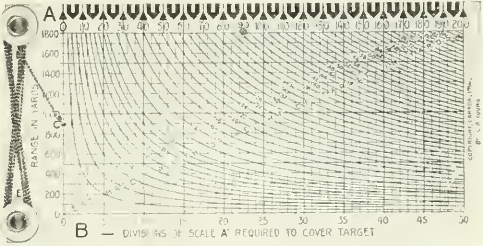
A 150-lb. man should be able to apply 75-lb. pull on rope at slow speed

DATA FOR DETERMINING SAFE LOADS ON HOISTING TACKLE cord is five times the length of the scale A at the top of the card (about 25 in.) The rest of the card is nothing more nor less than a stadia diagram.

The end of the cord is held close to the eye, and the card is held at the other end of it in a perpendicular plane. The width or height of the target or object sighted at is read on scale *A*. Reading up from the same division on scale *B*, at the lower edge, to the curve of the corresponding reading, gives the distance or range to the nearest 100 yd., or feet, as the case may be, on the scale at the left.

If the reading on scale *A* exceeds the number of divisions shown on scale *B*, it is necessary to divide the reading by such a number as will give a quotient not greater than the maximum number of divisions on scale *B*. The range then found must be divided by the same number by which the scale *A* reading was divided.

The device may, of course, be used to estimate the dimension of a target or object at a known distance, and by putting the cord through the center hole in the top scale and attaching a weight or plumb bob it can be used as a clinometer. For this purpose the reverse side of the card carries a scale of angular divisions. The reverse side of the card also has directions for using the instrument and a table of dimensions of common objects.



RANGE-FINDING DIAGRAM, WHICH CAN BE USED IN TAKING TOPOGRAPHY

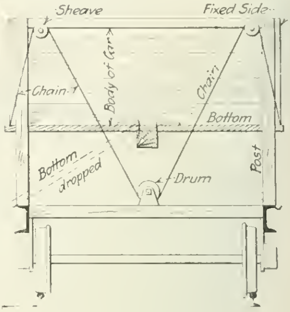
The device is copyrighted in Canada and may be obtained by engineers in the United States from Maj. C. R. Young, 98 Hilton Ave., Toronto, Ont., for 50c., postpaid.

Improvised Dump-Car

To handle the material from the foundation wells or caissons of the new Fox River bridge of the Chicago, Burlington & Quincy R.R. at Aurora, Ill., a special dump-car was rigged up on the work. As shown, it runs on a standard-gage track on a temporary filling trestle, and in loading position it stands under a hopper. The excavated material is hoisted in small buckets and emptied into skips; when these are full, they are raised and swung over the loading hopper by a derrick.

The car body is 6½x5 ft. and 30 in. deep, with a capacity of about 3 cu.yd. It is mounted on a frame of steel channels, with two axles and 18-in. wheels. The floor is set high and consists of two sections or leaves hinged along the center line and held up by chains attached to the outer side and wound upon a drum. To dump, the drum is released, and the floor sections fall to an inclined position, allowing the contents to slide off on both sides. The drum is then operated with a ratchet bar to wind up the cables and raise the floor sections to a horizontal position.

In operation the car forms part of an endless hauling system. A cable attached to one end is led direct to the drum of a hoisting engine; another cable leads from this engine to a snatchblock on a deadman at the end of the trestle, and back to the car. When full, the car is hauled out on the trestle, being ridden by a man who trips and closes the floor. The work is under the direction of W. Pringle, Assistant Engineer, Chicago, Burlington & Quincy R.R. The car was devised and built by R. E. Sheehan, foreman of the work on the bridge, which is being built by the railway company's forces.

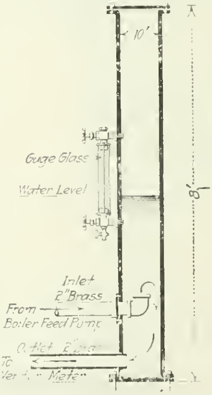


IMPROVISED DROP-BOTTOM DUMP CAR

Air Chamber Protects Venturi Meter from Pulsations

By A. O. Doane*

The accuracy of venturi meters is unfavorably affected by pulsations in the fluid passing through the meter tube. This trouble is easily remedied by placing an air chamber of proper design between the source of the pulsations and the meter tube. At the Chestnut Hill pumping station of the Metropolitan Water-Works of Massachusetts the feed water for one battery of boilers is pumped by a single-acting feed pump, the plunger of which is 2½ in. in diameter and is attached to the crosshead of the pumping engine which has a 60-in. stroke. At full speed the pumping engine makes 24 r.p.m. A small air chamber was connected to the pump, but this did not prevent very violent variations of pressure in the boiler-feed pipe line. This condition was very unfavorable for the satisfactory operation of a venturi meter, which it was desired to install.



AIR CHAMBER FOR VENTURI METER

A special air chamber, designed in the engineering department and constructed by the pumping-station employees, proved entirely successful in reducing the pulsations, so that the accuracy of the meter is not affected. It is of course necessary to keep the water level in the chamber at the point that gives the best results, and this is found to be about 4 ft. below the top.

The venturi meter is 2 in. in diameter with a ¾-in. throat, and the average registration for 24 hr. is about 28,800 gal.

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*Division Engineer, Metropolitan Water-Works, 1 Ashburton Place, Boston.

The air chamber is made of a piece of 10-in. flanged cast-iron pipe. The inlet- and outlet-pipe connections inside of the chamber were so arranged that the water could not take a short and direct course between them. It is thought that this feature has considerable effect, as it prevents pulsations from being carried through by a straight flow of water. The chamber is located about 6 ft. from the meter tube and about 165 ft. from the feed pump. It was found by experiment that the most satisfactory results were obtained when the chamber was located near the meter instead of at the pump end of the feed line.

Before the special air chamber was installed, the surges and shocks in the feed line were very severe. After it was put in operation, it was found that the life of the plunger packings was prolonged and the strain on pipes and pump greatly reduced.

⁂

Safe Grade Crossings

Six plans for making grade crossings safe have been sent out by the Railroad Commission of California to the larger railroads and to the larger cities and counties having a considerable mileage of improved roads, requesting that the plans be criticized and given a trial. Three of the schemes are shown herewith. Fig. 1 is based on a sketch submitted by the division engineer's office, Coast Division, Southern Pacific Co. Fig. 2, submitted by Scott W. Alexander, Long Beach, Calif., is of the same general type as Fig. 1, but provides no barrier requiring slower speed. Fig. 3, submitted by Charles R. Blake, commissioner of health, Richmond, Calif., involves a double right-angle turn in order to cross the tracks, depending upon this to slow down the automobile and to put caution in the driver's mind.

Another method, not illustrated in this article, was devised by J. H. Weatherford, city engineer, Memphis, Tenn., and depends for its effectiveness upon a soft or retarding pavement or surface for a short distance on each side of the tracks. Another design was submitted by William M. Humans, Los Angeles, and covers acute-angle roadways, railroad rights-of-way with or without parallel roadways, dangerous junctions of auto highways without car tracks, etc. The sixth plan, by F. E. Peters, Tropico, Calif., involves an elliptical park in the center of the street on each side of the track, much as shown in Fig. 2, but without the warning signs.

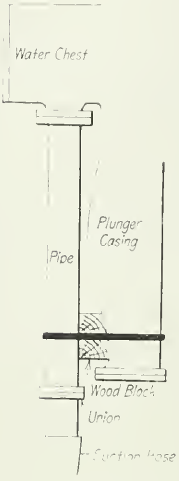
Plans similar to some of these approved by California are in use at the present time in other states. To be effective, the highway approach to the tracks must be laid out to *necessitate* a slowing-down of the automobile—a mere warning is inadequate.

⁂

Steadying the Suction Pipe*

By J. F. K. Brown†

The device illustrated herewith is for use on sinking pumps, and though it may be quite contrary to common practice, I have found it useful on a number of troublous occasions. It is given here for the benefit of others having the same trouble. In sinking it has always been my custom to use a length of pipe at the suction which will reach just below the bottom of the pump, and to attach the hose at this point with a union. This has been done because there is little room between the body of the pump and the pipe in which to place a union and to take off and put on the hose. It is easier doing it just below the pump. When this pipe was first used it caused trouble by frequently breaking off where it entered the pump, because of being knocked against the sides of the shaft in raising or lowering. To obviate this a piece of wood is now inserted as shown in the drawing. This has the effect of making this piece of pipe solid with the pump throughout its entire length. Breakage of this pipe is now infrequent.



THE STEADY BLOCK IN PLACE

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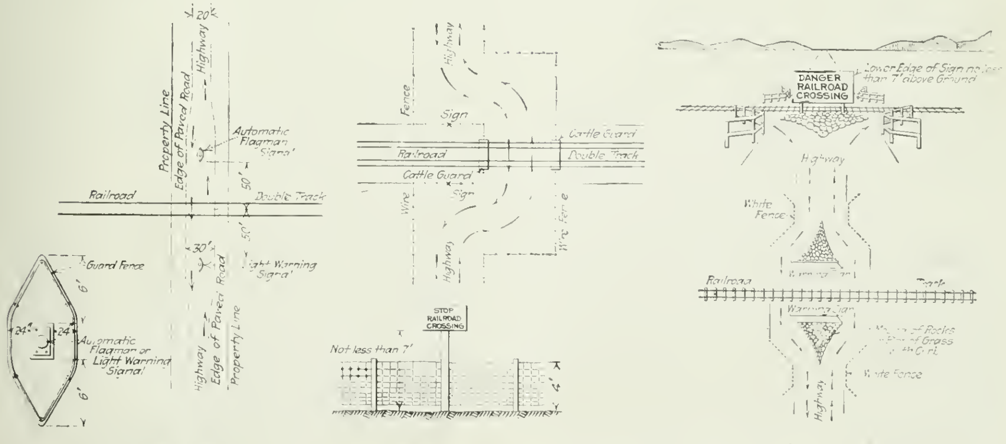
*From "Coal Age," Dec. 9

†Sydney, N. S.



LAYOUTS AIMING AT SAFE GRADE CROSSINGS, COMPILED BY CALIFORNIA RAILROAD COMMISSION

Short Method of Calculating Four-Sided Areas

By C. K. Averill*

The area of a three- or four-sided figure when the traverse has been closed may be calculated without any D. M. D. column or other preparation by the following method:

Course	Length	N	S	E	W	Lat × Dep
N 8° 10′ 20″ E	101 20	100 17		14 38		1,440 44
S 86° 20′ 10″ E.	50 0		3 20	49 90		159 69
S 8° 12′ 00″ W	100 0		98 98		14 26	1,411 45
N 87° 41′ 56″ W	50 06	2 01			50 02	100 54
		102 18	102 18	64 28	64 28	3,112 12

102 18 × 64 28 = 6,568.13
3,112.12 ÷ 2 = 1,556 06

Area = 5,012 07

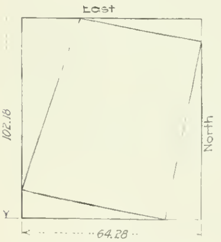
The latitude and departure of each course are multiplied together and the products placed in the column headed "Lat. × Dep." One-half the total of these products subtracted from the product of the sum of latitudes and sum of the departures will be the area.

By the usual method this calculation would be as follows:

Course	Distance	N	S	E	W	D M D	N	S
N 8° 10′ 20″ E..	101 20	100 17		14 38		14 38	1,440 44	
S 86° 20′ 10″ E	50 0		3 20	49 90		78 66		2511.71
S 8° 12′ 06″ W	100 0		98 98		14 26	114 30		11,313.41
N 87° 41′ 56″ W	50 0	2 01			50 02	50 02	100 54	
		102 18	102 18	64 28	64 28		1,540 98	11,565.12

11,565.12 — 1,540 98 = 10,024 14
10,024 14 ÷ 2 = 5·012 07

By reference to the accompanying sketch: The area of the inclosing rectangle is the product of the sum of latitudes and sum of departures. From this are to be deducted the areas of four triangles each of which is one-half the product of the latitude and the departure of a course. A triangular figure can be calculated by this method, but not one or more than four sides. The method is somewhat shorter than the double meridian distance method, as no columns have to be prepared and the multiplications can be started as soon as the traverse is closed. It is also a convenient check in connection with that method. It is plain that it makes no difference with which course the traverse is started, which is another advantage over the double meridian distance method.

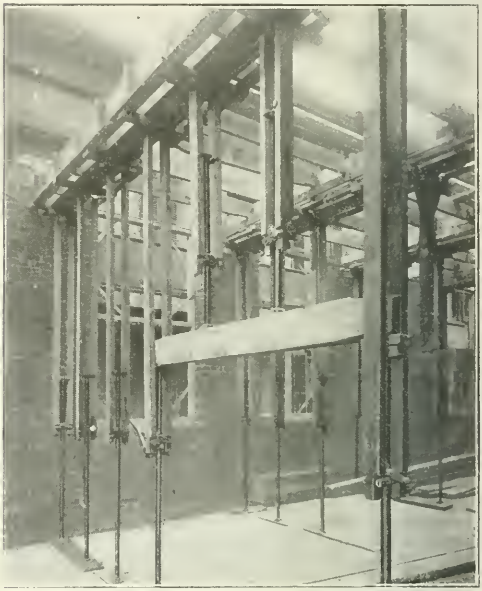


AREA TO BE COMPUTED BY NEW METHOD

FINE AGGREGATE

Inspecting Elevated Track by Periscope is used on the Queens elevated lines in peaceful New York City. The apparatus consists of a small hand mirror fastened to a stick about 3 ft. long and is stated by the "Public Service Record" to be "invaluable for inspecting and counting the hook bolts, lagscrews and all other track material located under the ties." The men engaged on this work are said to have nicknamed the device a "periscope." The original idea has been improved upon by cutting the handle about 3 in. from the mirror and jointing it with a thumbscrew in such a way that the mirror may be set at any desired angle.

Adjustable Building Shores are becoming very popular in reinforced-concrete work, several different types having been devised by various concrete specialists. The ones in the accompanying view are after a design patented by H. W. Roos, of Cincinnati, Ohio, and are used in the work of his company in that city. The shore consists of two legs of 2x4's to which are attached a pair of clamping yokes, which engage a piece of standard 1¼-in. pipe. The pipe is held by a head guide at the top and a base at the bottom. The operation consists merely in picking up the upper member and raising it to the required height. By pressing the two legs of the 2x4's together, the clamping yokes engage the pipe and the load supports itself. A portable jacking device is used to make the final adjustments, and a locking device on the yokes prevents the shores from slipping while lattice bracing is being nailed on or while the shore is telescoped for removal to other locations. A novel use of the shores, which is shown in the view, is the ease with which a lane may be left through a building under construction. The design permits the placing of the cross-beam on which foot the shores carrying the forms across the opening.



SPECIAL SHORES PERMIT SERVICE ALLEYWAY IN CINCINNATI BUILDING

Chords for Railroad Curves Measured on Arcs—The accompanying tables of chords for use in laying out curves based on an arc length of 100 ft. per degree of curvature, instead of the usual 100-ft. chord, are sent by W. C. West, Highway Engineer, Bureau of Public Works, Manila, P. I. In each case D is taken as the central angle subtended by an arc of 100 ft.

USING ONE CHORD OF ABOUT 100 FT.

$$\text{Chord} = \frac{360 \sin \frac{1}{2}D}{\pi D^\circ} \times \text{arc}$$

D	Chord	D	Chord
0°	100.00	16°	99.68
1	100.00	17°	99.63
2°	100.00	18°	99.59
3	99.99	19°	99.54
4°	99.98	20°	99.49
5	99.97	21°	99.44
6°	99.95	22°	99.39
7°	99.94	23°	99.33
8	99.92	24°	99.27
9°	99.90	25°	99.21
10°	99.87	26°	99 14
11	99.85	27°	99.08
12°	99.82	28°	99.01
13°	99.78	29	98 94
14°	99.75	30°	98.86
15°	99 72	..	....

USING TWO CHORDS OF ABOUT 50 FT. EACH

$$\text{Chord} = \frac{720 \sin \frac{1}{4}D}{\pi D^\circ} \times \text{arc}$$

D	Chord	D	Chord
0°	50.00	32°	49.84
2°	50.00	34°	49.82
4	50.00	36°	49.80
6°	50.00	38°	49.77
8°	49.99	40°	49.74
10	49 98	42°	49.72
12°	49.98	44°	49.70
14°	49.97	46°	49.67
16°	49.96	48°	49.64
18°	49.95	50°	49.60
20°	49.94	52°	49.57
22°	49.92	54°	49.54
24	49.90	56°	49.50
26°	49.89	58	49.47
28°	49.88	60°	49.43
30°	49.86	..	....

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*Yonkers, N. Y.

Editorials

Prize Announcement Postponed

The editors of *Engineering News* have been unable to complete the examination of the articles submitted in competition for the prizes offered in the issue of Oct. 26, in time to announce the award in this issue. The names of the prize winners will be published next week and the paper receiving prizes, with other meritorious papers, will be published in the following issues.

◆

A Bill To Suppress Publications of National Circulation

Since the United States first became a nation, the task that has engaged the best efforts of its ablest statesmen has been the development among its people of the spirit of national unity in place of the spirit of sectionalism.

Half a century ago, the nation's very life was threatened by the spirit of sectionalism, and four years of civil war were fought to save the Union. The history of other nations as well as that of the United States shows the vast importance of cultivating, by every means possible, common thoughts and ideals in the people of a nation.

Probably no other influence has been so potent during the half-century since the Civil War in tearing down sectional barriers and eliminating prejudices and misunderstandings between North and South and East and West as the circulation of national publications. Who can overestimate the value to the nation in the past fifty years of the circulation of such national journals as *Harper's,* the *Century,* the *Nation,* the *North American Review* and a hundred others in developing among a wide circle of readers, the country over, similar ideals and standards?

It is not often realized that the development of these publications of nation-wide scope has been made possible by the law, enacted since the Civil War, which fixed a uniform postal rate for the whole United States on all printed matter.

A bill has just been introduced in Congress as a "rider" on the Post Office Appropriation Bill, which proposes to tax national journals out of existence by placing upon all publications a postal rate based on the distance of transmission, as follows:

Up to 300 mi	1c. per lb.	1,000 to 1,400 mi	4c. per lb.
300 to 600 mi	2c. per lb.	1,400 to 1,800 mi	5c. per lb.
600 to 1,000 mi	3c per lb.	Over 1,800 mi	6c. per lb.

That this tax, if imposed, will greatly restrict the circulation of truly national journals, there is not the slightest doubt. The daily newspapers will be hardly touched. A large part of their circulation is distributed otherwise than through the mails, and few have any considerable circulation farther than 300 mi. from the place of publication. The journals that will be seriously affected are those which know no sectional distinctions or boundaries—the very journals whose circulation should be encouraged by every statesman who understands the great importance of national unity.

A great influence has been exerted on the national development during the past half-century by the journals devoted to literature, to science and the arts, to the professions and the industries. Doubtless the Congressmen who framed this bill have no conception of what it will mean to substitute journals of a sectional character in place of the national journals that have been so important a feature of American public life.

It is only in the journals of national circulation that one can expect to find public questions discussed from the broad point of view of the nation's interests, without regard to the interests of any particular locality. Surely, this is too important a matter to be lightly passed over. Surely, the unity of the nation is something which those in authority at Washington may not lightly dismiss.

The second-class postage question has often been discussed as if the only publications affected were the so-called trade journals, but they really cut only a small figure in the whole. To bring the matter home to engineers, the change proposed in second-class postage rate will mean a very heavy tax on the circulation of the "Proceedings" of the various national engineering societies. This is only typical of what will take place in all professions. Take the medical profession, for example. How important it is in the public interest that the physicians of the country shall be informed upon the latest advances in medical science as reported in the medical journals. The country doctor living west of the Mississippi River may find it too great a burden to pay an extra bill of perhaps ten dollars a year for postage on the medical journals to which he subscribes.

It is not only the men in the professions who will be affected. The change reaches all classes of society. The labor movement, for example, relies on national journals to reach men scattered in all parts of the country. There are many religious publications that have a nation-wide circulation. The Government is spending many millions of dollars to promote education of the farmers of the country toward better and more productive agriculture. What will this tax mean in cutting down the distribution of the best agricultural publications?

It may be said that the Government should charge sufficient postage on the publications to pay the cost of their transmission through the mails regardless of their value as a means of public education. Even on this basis, the proposed zone system of rates for second-class matter cannot be defended.

The Congressmen who framed this act doubtless imagine that the variation of the postage rates with the distances which they have schemed out corresponds in some measure to the cost to the Government of transmitting the mails. But every engineer familiar with modern transportation methods knows that under present-day conditions the great element in the cost of carriage *is not the hauling over the road, but the terminal expense.* This is true of ordinary merchandise, such as hardware, groceries and dry goods. Much more is it true of mail matter.

where the post-office employees must handle each individual piece and read its address perhaps half a dozen times in the course of its journey from sender to receiver. Take, for example, a journal mailed in New York to a subscriber in San Francisco. It is placed by the publisher in a mail bag, a car is loaded to its full capacity with hundreds of bags of such mail and started from New York on its journey across the continent. It costs no more to haul that pound of mail matter across the continent than it would cost to haul a pound of meat, or fish, or coffee, or oranges, or any other item of freight shipped on a fast schedule.

It would often involve greater expense to the Post Office Department to carry a copy of the same journal to some country town within a hundred miles' distance, where it had to be handled over three or four different lines of railway and finally carried over a rural free-delivery route.

All questions as to the relative cost of the service, however, are truly insignificant compared with the proposition to place a ban on the circulation of national journals. Surely, the lessons of the European War ought not to be wholly lost on us. In Germany, in Great Britain, in France, the uppermost question is national unity. What would be thought in any of these nations of a serious proposal to stop the circulation of journals of national scope? More than at any previous time in its history does the United States need to foster in every way the development of a national spirit among its people. Every influence that tends to preserve this national spirit must be fostered at any cost.

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Bridge Engineering Discussed by Masters of the Art

This issue of *Engineering News* is made notable by the publication in the Engineering Literature section of a remarkable review of a remarkable book. The book is the recently published treatise on "Bridge Engineering," by J. A. L. Waddell, which is doubtless the most complete and elaborate work in this field of engineering ever issued. It is notable, not only for its size and completeness, but because its author stands in the foremost rank of American bridge engineers. When a book is written by one of the masters in an art, the difficulty arises of finding someone to prepare a critical review of his work who will be, at least, a peer of the author in reputation, so that he may be qualified to pass judgment upon the work and so that his criticism may carry weight with the reader.

Engineering News believes that it has rendered a notable service to the profession in securing the consent of Gustav Lindenthal, the Nestor of American bridge engineers, to review Mr. Waddell's great work. Every bridge engineer in the United States will wish to read, and read with care, Mr. Lindenthal's critical review in this issue. As will be seen, it far transcends in length the space of an ordinary book review; and it is, in fact, very much more than a book review. It is a discussion, by one of the most eminent of living authorities, of certain principles of bridge design set forth in Mr. Waddell's treatise.

While Mr. Lindenthal speaks in highly commendatory terms of Mr. Waddell's monumental work as a whole, he also sets forth very frankly a number of important matters on which he disagrees with Mr. Waddell as to the essentials of sound practice in bridge design.

Without doubt, Mr. Waddell's book is destined for many years to come to rank as an authority in its field. It is of great value, therefore, to have a critical study made of its recommendations, so that the engineer may know in what parts of the book there is a disagreement among doctors as to the soundness of the principles which are there stated.

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Ship Canals To Aid the Navy in National Defense

There is general agreement apparently, that the United States can well afford to spend a vast sum of money in developing its navy as a means of national defense. Public attention has chiefly been directed toward the increase of the navy by the construction of additional vessels; but naval officers who are experts in strategy agree that the equipment of the navy with docks and shore stations properly located is just as important for efficient work in national defense as is the building of fighting ships.

A high official of the navy recently declared that an additional large dry dock for the navy, suitably located, would contribute more toward national security than an additional battleship.

At the recent annual meeting of the Society of Naval Architects and Marine Engineers a striking paper was read by Capt. A. C. Niblack, reviewing the elementary principles of naval strategy which should govern the United States in the development of shore stations and bases for its naval operations, but which neither the public nor Congress at all understands. By creating a naval base in Culebra Island just east of Porto Rico, Captain Niblack declared, as much could be accomplished for national defense as by the purchase of St. Thomas.

On the Atlantic Coast, Captain Niblack urged the importance of thorough protection for the main base, New York City, as follows:

> New York as the assumed center and Boston and Philadelphia on the periphery of the circle inclosing the main industrial area of the United States form the true strategical center. The instant we deepen the Cape Cod and the Delaware and Raritan Canals into ship canals and clear the East River of all obstructions from the Battery to Long Island Sound and adequately fortify Block Island, Vineyard Sound, Buzzards Bay and the Cape Cod Bay region, with exits at Delaware Bay, Sandy Hook, Block Island and Massachusetts Bay, the entire British navy as it exists today could not blockade our own navy as it is.

Captain Niblack further urged that, to protect the national capital and the important naval base at Norfolk, the entrance to Chesapeake Bay should be adequately defended, as well as the entrance to Delaware Bay, and the Delaware & Chesapeake Canal should be made a ship canal.

The average citizen and even the average engineer has little understanding of the problems of naval strategy, but it is easy even for a layman to comprehend the advantage of this long interior line of communication for a fleet acting on the defensive against a superior fleet operating outside.

As many readers of *Engineering News* will recall, complete surveys were made some years ago by the army engineers for a ship canal across New Jersey, extending from Raritan Bay to the Delaware River. A most favorable route was found for a sea-level canal that would offer a minimum of interference to existing railway lines, while nearly all the material could be removed at low cost by modern machinery for earth excavation. With the completion of this channel and the comparatively short ship canal between the Chesapeake and Delaware Bays, it would be possible for vessels of all classes to traverse the entire distance from Buzzards Bay to Norfolk without exposure to the risks of the open ocean. This extension of the territory available for barge navigation would add greatly to the value of the New York barge canal across New York State, soon to be ready for traffic.

Future Sources of Liquid-Fuel Supply

Investigations by the United States Geological Survey indicate that the known petroleum deposits of the United States are sufficient to supply the demand at the present rate of consumption for only about 30 years. While this investigation takes no account of the output from new oil fields, it also takes no account of the steady increase in consumption of oil fuel which is all the time going on. Of course, long before the supply is exhausted, a great advance in the price will occur; and as everyone knows, an increase in price has already taken place. Recent quotations for standard grades of crude oil in the Eastern markets have been the highest recorded since the Civil War. Agitation concerning the advance in the price of gasoline has been country wide. Only the development during the past five years of the enormously productive oil deposits of Mexico has prevented a fuel-oil famine and a much greater increase in price.

It is obvious that, if the supply of liquid fuel is exhausted, the consequences will be far reaching. The industrial and engineering world is just adapting itself to the use of the liquid-fuel motor in a hundred different fields. To have the fuel supply for automobiles, motor trucks, motor boats, gasoline engines, pumps, etc., suddenly cut off or even doubled in price would be a most serious matter. For example, many hundreds of millions of dollars are being expended to build roads adapted for motor vehicles. Were the motor vehicle to become obsolete for lack of fuel supply, a great part of this expenditure might be wasted. It is therefore of great importance to determine as far as possible what source may be available to supplement the stock of liquid petroleum when it is exhausted.

A great deal has been said concerning the possibilities in using waste vegetable matter for the manufacture of alcohol as an engine fuel. This has been done to a considerable extent in Europe, where high prices for gasoline have made the process commercially feasible. Something of the same sort may perhaps be done in this country when the price of gasoline rises sufficiently high. The difficulty to be met is that means are being found of utilizing in other ways the vegetable matter that was formerly a waste product. The refuse molasses from the sugar plantations, which was formerly burned to get rid of it and was later used on a large scale for industrial-alcohol manufacture, is now taken for stock feeding. The bagasse, or crushed cane, discharged by the sugar mills after the juice has been extracted from it, commonly serves as fuel under the boilers, but a beginning has already been made in its utilization for paper manufacture.

Over a quarter of a century ago the late Prof. N. S. Shaler, in his famous book, "Man and the Earth," pointed out that, when the nation's petroleum wells are exhausted, the enormous deposits of bituminous shale, several hundred feet in thickness, underlying a considerable part of the Mississippi Valley, will be capable of producing oil by distillation. The increasing urgency of the liquid-fuel situation makes the possibilities in shale distillation of renewed interest. The Geological Survey on Dec. 18 announced the results of recent investigations of the oil-shale deposits in the Green River Formation in Colorado, Utah, Nevada and Wyoming, as follows:

> In northwestern Colorado alone there is sufficient shale in beds at least 3 ft. thick and containing more oil than the average shale now mined in Scotland to yield about 20 billion barrels of crude oil, which is more than five times the total amount of crude oil produced in the United States to date. In Utah there is probably nearly as much shale just as rich. This shale oil will yield 10 to 15% of gasoline by ordinary methods of refining.

The distillation of bituminous shale to obtain oil has been a prosperous industry in Scotland for three-quarters of a century, notwithstanding the competition of petroleum. As long as crude petroleum was sold at a dollar a barrel or less, it has been impossible profitably to exploit the oil-shale deposits of the United States. With the increasing demand and higher prices for oil, a great industry should grow up in the production of oil from shale.

Do Engineers Need To Eat?

The recent report of the Detroit Bureau of Governmental Research on Detroit sewer construction contains some interesting sidelights on what is considered fair compensation for the lower grades of engineering service. It is the more interesting because it was written by a graduate civil engineer (Massachusetts Institute of Technology) of 13 years' experience, most of it in municipal work. The report states:

> As compared with similar positions throughout the country a salary of $1,500 per year for chief of survey party (giving lines and grade for sewers and sidewalks) is a little above the average. However, increased responsibilities through absence of constant support from the sewer engineer, together with a recognition of the high cost of living in Detroit [written in September, 1916], would warrant this or a slightly increased salary. A leveler at $1,400, even though he be proficient both as a leveler and transitman, is overpaid. In most places $75 per month is paid for such services, unless the duties include charge of party. Certainly, a maximum of $100 should secure a first-class man for this position. A salary of $1,200 for the position of rodman is out of all proportion to the duties involved, regardless of the ability of the rodman. . . . Young ambitious graduates of technical schools are eager for such experience and can be secured at a compensation of $85 per month, and undergraduates for even less.

The minimum price now paid for common day labor everywhere is $2.50 per day; in most large cities and probably in Detroit it is nearer $3 per day. In Detroit also is the Ford automobile plant, where the minimum wage for man, woman and child is $5 per day. Let us see: a daily wage of $3 for six days a week is a little better than $85 a month, which "young ambitious graduates of technical schools are eager for." The graduate's little sister may be employed by the Ford company or some other prosperous manufacturing concern as a stenographer at $5 per day, or $125 per month, or $1,500 a year, which our municipal investigator—an engineer, too—considers a little extravagant for a chief of party, a technical graduate of three or four years' experience, we will say. This is indeed being wounded in the house of our friends.

Letters to the Editor

Proposed 30-Mile Tunnel Under the Cascade Range

Sir—General Chittenden's article on his suggested 30-mi. tunnel under the Cascade Mountains, in *Engineering News* of Nov. 16, is extremely interesting. The writer believes, however, after his experience of four years from 1901 to 1905 on this particular division of the Great Northern, that the 12-mi. tunnel from Scenic Hot Springs to Merrit would be preferable.

This tunnel was first suggested in 1901 by the late W. D. Scott and was several times discussed by the late Alex Stewart and the writer while we were having so many snowslides on the west slope. All of our snow and fire troubles up to 1905 took place between Scenic and Merrit, so that the shorter tunnel would have served the purpose fully as well as the 30-mi. tunnel. The writer still agrees with Messrs. Scott and Stewart that the 12-mi. tunnel would be sufficient.

VIEW ON THE GREAT NORTHERN RY. NEAR WEST PORTAL OF PROPOSED 30-MILE TUNNEL

Should the 30-mi. tunnel ever be constructed, one of the greatest troubles will be from excessive water. The entire west slope of the Cascades is subject to heavy rainfall, and during the winter the snow falls at the rate of a foot an hour at times. Large amounts of water were struck on the present 2.6-mi. Great Northern tunnel, and a million gallons per day were discharged from the west portal when the writer built the portals in 1901. There were no lakes or creeks anywhere near the line across the mountain over the tunnel.

The granite of the Cascade Range is badly faulted; and as the line of the suggested 30-mi. tunnel passes directly below many lakes and mountain torrents, the amount of water to be taken care of would be a serious engineering matter and possibly an actual menace to traffic.

The accompanying photograph shows something of the country on the Great Northern line near Foss Creek, about where the west portal of the 30-mi. tunnel would be located. FRANK B. WALKER.

84 State St., Boston, Mass., Nov. 22, 1916.

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The Ohio Conservancy Act

Sir—General Chittenden's instructive article in *Engineering News* of Nov. 9, entitled "The Battle over the Miami Flood-Prevention Plans," leads me to present the results of my experience in another such battle fought under the Conservancy Act of Ohio.

The great State of Ohio, stricken in 1913 and 1915 by unexampled floods, is attempting the part of a pioneer in the construction and management of public works, although its people are probably unconscious of this feature of the situation.

The subject has thus become one of broad general interest. It revives the great question: How shall public works within the United States be planned and built? Shall what has been called "the commission habit" be continued and added to, or shall there be a *permanent* department of government—national, state, county and municipal—charged with the duty of planning, constructing, operating and maintaining public works?

Whoever drew the Ohio Conservancy Act undoubtedly had a difficult task before him, and being a lawyer, had but few law-making precedents to guide him. That he did as well as he did, is to be wondered at; that the act has stood the test of Ohio's Supreme Court as to its constitutionality shows it to have been the work of no mean draftsman; that it fails lamentably, as I shall endeavor to prove, in promising to do the greatest good to the greatest number, at a minimum expenditure of public money, is but the natural result of an apparent lack of a proper and practical knowledge, on the part of the draftsman, of the conception and administration of public works.

Let us briefly review the act. It provides for the appointment in any county of commissioners. Note that two mistakes have already been made, for: (1) County lines are no proper boundary of jurisdiction in matters of engineering construction, especially not for flood protection; (2) nor is an emergency commission of laymen a proper body to oversee to the best advantage the design, construction, operation and maintenance of such works.

The act provides, to be sure, that the commission appointed may enlarge its jurisdiction into, perhaps over, adjoining counties; but that is a bungling method of avoiding the natural demand for including, in the case of such hydraulic works, in the jurisdiction of the supervising body, for engineering and construction purposes, the *drainage area* of the river the inhabitants of whose valley are to be protected from floods, and nothing more or less.

That is, it should not be possible to locate two or more independent conservancy commissions within the drainage area of any of Ohio's principal rivers. Some glimmering of this idea appears to have been present in the minds of the legislators when it was provided that several conservancy districts might be forced to unite or be united. But that may prove, as an afterthought and from the human side of the situation, to be a difficult matter to accomplish.

The law should operate *on drainage areas*, not on counties or on parts of counties or on parts of drainage areas. The latter feature has brought with it in Ohio the spectacle of nine county judges sitting as engineers to test the propriety of constructing works laboriously designed after three years of work by presumably able engineers at a cost of some $750,000. These plans have been made under the mandate of a board of commissioners appointed for the purpose of recommending to the people the best and most economical method and structures for protecting their property from damage by floods.

In what way, it may be asked, can these nine judges be more skilled as engineers than were the three conservancy commissioners, let alone the engineer whom the commissioners employed? If the commissioners had doubts in the matter, a numerous profession of consulting engineers could surely have aided them, and by a more rational procedure than that of a court with its public exhibition of questions and answers.

Other fundamental defects in the act have been referred to and may be illustrated. On the Scioto River is another conservancy district, for which has been made an able engineering report by John W. Alvord. Adopting the method of detention reservoirs, he designed the construction of two such reservoirs, which together with the use of two natural detention reservoirs (one of them the Great Marsh, 15,000 acres, in Hardin County) would suffice to protect the whole valley from flood flow. Of course, such a group of reservoirs must be in balance among themselves and with the flood flow from the territory they are to protect; but along comes another conservancy commission, organized under the same Conservancy Act, but having for its jurisdiction only a small part of the Scioto drainage area, and calmly proceeds to condemn the Great Marsh to cease to operate as a detention reservoir. No concern of theirs that this would spoil the plans of the Franklin County conservancy commissioners, for they are looking out only for their immediate clients or petitioners, the owners (or some of them) of the Great Marsh, who want the marsh drained. Incidentally be it noted that the proposed drainage plans do not even "conserve" the marsh. (This is the marsh near Kenton, Ohio, which a sympathizing public throughout the United States was recently called upon, by the Associated Press, to bewail, because it was on fire, and which may be burning yet, as it did for weeks.) Both for purposes of flood protection and to "conserve" the marsh, what is plainly needed at the outlet of the marsh is a dam, not a drainage canal, which latter would aggravate the floods and flood damage downstream from the marsh; a low dam, its crest 18 in. or 2 ft. below the general level of the marsh; sluice gates and culverts through or in it, if one likes, so that by the operation of these gates, or of flashboards on the dam, or of both, one could either to a sufficient agricultural extent drain the marsh or, when necessary (as to put out bog fires) flood it; or let flood flows pass by to the same amount per day that they now do, and no more.

I have been told that it was proposed for the case named to have a hydraulic engineer sit with the judge as an "assessor," as it is called, to aid the judge with his expert knowledge; for evidently in such a situation the presiding tribunal should be learned in the subject matter and not be hampered by having only testimony, even though it be "expert or opinion testimony," to rely upon. But the project failed, because the act does not provide for the payment of such an *amicus curiae.*

I come back to the thoughts expressed at the beginning of this letter. In the complex civilization under which we live, methods of constructing the public works of commonwealths which sufficed in colonial or pioneer days no longer serve; and to a still greater degree is this true of the operation and maintenance of such works. We are approaching the day, if it is not already here, when *permanent* organizations for the construction and care of all public works will have to be provided for—in the Cabinet at Washington; in the capitals of the several states; in counties, if one likes; and in the municipalities of the nation. CLEMENS HERSCHEL.

New York City, Nov. 25, 1916.

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Turning Moments on the Quebec Suspended-Span Supports

Sir—Since my letter regarding the Quebec Bridge accident was published in *Engineering News*, Nov. 2, it has been pointed out that if the counterbalancing effect of the dead weight of the lifting girder were taken into account, it would take 0.34 in. instead of "slightly more than one-eighth of an inch" to make the top of the girder tend to assume a slope of 5%. An eccentricity of ⅓ in. would produce a moment of 800,000 in.-lb. As it would require a moment of 1,920,000 in.-lb. to overcome the friction (assumed at 20%) on the 8-in. pin, above the rocker casting, it is plain that even if a ⅓-in. eccentricity existed, some further turning moment would be required to overcome pin friction.

Among the conditions that might be suggested as possibly producing a turning moment the following has been mentioned: When the suspended span was floated under the cantilever arm and moored by wire-rope guys to the mooring trusses, it is possible that the center of gravity of the span might have been a foot or more north of a point halfway between the jacking girders of the north and south cantilever arms. The guys at the ends might have been tightened up with the span in this incorrect position. Then, when the chains were attached, the pins in them would be in a catenary having its vertex at the point of attachment. With the falling tide the weight of the span would be transferred from the barges to the chains, and at the same time a considerable stress would be put on the guys to the north mooring truss. As the jacking proceeded and the span rose, the guys to the north mooring truss would revolve around their point of attachment to the mooring truss, and the center of gravity of the span would move south toward the point halfway between the jacking girders of the north and south sides. This horizontal movement of the bottoms of the hanger chains would produce bending moments in the chains and a resultant moment tending to turn the lifting girders about the 8-in. pin, above the rocker, out from under the span. If the eccentricity of the center of gravity of the span be assumed as 3.5 in., the resulting moment tending to overcome friction on the 8-in. pin is as follows (see Fig. 2). Pin friction is assumed to prevent rotation on any of the 12-in. pins, and a constant moment of inertia of the chain is assumed.

$$\frac{Wl^3}{3EI} = 3.5$$

$$W = \frac{3 \times 30{,}000{,}000 \times 9 \times 30 \times 30 \times 30 \times 3.5}{150 \times 150 \times 150 \times 12 \times 12 \times 12 \times 12} = 1{,}100$$

$$\begin{array}{rl} M = 1{,}100 \times 150 \times 12 = & 1{,}980{,}000 \\ -1{,}100 \times 4 = & -4{,}400 \\ \hline & 1{,}975{,}600 \end{array}$$

Though this moment is enough to produce rotation of all four lifting girders under the transverse 8-in. pins, it depends on constant moment of inertia of the chains, whereas that is considerably reduced at the pin points in the chains, and a greater eccentricity than 3.5 in. would be necessary to produce rotation.

If the coefficient of friction on the greased longitudinal pin under the casting be 8% in a longitudinal direction, and if it requires about 2% additional to bend the centering plates, an initial eccentricity of 4¼ in. of the center of gravity of the span would be required theoretically to cause a lifting girder to slip out under the span. It would seem that there would be first turning on the 8-in. pin and then sliding on the 9½-in. longitudinal pin. In this hypothesis it is necessary to assume some disturbing elements at the southwest shoe, more serious than at the other points, particularly at the southeast shoe. It might have been that the 8-in. pin was eccentric with respect to the lowest 12-in. pins in the chains. It might have been that the lifting girder did not hang plumb. It might have been that the casting broke, though it was subjected to less stress from combined external direct and bending forces than it was at Sillery Cove.

There were other forces acting on all four points. The south end of the span was 2 ft. higher than the north end and this rotated the lifting girders slightly. From the time the chains were attached till the time of the collapse a possible temperature expansion of 2½ in. took place, pushing the bottom of each chain 1¼ in. with respect to the jacking girders, away from the center of the stream. Continual shortening of the chains would aggravate turning moments produced by these two circumstances, and in the above hypothesis the two conditions would aggravate the moments at the south lifting girders and improve them at the north lifting girders. Bending stresses in the girders, bending the top flanges transversely, and the slight strains would produce, or would aggravate, an eccentricity of the 8-in. pin, with respect to the 12-in. pins.

The assumptions made in designing the casting may be open to criticism, but in determining the stresses to which good castings already made must have been subjected it would seem necessary to make a lenient assumption as to the distribution of the external forces. The distribution curve would presumably be smooth, but on account of the distribution of the metal a good portion of the load would naturally come down direct where there was the most metal.

If a smooth curve, such as is shown in Fig. 1, be assumed and then be approximated by the straight lines, the computed stresses due to direct load, at Sillery Cove, would be 20,600 lb. per sq.in. tension at the root of the bracket and 38,000 lb. per sq.in. at the center. If the stresses due to expansion of the span (coefficient of friction equal to 8%) be added, they are respectively 24,330 and 44,950 lb. per sq.in. At the bridge site the stresses due to direct load would be 18,700 lb. per sq.in. and 35,400 lb. per sq.in. respectively; and if the stresses due to bending loads (friction equal to 8%, plus centering plates equal to 2%) are added, they would be 22,950 lb. per sq.in. and 43,200, lb. per sq.in. respectively. The above stresses are high, but from a consideration of the tensile strength of cast steel, which varies from 33,000 to 99,000 lb. per sq.in., and of the tests on cast iron, summarized in Johnson's "Materials of Construction" in Table XXIV, p. 478, where cast iron varies in tensile strength from 12,688 to 32,821 lb. per sq.in., and in cross-bending from 25,820 to 47,710 lb. per sq.in., it would seem that good rocker castings would be able to withstand the above computed stresses, especially if, as many would believe, the root of the bracket is practically the weakest point. If the southwest rocker was faulty and contributed to the failure, it would seem probable that cracks had started at Sillery Cove, though they might be invisible.

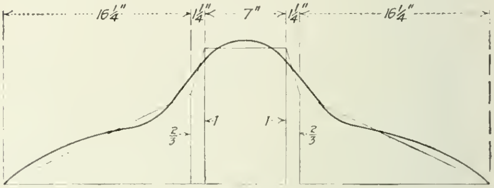

FIG. 1

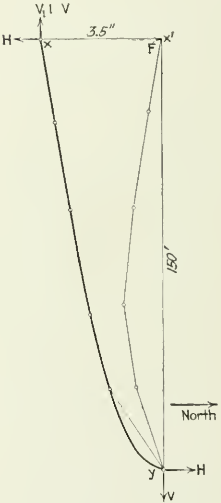

FIG. 2

FIGS. 1 AND 2. ROCKER-LOAD AND CHAIN BENDING - MOMENTS

Fig. 2—Before V is applied the 12-in. pins are on the catenary. If the point x is moved 3.5 in. north with respect to y the force F necessary to produce such a deflection may be computed. Then the moment at y produced by F can be computed

Possibly, some of the foregoing might be the occasion of bringing out facts that would throw light on the cause of the disaster. ROBERT S. FOULDS.

Phoenixville, Penn., Nov. 9, 1916.

Charges for Use of Sewers

Sir—On page 512 of *Engineering News* of Sept. 14, 1916, you published some editorial comments on "Making Water Consumers Pay for Sewer Services" and quoted a statement by George G. Earl, of New Orleans, to the effect that sanitary sewers are merely carrying off the water that the water-works bring in.

If the water consumer is to pay the cost of sewerage as well as of water-works service, then the charge for the water should be so proportioned that every water taker pays in part for the sewerage service. This is unjust to water takers who do not have a sanitary-sewer service, and also to such residents as use the city water for sprinkling, manufacturing, etc. I presume that one of the reasons for not charging for sewer service is the lack of a medium to measure the liquids run into the sewer. With a 100% metered water-supply, as in Manila, this difficulty is, however, done away with.

Seven years ago the writer drew up an ordinance for the new sewerage system of Manila, establishing a sewerage charge based on the amount of water entering the property through the meter, except that for water not reaching the sewer a separate meter might be installed, on which no sewerage-service charge would be made. There were a few objections when the ordinance was first enacted, the chief one being that the price of water had been raised. After a few explanations the justice of the charge was accepted. This ordinance has been in existence since 1909 and has given satisfaction and justice to all served.

In 1915 I was passing through Honolulu and saw a sign in the City Hall window, "Sewerage charges due." I called on the superintendent to learn the basis of the charges. He stated that, not having universally metered services, they charged various prices for various kinds of services and that there always was considerable argument with the residents as to the classification. I believe that with some little study a just arrangement can be made to charge for this service, even if there are no meters.

A. Gideon,
Superintendent of Water-Supply and Sewers.
Manila, P. I., Oct. 25, 1916.

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Comparative Costs of Concrete and Mill Construction

Sir—As a contribution to the current discussion of the comparative cost of mill building and concrete construction, I append a comparison of the estimated cost of a combination steel skeleton and wood joist building, and an alternate design of reinforced-concrete skeleton construction for the same building, which was located in Wilmington, Del.

The dimensions of the building were 45x65 ft. in plan for two floors and roof, with a wing 16x60-ft., one floor and roof. The plans, as drawn by the architect, showed steel columns and girders with wood joists, flooring and wood lath. The walls were 12x8-in. hollow tile with stucco finish outside. I made a redesign of the structural part of the building, keeping the same architectural effect as originally shown, substituting reinforced-concrete columns and floors and metal lath for the wood lath. This redesign was a thoroughly fireproof building, while the original was not. The itemized costs are given in the accompanying table.

The total area of the floors and roof is 10,695 sq.ft., making a cost of $3.23 per sq.ft. for original design, as against $2.97 per sq.ft. for the redesign. This shows a saving of 7.9% in favor of reinforced concrete.

COMPARATIVE COSTS OF MILL-BUILDING AND REINFORCED-CONCRETE DESIGN FOR SAME STRUCTURE

	Original	Redesign
Permit, bonds, insurance, shoring, pumping, foreman and watchman, miscellaneous expenses, etc...	$2,996	$2,985
Lumber...	1,507	987
Millwork....	2,500	2,500
Carpenter labor..	3,095	2,595
Demolition, excavation and stone masonry.	2,854	2,854
Brickwork.....	5,337	4,337
Cut stone.........	331	331
Ornamental terra-cotta work.	1,858	1,858
Structural steel...	4,759	.
Reinforced concrete and cement	2,600	6,569
Ornamental iron	874	874
Dahlstrom door...	288	288
Ash hoist......	165	165
Stair work (wood) ...	185	185
Tile........	192	192
Weather stripping ..	63	63
Roofing and sheet metal.......	317	317
Plastering..........	2,998	3,100
Hardware.	618	618
Painting and glazing.....	984	984
	$34,521	$31,802

The table is compiled with actual sub-bids received and used in the make-up of the estimate.

Louis Muhlhausen.
1029 Brown St., Philadelphia, Penn., Dec. 1, 1916.

NOTES AND QUERIES

The Steel Column Forms used in the American Tool Works' building at Cincinnati described in "Engineering News," Nov. 23, 1916, p. 991, were for the most part furnished by the Blaw Steel Construction Co., Pittsburgh, Penn. The Hodges form, described in the article, was used only for some special locations.

The Galveston Causeway decision report on p. 1153 of "Engineering News," Dec. 14, 1916, was slightly in error when it said that a "Board of Engineers is to decide upon the proper structure." This Board originally had the decision to make, but, not being able to agree, called in the Board of Arbitration and agreed to abide by the decision of at least two out of the three arbiters. The unanimous report of these arbiters, as noted in the last issue, is therefore final.

Single-Track Concrete Roads with Turnouts—A correspondent wishes information on highway practice where narrow concrete pavements have been used with provision, say every 500 ft., for an additional width of 6 ft. for a length of 40 ft., to be used as a turnout. Data are also wanted on the advisability of constructing concrete-paved roads without shoulders. "Engineering News" will be glad to receive information from engineers who have had experience with these types of road construction.

Position-Light Signals on the Pennsylvania R.R.—In the article on the new position-light signals of the Pennsylvania R.R., in "Engineering News," of Nov. 9, the operating voltage was stated incorrectly. The signals are operated with 11-volt current by day and 6-volt current at night. The day voltage is used on foggy nights. The term "signal track" tunnel (on page 878) is an obvious typographical error for "single-track" tunnel. The explanation (on page 877) of the signal indications in the photographic view, Fig. 2, is also incorrect, due to the fact that no explanation was sent with the photograph. It was assumed that this was the equivalent of a two-arm home and distant signal system, but as a matter of fact it is a three-position system. The description should read as follows: "In this view the east train has just set the right-hand signal at 'stop.' The left-hand signal indicates 'proceed prepared to stop at next signal' (one block being clear). When the train passes out of the second block, the bottom row will show vertical with top row diagonal, giving indication 'proceed, prepared to pass next signal at medium speed.' When the third block is clear the top row will be vertical and bottom row horizontal, indicating 'proceed.' The blocks here are 3,500 ft. long."

Electric-Driven Cement Mill of Oregon Portland Cement Co.

By D. C. Findlay*

On June 1, 1916, the Oregon Portland Cement Co. made the first barrel of cement ever manufactured in Oregon. The plant is located at Oswego, Ore., approximately eight miles south of Portland on the Southern Pacific and on the banks of the Willamette River, thus affording alternative transportation of the finished product. In equipping the plant all the most modern features of cement manufacture have been adopted, and every effort has been made to secure a dustless plant. That it is a really dustless plant can readily be appreciated when it is stated that the photographs here reproduced were taken when the plant was running full blast, and only a faint trace of vapor is noticeable from the top of the stack shown on some other photographs of the exterior taken at the same time but not reproduced here.

The entire construction is of reinforced concrete, even including the roofs, practically eliminating depreciation and fire hazard. Because of the economical layout of the plant only 40 men are required to operate it, which is considerably below the average number required for the ordinary 1,000-bbl. plant. Further, while this is normally a 1,000-bbl. plant, 1,200 bbl. a day are being steadily turned out and sometimes as many even as 1,300 bbl. Another feature is that one barrel of cement is obtained for each 8.4 gal. of crude-oil fuel, which is considerably below the average.

This plant uses electric drive entirely. The entire electrical equipment was supplied by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Penn., and was installed by the cement company.

In the manufacture of cement at this plant, two kinds of rock are used—lime rock from Roseburg, Ore., running about 96% $CaCO_3$; and a cement rock from Dallas, Ore., running about 60%. This rock is first fed to a No. 7½ Austin gyratory crusher driven by a 75-hp. squirrel-cage induction motor. It is then elevated and stored in 10 circular reinforced-concrete storage bins 69 ft. high and 22 ft. in diameter, with 6-in. walls. These bins hold 12,000 tons. From the bins the rock is elevated by a belt conveyor and discharged into feed bins over the kominuter. In this mill, which is driven by a 150-hp. motor with "Lenix" drive (a short belt with a ball-bearing idler in a counterweighted frame), the proportioning of the two rocks is done by two automatic feeders discharging into the kominuter, into which a stream of water is also fed.

The final grinding is done in two cylpeb tube mills using small steel cylpebs and driven by 200-hp. motors, also with "Lenix" drives. These mills take their feed from a reinforced-concrete feed trough built as a unit with the floorbeams and having an agitating shaft and paddles.

Three circular correcting basins 24 ft. in diameter permit the chemist to vary his feed until he gets 76.6% $CaCO_3$ when mixed in the agitating basin below. An air-lift pumping system is used for pumping the slurry over to a 2,000-bbl. reinforced-concrete storage basin under the kiln. This basin is built partly above and partly below ground. It is 26 ft. deep, and the kiln piers are part of the structure. The plant is unique in that pumps have been discarded for feeding slurry to the kiln; a double reinforced-concrete continuous bucket elevator is used. The slurry stands at the same level in

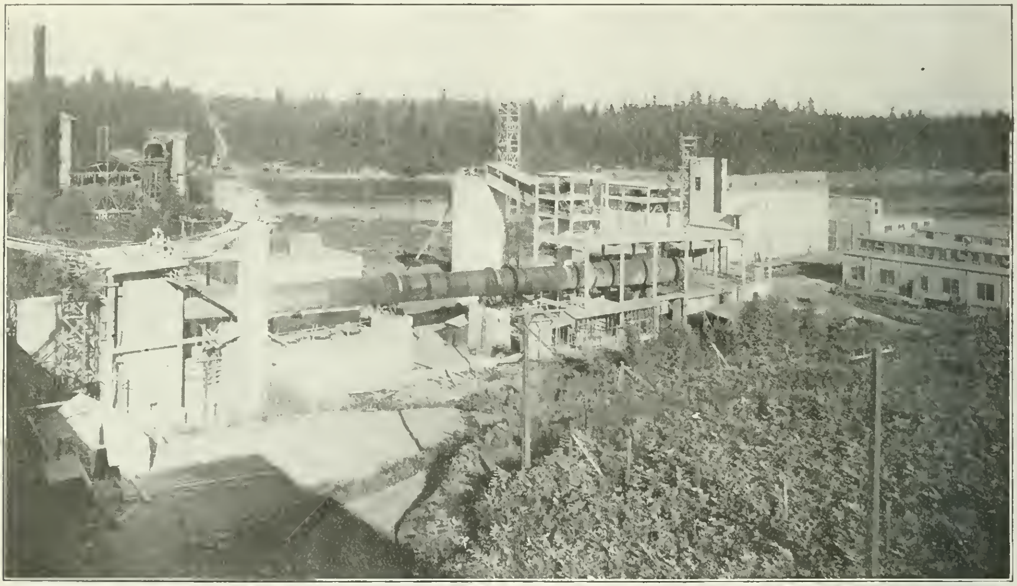

FIG. 1. GENERAL VIEW OF OREGON PORTLAND CEMENT PLANT AT OSWEGO, ORE.
Looking east, showing 210-ft. kiln and plant location on banks of Willamette River

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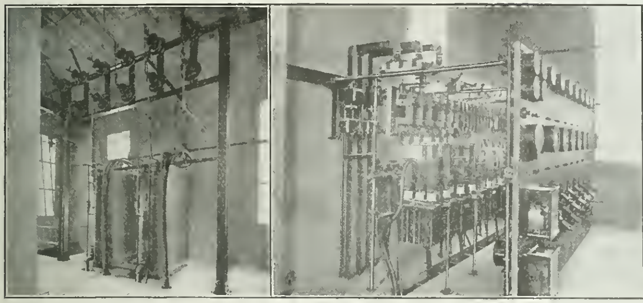
*Electrical and Mechanical Engineer, Oregon Portland Cement Co., Oswego, Ore.



FIGS. 2 AND 3. INTERIOR VIEWS IN SUBSTATION OF MILL

Showing in left view two 1,000-k.-va. three-phase transformers disconnecting switches and high-tension bus, and in right view switchboard and bus structure

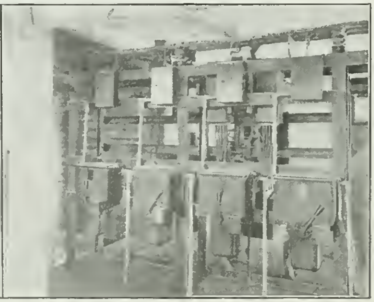


FIG. 4. VIEW OF CENTRALIZED CONTROL IN FINISHING DEPARTMENT

One operator controls large part of plant

the elevator as in the basin and exerts a great pressure on the walls. This elevator has proved very economical, as it requires little attention and is much cleaner than pumps.

A mechanical feeder lifts out a definite amount of slurry at each revolution and feeds it into the rotary kiln, which is 210 ft. long by 9 ft. and 10 ft. in diameter, being the largest kiln on the Pacific Coast. It rests on five tires and weighs about 500 tons. It is driven by a 75-hp. variable-speed motor located under the burners control. Crude oil is used, with air at 2 lb. pressure for atomizing (Fig. 5). The kiln is rated at 1,000 bbl.; but as previously stated, it easily produces 1,200 bbl. per day and requires only two men to operate it on each shift.

The clinker is cooled by a Smidth horizontal pressure cooler, using a blast of air from a 12-ft. diameter pressure fan. Another novelty in this plant is the method of handling the clinker, using No. 480 drag conveyor chain in a cast-iron-lined reinforced-concrete trough and discharging into a reinforced-concrete elevator leg from which a belt conveyor takes it to circular storage bins holding 6,600 bbl. each. In this condition, as soon as the clinker is ground fine enough, it becomes the finished cement. A kominuter and a 22-ft. tube mill in the grinding department grind 1,200 bbl. per day with two men on each shift of 12 hr. each. The kominuter is driven by a 150-hp. motor with "Lenix" drive. The tube mill is driven by a 250-hp. motor with "Lenix" drive. While the use of "Lenix" drive is not new, this is a notable installation in that the motor drives the tube mill through a 24-in. belt with only a 7-ft. distance from center line of driving pulley to center line of driven pulley.

From the storage bins, which are of reinforced concrete, the cement is drawn off and packed into sacks as required.

Substation and Equipment

Power for operating the plant is purchased from the Portland Railway, Light and Power Co., on a basis of maximum demand for a 20-min. peak. It is received from the company's transmission line as three-phase 60-cycle 57,000-volt current through a three-pole air-break 60,000-volt switch mounted on a two-pole structure 8 ft. from the rear of the substation wall. The power enters the substation through aluminum outdoor-type choke coils and Locke high-voltage roof insulators to a high-tension bus suspended by disk insulators from the concrete roof slab. The high-tension bus and all the 57,000-volt wiring consist of ½-in. galvanized conduit instead of copper tubing, greatly reducing the cost of insulation. All joints in the conduit were cleaned with gasoline and the couplings sweated to the pipe, insuring as good conductivity as the pipe, which has sufficient carrying capacity for the high-tension current. Taps are taken off this bus to three single-pole knife switches leading to high-tension series relays mounted vertically on insulators. The low-voltage relays are mounted horizontally on a 6-in. channel and are operated by means of insulating links. The latter are 66 in. long, but the channel is provided with adjusting screws to regulate the exact length of the links for tripping. These relays have inverse time limits operated by bellows, which prevent them from short-circuiting the magnet coil employed for keeping a 60,000-volt oil circuit-breaker in closed position. The magnet coil also has a snap switch on the back of the board in its circuit, to enable the operator to trip the switch from the board when desired.

Disconnecting switches mounted on the back of the same structural-steel framework over the circuit-breaker, which supports the relays, connect to a transfer bus suspended from the roof. From this, taps are taken to two three-phase 1,000-kv.-a. water-cooled transformers (Fig. 2), which step down the current from 57,000 to 480 volt. They are Y-connected with grounded neutral and have four high-tension taps. Only one transformer is used at a time, the other being held as an emergency spare, disconnected from the line on both sides.

The power leaves the transformers through cables that drop through fiber bushings into the basement and pass through a novel type of disconnecting switch, consisting of two 3-pole 1,500-amp. unfused knife switches, with quick-break clips, mounted face to face in the ends of a steel cabinet supported on a concrete slab, which in turn is on piers about 5 ft. from the floor. The bottoms of the switches are tied together with heavy copper straps, and the busbar copper rises vertically from the middle of this through slate-protected openings in the top. The main busbar then passes horizontally under the floor-beams through the floor and directly to the switchboard distribution busbars.

Cable-type current transformers are mounted on the vertical rise of the busbar on an iron frame that supports both the power company's and the cement company's transformers. The secondary leads are taken in conduit through the floor and directly to the bottom of the totaling panel on the switchboard. Potential transformers for operating the control circuit of the curve-drawing wattmeters are mounted under the floor slab in the basement, directly below the switchboard.

On account of inability to procure solid busbar copper in Portland or vicinity the expedient of taping together twenty No. 1 solid bare copper wires into a busbar was adopted, connecting them at all angles with red-brass castings having the wires securely soldered in.

The substation is protected by a bank of four tank electrolytic aluminum-cell lightning arresters, mounted inside the station, but with horn gaps and transfer switch on the roof. These arresters are charged three times a day. A unique feature of the substation is that a private telephone system is installed for communicating directly with the load dispatcher in Portland.

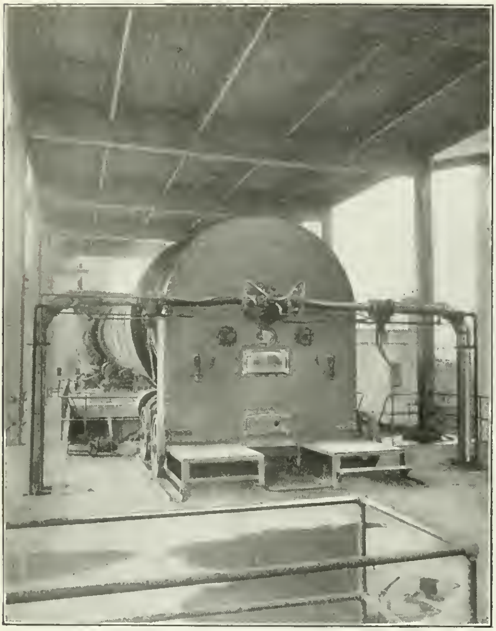


FIG. 5. END VIEW OF KILN, SHOWING CRUDE-OIL FEED

The lighting load is handled by two 10-kw. 440—110-volt transformers in open delta in the basement, connected to 10 single-pole knife switches mounted on the lighting panel, each switch controlling one department in the plant.

Layout of Switchboard

The switchboard is divided into nine panels (Fig. 3). Natural black slate is used, and the oil switches are mounted on a framework and operated by bell cranks, with levers under the floor, leaving a clear passage behind the board. Single-pole unfused knife switches are mounted between the busbars and the oil switch on each panel, so that each department of the plant can be cut clear of the board without disturbing any of the remaining circuits. Current transformers on the two outside legs of each circuit are used for the indicating and integrating wattmeters on each panel. By means of these instruments a record is kept each day. The totaling panel has the following instruments mounted on it: An ammeter with a 3,000-amp. scale, an ammeter for measuring all three phases, an indicating wattmeter, a power-factor meter, a voltmeter, a Bristol recording voltmeter and two curve-drawing wattmeters—one belonging to the power company and the other to the cement company, one meter checking against the other. The power company also has an integrating wattmeter mounted on the back of the board.

Distribution of Power

The entire distribution system is underground. A main cable tunnel runs the entire length of the plant and is taken off to the various departments. All power and lighting cables pass directly from the switchboard into a cable tunnel that runs in the form of a T for 300 ft. The heavy power feeders, varying from 400,000 to 1,000,000 circ.mil, are carried on insulators, supported by galvanized-iron pipe frames built into the concrete walls of the tunnel, which is waterproof and is 5 ft. wide by 5 ft. high. All remaining power and lighting circuits are in conduit carried by the pipe frames, the entire system insuring absolute safety against interruption of service. All service taps are taken off in conduit, buried in the concrete, directly to the distributing compensator structure in each department.

Each department of the plant has all starting compensators assembled together on a structural-steel frame from which the various motor circuits radiate in conduit. Dustproof compensators were used throughout, having conduit entrance and outlet bushings. Each compensator is provided with an ammeter for all sizes above 75 hp.

The main circuit from the cable tunnel forms a busbar running horizontally above the system, from which taps are taken through three-pole knife switches in steel cabinets, whose functions are to disconnect each motor for repairs or when not in service.

A novel feature of the installation is that every motor has a 60-volt snap switch located directly at the motor and connected to the low-voltage release coil of the compensator by No. 14 duplex cable, so that the operator can open this circuit and shut down the motor, without taking time to go to the board, in case of emergency. This system of concentrated control permits one operator to stop or start some 700 hp. in motors without moving more than 10 ft., and in a very short time (Fig. 4).

H. P. Butchart, Victoria, B. C., is President of the company, and L. C. Newlands, Superintendent. The entire civil, electrical and mechanical construction was designed and supervised by the author.

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The Lead-Drilling Beetle, described in "Engineering News" of Nov. 18, 1915, p. 1006, is still doing serious damage on telephone lines in California. In Pomona, Calif., on Sept. 30, when the first rain of the season fell, more than 50 lines of the local telephone company were put out of service by short-circuits in an hour. The beetle bores holes through the lead armor of the telephone cable; when rain comes, moisture enters the interior of the cable through the holes.

American Engineers Engaged in Developing Foreign Trade

The annual report of the American International Corporation, organized in New York City a year ago, is of especial interest to engineers because of the number of prominent engineers in its organization and because of the notable engineering enterprises which it has undertaken. The president, Charles A. Stone, is widely known from his connection with the firm of Stone & Webster, and on its Board of Directors are such prominent engineers as William L. Saunders, Guy E. Tripp, Edwin S. Webster and Henry S. Pritchett.

It was announced at the organization of the company that its principal purpose was to enlist American capital in the development of enterprises in foreign countries. Since the company was organized, Dec. 1, 1916, there have been 1,230 propositions submitted to the company for consideration.

These propositions were distributed among different parts of the world as follows: Africa, 29; Alaska, 4; Asia, 73; Australia, 10; Canada, 11; Central America, 47; Europe, 256; Mexico, 26; South America, 347; United States, 326; West Indies, 71. The propositions were classified as to their nature as follows: Agriculture, including irrigation, drainage, timber, sugar, cattle, etc., 143; commerce, 13; financing, 90; manufacturing, 201; merchandising, 139; mining, 185; public utilities, 127; railways, terminals, telephones, 332. Of the 1,230 propositions received, 917 were declined, and 313 have not yet been disposed of.

Among the enterprises which the company has actually undertaken are the contracts for building water-works and sewerage systems in the towns of Salto, Paysanbu, and Mercedes, Uruguay. This work was undertaken jointly with the firm of Messrs. Stone & Webster and the Ulen Contracting Co. It has been agreed to take $4,000,000 in 6% gold bonds of the Uruguay government in payment for this work, which is now well under way and will be completed during the coming year. There is other business of a similar nature pending both in Uruguay and in Argentine. Such enterprises can be undertaken advantageously whenever it is possible to sell such bonds in the United States.

To investigate propositions in South America, the Latin-American Corporation has been formed in conjunction with the firm of Stone & Webster to investigate construction propositions in South America and properly supervise the work during construction. The officers of this company are made up in part from the engineering force of Stone & Webster. An expedition to investigate opportunities in South America sailed from New York on July 29 last, and on its return to the United States it is expected that some undertakings will be entered into.

In the field of ocean transportation the American International Corporation has secured control of the Pacific Mail Steamship Co., and has acquired a large interest in the United Fruit Co., the International Mercantile Marine Co., and the New York Shipbuilding Co. It has also organized the American International Terminals Corporation to undertake the study of terminal problems at the port of New York and ultimately develop an organization for the construction of terminals, port works and harbor facilities in other places.

In connection with various contracts proposed in China, particularly for railway construction, the China Corporation and the Siems-Carey Railway and Canal Co. were organized in July last. Mr. Carey, of the Siems-Carey Co., of St. Paul, Minn., and a group of engineers and experts have been in China since August. The company has advanced to the government of China $500,000 to make surveys and other investigations for railways to be built under the contract. The work in China is in charge of Willard B. Straight, vice-president of the American International Corporation, formerly connected with the firm of J. P. Morgan.

The company is investigating various opportunities for business in Russia, and on Aug. 31, 1916, Frederick Holbrook, head of the Holbrook, Cabot & Rollins Corporation, was chosen vice-president of the American International Corporation to represent its interests in Petrograd. An office has been opened in Petrograd and a thorough investigation is now being made of two or three important matters with the aid of American experts.

⁂

Columbia University Organizes Engineering Society

In imitation of the association of the four national engineering societies (the United Engineering Society) the various student engineering societies of Columbia University have organized the United Engineering Societies of Columbia University. This is managed by a board similar to the Board of Trustees of the United Engineering Society.

The first meeting arranged under the auspices of the new society was a smoker on the evening of Dec. 14, at which Calvin W. Rice, secretary of the American Society of Mechanical Engineers; H. H. Norris, associate editor of the *Electrical World;* Charles Butters, mining engineer and metallurgist, and Herman A. Metz, former comptroller of the City of New York and a prominent manufacturer, were the guests and speakers of the evening.

Both Messrs. Butters and Metz talked chiefly in the strain of personal reminiscences; when a successful engineer or manufacturer tells intimately the steps and incidents which have led to fame and fortune, the talk is sure to be interesting, and judged by this meeting, highly instructive and inspiring to a body of engineering students.

⁂

Shutting Down Portland Cement Kilns on Sunday was the subject of a paper presented by G. F. Brown to the Portland Cement Association at its annual meeting on Dec. 12. The Alpha Portland Cement Co. began shutting down its cement kilns on Sunday in June last and has continued the practice ever since. After trying shutting down with the kilns empty and loaded, it has been found best to shut down the kilns with the load in them. It is found that the output per day for the days in operation has increased slightly over the output when the kilns are run for the whole week. While it is theoretically correct to say that it costs more to manufacture cement with the Sunday shutdown, the cost records do not as yet show any material increase. There does not appear to be the slightest change in the quality of output. The kiln linings do not last quite as long, but the cost of repairs appears to be lower. Though the wages per week are lower, since the wages paid are for six days' work instead of for seven, the workmen are satisfied with the change.

Erecting and Swinging 720-Ft. Span of Metropolis Bridge

Progressive methods were used in erecting the great channel span of the Metropolis Bridge over the Ohio River, on the new Paducah & Illinois R.R. of the Chicago, Burlington & Quincy. The span is 720 ft. long between centers of end pins. Though the trusses are 110 ft. high at midspan, they were erected by derrick car and crane, to which fact the speed of erection is largely due.

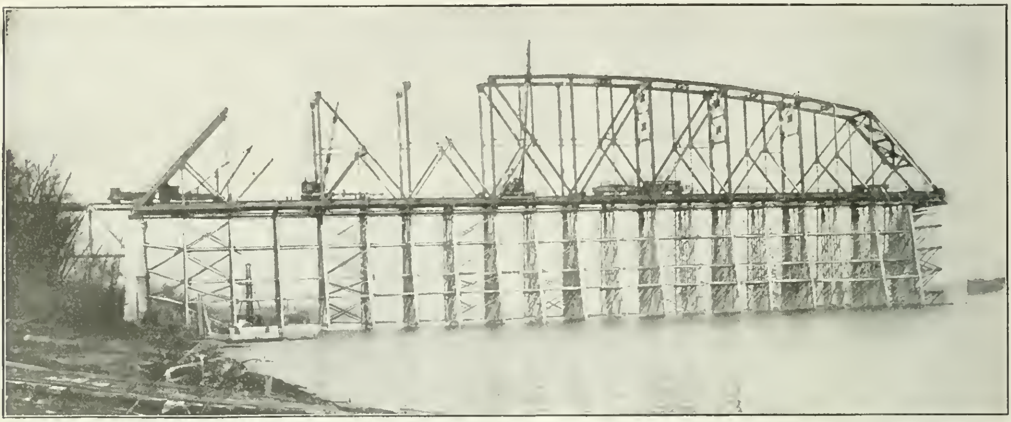


FIG. 1. ERECTION OF 720-FT. SPAN ON NOV. 25, 1916; CRANE WITH 135-FT. BOOM PLACING TOP CHORD

Swinging the span was done by lowering on hydraulic jacks and steel blocking, and was carried out in slow stages so that the elastic behavior of the silicon-steel structure could be studied. A remarkably effective, yet simple, rig was employed in the lowering.

The span is double-track, is semi-pinconnected, and is of subpost Pratt type, with 36-ft. subpanels. The subhangers are not connected to the chord, which eliminates an item of stress uncertainty. Stirrups formed on the ends of the subfloorbeams embrace and support the lower-chord bars. The eyebars are over 72 ft. long; their maximum size is 16x1$\frac{15}{16}$ in., with 15-in. pins, both pins and bars being nickel steel. The rest of the span is "silicon steel," except that the rivets (1 and $\frac{7}{8}$ in.) are carbon steel.

The erection machinery consisted of one derrick car, two 60-ton, one 85-ton, and one 150-ton crane; the latter was provided with three boom lengths; 85 ft., 110 ft., and 135 ft. The long boom set the high top chords; the heaviest of these weighed 44 tons and was set at 26-ft. reach.

Falsework bents were located under subpanel and main panel points, or at 36 ft. spacing, and rested each on a transverse row of piles driven in the sand bottom to 15 or 20 tons bearing power. On the piles were set three-story framed bents of 18 posts each; they were made of 12x12 yellow pine posts and 12x12 oak caps sized for depth, with steel scabs bolted over all joints.

Piles were driven by a floating driver. The timber bents, however, were placed from the floor, working forward one subpanel at a time. The stringers were set on the bent as soon as this had been erected; then the track was laid on them and the derrick car moved forward to place the next floorbeam and still further forward to place the bent at the next panel point.

This work began Aug. 26, 1916, and was completed about the middle of October. It was followed by the laying down of the end sections of the bottom chord (four-rib stiff members for this 72 ft. length, the rest of the bottom chord being eyebars), and the erection of the end post bottom halves, the subhanger and the subpost. Then the vertical posts of the entire span were set up.

The posts were set on steel blocking built up of crossed layers of rails separated by plates and topped off by a pile of $\frac{1}{2}$-in. shim plates totaling about 15 in. thickness. This blocking was for use in swinging the span.

Placing the eyebar lower chords through the posts gave some trouble, because of the great length of the eyebars—72 ft.—there being no chord connection at the subpanels (except at the middle of the stiff section, panel-point 1). In spite of block packing by which the eyebar groups were stiffened for handling, they proved excessively limber. The erectors would have preferred stiff members throughout, but the added weight was objectionable.

Erection of web diagonals and top chords started at the north (fixed) end of the span, and continued to panel-point 4 south, where it met erection work proceeding

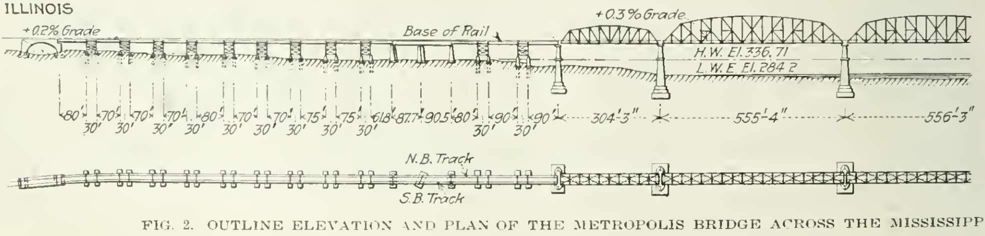


FIG. 2. OUTLINE ELEVATION AND PLAN OF THE METROPOLIS BRIDGE ACROSS THE MISSISSIPPI

from the south end. Closure was made Dec. 1, at pin 1.

The floorbeam blocking at the main panel-points had been removed when the posts were set, so as to bring the truss weight on a three-post group in the falsework bent, directly under the truss. The subpanel floorbeams, however, rested on their blocking until the span was connected up. This blocking was cut out when all was ready for lowering, on Dec. 7, and the whole load then rested on the steel blocking.

Practically no riveting had been done; only a few of the main web connections near midspan were riveted, and the other joints were merely drifted and bolted, practically full. The intention was to allow adjustment of all joints, and especially of all top-chord splices, while the span was being swung, so as to avoid introducing dead-load secondary stresses.

The most important region of secondary stress, the end triangle, was deformed during erection by depressing the middle of the end post about 2 in. and jacking up the middle joint of the stiff lower-chord section about $\frac{3}{4}$ in. The hip-vertical, consisting of two eyebars, was provided with a central plate web to partly stiffen it against buckling under the compressive load due to this distortion. A slight amount of transverse buckling was noticed in this member, however.

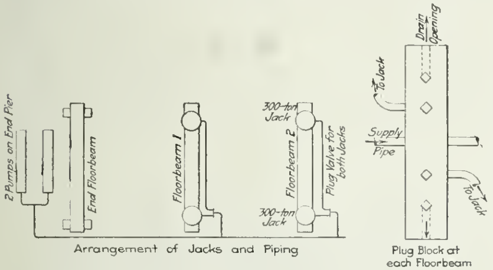


FIG. 3. JACK AND PIPING ARRANGEMENT

When the top chord was brought to closure, it came right within less than 1 in., and was easily drawn to bearing at the bottom flange. The top flange remained open about $\frac{1}{4}$ in., which could not close until the span was swung.

One 300-ton hydraulic jack was set under either end of each floorbeam, for swinging. All the jacks were coupled up to a single hydraulic line, in the arrangement shown by Fig. 3. The operation of lowering to swing consisted in jacking up one floorbeam, taking out a shim plate, lowering to bear, and then doing the same at the next floorbeam. In each stage, the work started at the fixed (north) end, as is customary practice.

The span had been built to a shop camber of 13 in., of which 8 in. represented dead-load camber plus pin clearance, and 5 in. represented camber for half live-load. The span is intended to be level under half live-load. About $3\frac{1}{2}$ in. additional camber was put into the blocking, to allow for settlement and crushing down; some of this amount was left when lowering began. Exact elevations of the various panel-points for the true no-stress condition had been computed, and in the first stages of lowering the span was brought to this precise position. At this time also the longitudinal bracing of the falsework was loosened, to allow for the crawl of the truss during lowering. The span was then lowered carefully by $\frac{1}{2}$-in. (and sometimes $\frac{1}{4}$-in.) amounts, and at the same time the temperature was read and the position of the expansion-end shoe was noted.

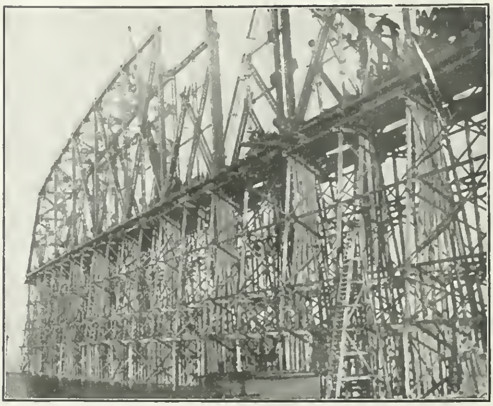


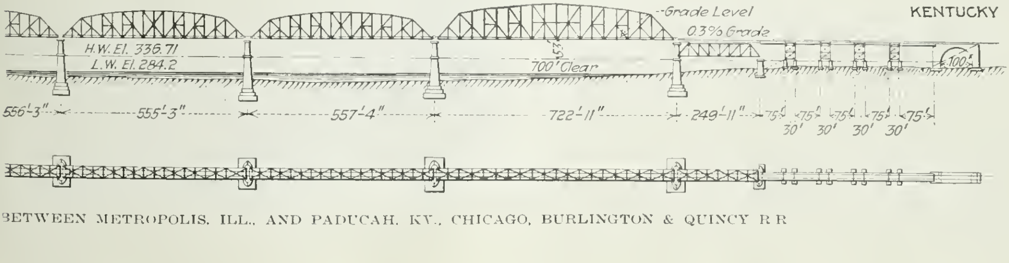
FIG. 4. SINGLE-BENT FALSEWORK OF 720-FT. SPAN

To lift one panel-point, usually three floorbeams were jacked; thus, points 4, 6 and 8 were jacked to lower point 6, and points 6, 8 and 10 were jacked to lower 8. The stiffness of the trusses and the desire to avoid excessive jack loads and local distortion were the reasons for this procedure.

Throughout the lowering, the span behaved as expected. It swung clear at 3 p.m., Dec. 11, and rough levels taken immediately thereafter indicated that the center is low (0.08 ft.) and the haunches high (0.02 ft.). The expansion shoes came within $\frac{3}{8}$ in. of theoretical position, after temperature correction had been made.

The jacking process was exceptional in using remarkably high pressures. In some of the lifts a pressure of 11,000 lb. per sq.in. was indicated on the gage.

The work was carried out by the American Bridge Company, with H. A. Green in general charge and S. P. Franz in charge at the bridge. For the Paducah and Illinois Railroad, the work was directed by C. R. Fickes, Chief Engineer.



BETWEEN METROPOLIS, ILL., AND PADUCAH, KY., CHICAGO, BURLINGTON & QUINCY R R

News of the Engineering World

Power in National Forests

The annual report of H. S. Graves, Chief of the United States Forest Service, shows that 20 new power projects started operation during 1916 in the Government forest lands. This gave 18½% increase in the total number; about 42% of the total developed water power of the country utilizes national forests. In 1916, 40 applications for power-development permits were received—8 being from Alaska. California leads in amount of power under permit and in operation.

New York State Recovers Long Sault Rapids

A decision of the United States Supreme Court handed down last week declared unconstitutional the charter and rights given the Long Sault Development Co. by the New York Legislature in 1907. The charter granted rights for power development by construction of dams and locks; the bed of the stream was to pass to the company.

In 1913 the Court of Appeals held that the charter was for the control of navigation, divesting the state of which was beyond the power of the Legislature. It is estimated that 600,000 hp. can be developed on the American side of the Long Sault Rapids and 100,000 hp. on the Canadian side.

Civil Service Examinations Without Leaving Home

The Illinois State Civil Service Commission has adopted a new plan for holding examinations for Junior Highway Engineer, State Highway Department. This plan is to mail a list of questions to be answered by the applicants at their homes and returned to the Civil Service Commission. The questions will be designed to cover the training, experience and qualifications of the candidates. This plan was proposed by the engineers of the State Highway Department because the usual written technical examinations have not secured very satisfactory results. The examination for Junior Highway Engineer, announced for Feb. 3, 1917, will be open to nonresidents of the state. The salary in $75 to $100 per month.

Illinois Central Terminal

Electrification of suburban traffic within five years is a prominent feature of the proposed new railway terminal and lake-front improvement proposition which the Illinois Central R.R. submitted to the City Council of Chicago, on Dec. 15. No steam locomotives would be run north of the 12th St. terminal, except those hauling freight trains to the yards along the Chicago River. The suburban line would have a loop beneath Grant Park, near the present Randolph St. suburban terminal.

The new main-line terminal station would be at the southeast corner of 12th St. and the extension of Indiana Ave. The railway would be depressed between 31st and 47th St. to enable the city to extend streets across the tracks to the new lake-front park. Another important feature is a proposed cross-town branch at 18th St. to afford connection with other lines further west and enable these lines to enter the new terminal station and abandon some of the present terminals. The lakefront park, to be formed by filling along the present shore line, would have a long lagoon, separated from the lake by an island parallel with the shore. The lagoon would have five public bathing beaches, and would be crossed by a number of bridges. To meet the demands for an outer harbor, the stretch of new lake-front from 12th to 31st St. is designated as a harbor district. The ordinance must be approved by the City Council and the South Park Commission before it can go into effect. The cost of the work is estimated at $20,000,000 to $25,000,000.

Los Angeles Power-Line Suits Are Ended

The City of Los Angeles, the Pacific Light and Power Co. and the Southern California Edison Co. have finally come to an agreement on the city's taking over the lines of these companies inside the city, for the distribution of power from the generating plants of the municipal aqueduct. This adjustment ends a long dispute over the value of the lines and the severance damages that would be caused by expropriation, and makes unnecessary the duplication of lines. The agreed price is $9,415,000—made up of $8,270,000 for the physical property and $1,145,000 for severance damages. These sums are based on the findings of the State Railroad Commission in the eminent-domain proceedings brought before it. The city agrees also to purchase from the two concerns such power as it needs while its generating system is being built up, the price being cost plus severance damages. The city is now selling power at 5c. per kw.-hr. base rate.

As a sequel to this agreement, it is announced that the Pacific Light and Power Co. and the Southern California Edison Co. will consolidate and retire from business within the city. The new concern will be known as the Southern California Edison Co. and will be in size about the fifth power company in the country. It will have five steam and thirteen hydro-electric plants of 130,000 and 150,000 hp. aggregate capacities. There are owned undeveloped water powers aggregating 4,000,000 hp. The new concern will have 1,380 mi. of transmission lines, 103 substations and 3,700 mi. of distribution lines reaching some 165,000 customers in 150 towns and cities.

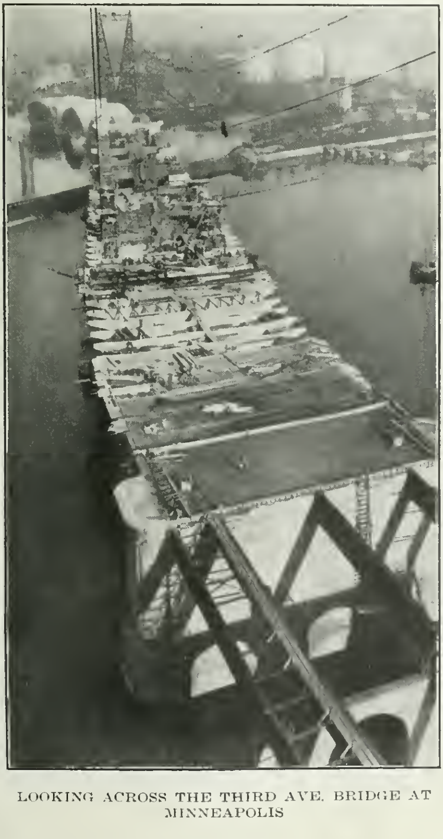
The Edison company will take up 95% of the capital stock of the Pacific company and assume its bonded debt of $25,000,000. The face of Pacific stocks, bonds and notes taken over is $31,880,298, and for it the Edison company will issue $12,029,900 of 5% second preferred stock, give $4,000,000 cash and issue $11,152,200 in common stock to remain in the Pacific treasury.

At this same time the city's condemnation suit for a 150-ft. right-of-way in the San Fernando Valley was finished in a local court. The six large real-estate holders were allowed $46,545, which was more than the city appraisal ($15,282), but much less than the owners' figure ($337,250).

⁂

Progress on the Minneapolis Concrete-Arch Bridge

The work on the Third Ave. reinforced-concrete arch bridge across the Mississippi River at Minneapolis, Minn., has not made such progress during 1916 as had been expected. A late start was made, and as the work now being done consists of the floor slabs and intermediate bents, it was necessary to stop as soon as freezing weather began, so as not to take any chances of injury to the concrete. The accompanying view (looking eastward) shows the condition of the structure two weeks before construction was shut down. In the distance will be seen one of the towers of the double cableway employed in handling material all the way across the bridge.



LOOKING ACROSS THE THIRD AVE. BRIDGE AT MINNEAPOLIS

The bridge (described at some length in *Engineering News*, Dec. 30, 1915) is peculiar in having a reverse curve in plan, the location being so made as to place all the piers on solid rock and to avoid breaks, or faults, in the rock of the river bed. The bridge is 2,223 ft. long, with five arch spans of 211 ft. and two of 134 ft. The structure was designed by F. W. Cappelen, City Engineer of Minneapolis, and is being built under his direction by city forces on the day-labor system.

⁂

Chicago Engineers Ask for Higher Salaries

The high cost of living has led the engineering employees of the City of Chicago to submit to the Mayor and City Council a petition requesting a substantial increase of salaries. The present rates of pay were established in 1910, but are not materially different from those prevailing since 1897. The changes suggested for the three principal grades are as follows:

	Present Pay	Proposed Pay
Grade 1	$90 to 110	$120 to 140
Grade 2	125 to 145	155 to 185
Grade 3	160 to 200	200 to 240

The petition is accompanied by diagrams and tables showing the rise in cost of food, and comparing the rates of payment for common and skilled labor, foremen and engineers. The following is a quotation from the engineers' petition:

> We submit that when engineers, who are in charge of work and responsible for its proper execution, are paid less than the foremen and some of the mechanics working under their direction and supervision, neither will attain the highest efficiency; the engineer, because he is discouraged by the comparison; and the workman, because he feels that the man over him is not recognized by the authorities. We now request that our salaries be also increased in order to maintain the proper relation between the compensation of laborers, skilled mechanics and technically trained men.
>
> On the men in the engineering service of Chicago rests the responsibility to design and execute the municipal improvements of the city, costing millions of dollars. A corps of men feeling themselves underpaid as compared with other employees cannot, in spite of the best intentions on their part, render the service which will result in the most economical expenditure of the city's funds appropriated for such improvements.

⁂

Profit-Sharing Franchise Asked in Minneapolis

The Minneapolis Street Railway Co. has submitted to the City Council a draft of a desired franchise that has been framed as the result of various conferences over the local traction situation.

The company asks for: A 30-year franchise containing customary provisions, with an additional 30-year term if council does not see fit to buy; 7% on the investment; half the surplus earnings until 1923 and then one-fourth; a general protective clause to prevent the city from requiring the company to do anything, beyond giving good service, that will impair the capital value of the company.

The company offers: To surrender its present franchise right, Jan. 1, 1918; city always to have right to purchase on one year's notice; company to initiate $1,000,000-a-year set program of extensions, new lines and general improvements, to be agreed on and specified in franchise; council thereafter to have full power to enforce extensions and new lines; council to have right to regulate service and construction; city to have 50% of surplus earnings until 1923 and then 75%; city to have privilege of applying surplus toward reduction from the prescribed 5%; universal transfer, but not to permit "looping"; city council to employ street-railway supervisor and staff and to require company to bear expense thereof; company to make financial reports to city and to permit inspection of books; company to pave and repair its right-of-way, to sweep, oil and sprinkle it; width to be 19 ft. in place of 15 now in force; company to grant suburban lines right of use of tracks into city center.

A recent valuation of the company's property by the City Engineer, F. W. Cappelen, showed $21,152,221 present value of physical equipment, $4,270,230 business development, $631,857 power-plant leases, $1,300,000 terminal block, $142,045 property outside of the city; total, $27,496,353.

*

Changing Highway Officials for Politics Expensive

The American Highway Officials Association, which met in St. Louis, Mo., the week of Dec. 4, adopted the following resolution:

> We deplore the changing of local and state highway officials for political reasons and suggest that the energies and efforts of this Association be exerted to establish in the public mind and conscience a recognition and appreciation of experienced and faithful officials. The public must pay the expense of training every person engaged in administrative and scientific pursuits that affect the public interest, and as sound business officials who have been trained, or who have acquired experience, they should be retained in office so long as they render service with a loyalty of purpose. The keynote that should govern the selection of highway engineers should be efficiency. For this reason we would urge upon the legislatures and governors of every state to secure the passage of such laws as will place the office of highway engineers free from political embarrassment and secure to the people the benefit of experience for which they have paid. Until this method is established and the public realizes the importance of such a move, the taxpayers of the country cannot hope to receive the best results for their money.

Other resolutions passed at the meeting recommended the passage of the bill now before Congress, which provides for the working of Federal prisoners upon the public roads; pledging the coöperation of the state highway officials and departments in carrying out the Federal aid road law; and recommending a conference of representatives from the various state highway department laboratories to obtain closer coöperation with the testing laboratories of the Federal Government. The Federal Trade Bureau was asked to investigate alleged illegal practices on the part of owners of patents on road-making processes and methods. It was recommended that the various good roads organizations endeavor to consolidate, or at least arrange for a single national meeting.

*

Five Second Lieutenants of Engineers in the United States Army were appointed from civil life as a result of the recent examinations. This brings the civilian appointees to the Corps of Engineers up to thirteen.

Cleveland Garbage Tankage will yield the city $57,600 in 1917 for an output of 6,000 tons, in accordance with a contract just let to F. G. Royster, Norfolk, Va. This is said to be the highest unit price ever received.

Paving and Street Repair Work in New Orleans, La., next year (1917) will amount to $750,000, according to present estimates. Newspaper reports state that the larger part of the new pavements will be of creosoted wood block.

St. Louis County Road Bond Issue Is Valid, according to a decision of the United States District Court. This will make $3,000,000 available for road improvement around St. Louis, Mo., unless further legal obstacles are encountered.

Improvements to the Water-Works of Atlanta, Ga., recommended by Z. Smith, manager, include: Low intake dam across Chattahooche River, $15,000; coagulating basins, $150,000; clear-water reservoir, $100,000; 20,000,000-gal. pump with boilers, etc., at Chattahooche River station and also at Hemphill station, $400,000 for the two; cast-iron pipe in place, $310,000.

Sewage Disposal for Buffalo, the Tonawanda's, La Salle and Niagara Falls, N. Y., is being investigated by Rudolph Hering and George W. Fuller, New York City, and Harrison P. Eddy, Boston, to pass upon questions raised by the International Joint Commission in its studies and recent report on the pollution of the boundary waters of the United States and Canada.

The Memphis Municipal Electric Project has been dropped by the city government. An agreement has been made with the two local companies for 33% reduction in rates and the payment of $100,000 by the companies. The new base rate is 6c. per kw.-hr. and the minimum is 3c. A 30c. service charge is allowed, but no charge is to exceed 7½c. per kw.-hr. The two concerns will consolidate under an extended franchise. The city will cancel the $1,500,000 bonds already sold and pay the purchasers $15,000.

Reservation of Petroleum Deposits on Government lands for naval use was recommended by the Naval Consulting Board on Dec. 9. In view of the adoption of oil fuel for naval vessels the board believes the Government should reserve the title to public lands containing oil deposits sufficient to assure the supply of the navy for at least half a century to come. The navy is now using 842,000 bbl. of fuel oil a year in time of peace, and it is estimated that this will increase to over 10,000,000 bbl. in 1927. In time of war this consumption would be increased at least threefold.

That the Activated-Sludge Process will handle the trade wastes from the Chicago packing-house district in such a manner as to produce an effluent suitable for discharge into the channels of the Sanitary District of Chicago, is the conclusion of a report made to the Sanitary District. This report was prepared by Langdon Pearse, division engineer, representing the Sanitary District, and Dr. W. D. Richardson, chief chemist, Swift & Co., representing the stockyards interests. Having decided upon this point they are now considering the manner of collecting the sewage and wastes from the several plants, and also the general character of the works necessary for carrying out this treatment.

An Increase in Car Demurrage Rates went into effect on Dec. 15 with the approval of the Interstate Commerce Commission. The receiver of a carload of freight has two days' free time in which to unload his consignment, after which demurrage will be charged at the rate of $1 for the first day, $2 for the second, $3 for the third, $4 for the fourth and $5 for the fifth and each succeeding day that the car is detained. At the same time the railways raised the per diem rate for cars used in interchange from 45c. a day to 75c. a day. It is hoped that this will have some influence in impelling railway companies to send home cars belonging to other companies which they are now detaining for their own use.

Water-Works Improvements at Nashville, Tenn., have been reported on by a committee of the Nashville Engineering Society, headed by W. H. Schuerman, dean of engineering, Vanderbilt University. The committee advises that instead of carrying out immediately the $1,750,000 scheme of Commissioner Robert Elliott, now before the City Commission, less extensive improvements at a cost of about $500,000 be made to serve for some years. The Elliott scheme included a new intake and pumping station with two low-lift and two high-lift pumps 5 mi. in a straight line and 12 mi. by river above the present intake and above two undesirable tributaries of the Cumberland River; a 75,000,000-gal. coagulation and sedimentation basin at or near the new pumping station; two 36-in. force mains, 62,280 ft. long, and the use of the present settling reservoir as a clear-water basin. The committee already named says the Elliott project is feasible, but thinks its execution should be deferred. The committee advises the employment of an outside engineer to pass on the alternative plans for improving the present pumping station, as proposed in 1915 by Barclay Parsons & Klapp, consulting engineers, New York City. (See "Engineering News," Dec. 16, 1915, p. 1196). One of these plans was for a 20,000,000-gal. steam pumping engine and the other was for three electrically driven 7,500,000-gal. centrifugal pumps. The committee recommends the employment of a bacteriologist to make daily tests of the water; a chemist for occasional tests; a draftsman to prepare maps of the distribution system and to do other work; and that the reserve coal supply be increased to a month from the present supply of only a few days.

PERSONALS

W. J. Parkes has been appointed County Highway Engineer of Jefferson County, Arkansas, succeeding H. H. Humphreys.

E. L. Crugar, Assistant Engineer of the Illinois Central R.R., Chicago, Ill., has been promoted to be District Engineer at New Orleans, La.

E. L. Cannon, recently chief clerk to the Chief Engineer of the Seaboard Air Line Ry., has been promoted to be Office Engineer at Norfolk, Va.

J. Harry Deane, Assistant Engineer in the city engineering department of Indianapolis, Ind., has resigned after about 25 years' continuous service.

W. S. Curtis, of San Francisco, has been appointed Assistant State Engineer of California. He was one of three who passed the required civil service examination.

J. H. Schuch has been appointed Chief Engineer of the Butte, Anaconda & Pacific Ry., to succeed Charles A. Lemmon, resigned, as noted in these columns, Nov. 9, 1916.

W. L. Kellogg, Superintendent of Motive Power of the Missouri, Kansas & Texas Ry., has resigned to accept the same position with the Chicago, Rock Island & Pacific Ry.

C. C. Hufline has been appointed City Engineer of Frankfort, Ind., succeeding the late R. H. Boynton. He served as City Engineer previous to 1905, when he entered the contracting business.

Robert E. Barrett, Assoc. M. Am. Soc. C. E., formerly Acting Chief Engineer of the Directors of the Port of Boston, Mass., is now with Fay, Spofford & Thorndike, Consulting Engineers, Boston.

W. D. Salter, for the past 10 years an Assistant Engineer in the city engineering department of Denver, Colo., has been appointed City Engineer of Boulder, Colo., succeeding George R. Joslin, resigned.

John Swan, Jr., has been appointed Director of the Department of Public Works of Pittsburgh, Penn., succeeding the late Edward M. Bigelow. He is a brother of th [illegible] Robert Swan, the former Director of Public Works.

Gordon Sumner, Civil Engineer, of Wauchula, Fla., has been appointed Highway Engineer of Bay County, Florida, of which Panama City is the county seat. He will have charge of surveys and construction of a road system to cost $375,000.

W. F. Angus, M. Can. Soc. C. E., Vice-President and Managing Director of the Canadian Steel Foundries Co., Montreal, Que., has resigned to become an official of the Dominion Bridge Co., Montreal, with which he was formerly connected.

Theron Wasson, formerly connected with the New Jersey and Pennsylvania joint commission on toll bridges over the Delaware River, has been appointed Water Engineer of the Department of Conservation and Development of the State of New Jersey

C. E. Scribner, F. Am. Inst. E. E., Chief Engineer of the Western Electric Co., New York City, has been relieved of his executive duties, at his own request, and has been appointed Consulting Engineer of the company. He has been connected with the company for 40 years.

W. L. Clark, Assistant Highway Engineer, State Highway Department of California, has been made Division Engineer of the division including San Francisco, to succeed A. E. Loder, who resigned to become Assistant Chief Engineer of the United States Office of Public Lands, as noted in these columns, Oct. 26, 1916.

John P. Morgan, a student in the School of Applied Design, Carnegie Institute of Technology, is the winner of the $250 prize offered by the Pittsburgh Beaux Arts salon for designs of methods of improving street intersections in the residential districts of the city. The competition was open to all engineers, architects and students in Allegheny County.

George McCormick, former Mechanical Engineer of the Southern Pacific Ry. and more recently Assistant General Manager at Houston, Tex., has been appointed General Superintendent of Motive Power of the lines west of El Paso, with headquarters at San Francisco, Calif. He is a mechanical engineering graduate of the Agricultural and Mechanical College of Texas, class of 1891, and entered the railway service as a shop apprentice of the Galveston, Harrisburg & San Antonio R.R.

OBITUARY

Frederic H. Reed, Assoc. Am. Inst. E. E., Vice-President of J. G. White & Co. and a director of many electric companies, died Dec. 9 at his home in New York City.

Erwin Chester Sherman, Mechanical Engineer with the William B. Pollock Co., Youngstown, Ohio, died Dec. 8, aged 36 years.

Grant Rohrer, M. Am. Soc. C. E., a contractor of New York City, died Dec. 12. He was born in Lancaster, Penn., in 1864, and his early experience in engineering was in Western railway construction. He opened a New York office as a contractor in 1890.

William C. Nixon, President of the St. Louis & San Francisco R.R., died Dec. 16, in his 59th year. He was born in Illinois and began his railway experience as a bridge carpenter on the Burlington & Missouri R.R. in Nebraska in 1878. From this position he rose through clerical work to become Trainmaster of the Southern Kansas Ry. in 1885. In 1900 he became General Superintendent of the Gulf, Colorado & Santa Fe Ry., at Galveston, Tex., and in 1906 General Manager of the St. Louis & San Francisco R.R. He was elected President in 1913.

F. C. Fisher, President of the Ferro Construction Co., Chicago, whose death on Dec. 6 was noted in these columns last week, was born at Lake Linden, Mich., May 24, 1871. He graduated from the grammar and high school at Lake Linden, and also graduated from the Engineering Department of the University of Michigan at Ann Arbor. After leaving the University he was employed by the Detroit Bridge Co., and also the American Bridge Works, of Chicago, as draftsman and engineer. In 1899 he had charge of the erection of the steelwork for the Great Northern Ry. grain elevator at West Superior, Wis. He also had charge of the erection of the railway cantilever bridge over the Mississippi River at Thebes, Ill., and the bridge of the Fort Dodge, Des Moines & Southern Ry. at Fort Dodge, Iowa. In March, 1907, he and B. B. Sieris formed the Ferro Construction Co., of Chicago, and he was its President until his death. His company has done erection work for several of the large railways, and its business will be continued. His most recent work was the erection of the 600-ft. steel-arch span for the new Detroit-Superior viaduct at Cleveland, Ohio, and he also erected the mile of steel towers and girders for the new Clark Ave. viaduct, at Cleveland. Mr. Fisher leaves a widow and two children.

ENGINEERING SOCIETIES

OKLAHOMA SOCIETY OF ENGINEERS.
Dec. 27-28. Annual meeting in Tulsa. Secy., H. G. Hinckley, Oklahoma City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 27-29. Annual meeting at Chicago. Secy., D. K. Shedd, Ames, Iowa.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

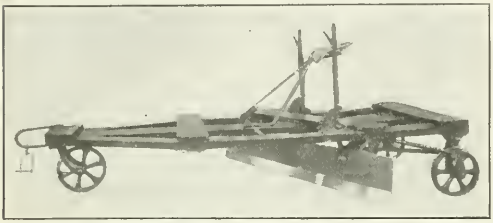
SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

The Minnesota Branch of the American Water-Works Association was organized at a recent meeting in Minneapolis. The officers elected are: President, F. W. Cappelen, city engineer of Minneapolis; vice-president G. O. House; treasurer, W. R. Young; directors, William [illegible], L. A. Gordon and D. A. Reed. The meeting was attended by about 30 water-works men, of whom two-thirds were members of the American Water-Works Association.

Appliances and Materials

Light, Inexpensive Road Plane

A road plane, of light and simple construction and with an adjustable cutting blade has been put on the market by the Hodge Road Machine Co., Ligonier, Ind. The cutting blade is so arranged that it can be lifted clear of the ground or, by the use of levers, can be made to cut to a depth of several inches, either horizontally or at an inclination, so as to give a finished crown. The accompanying illustration shows its size and appearance. It is sold for $50.



NEW $50 ROAD PLANE

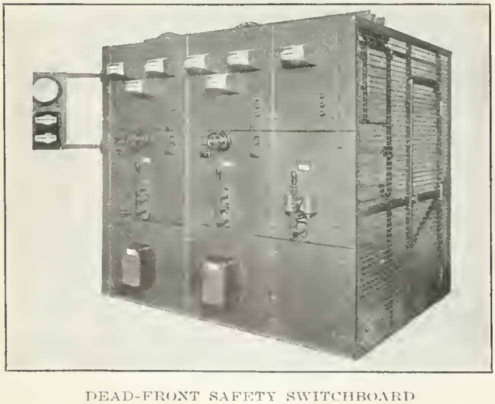
* * *

Safety-First Switchboard

In response to the demands of large users of electrical machinery the General Electric Co., of Schenectady, has developed a type of switchboard, shown in the accompanying view, on which it is almost impossible for an attendant to be injured.

All live parts, except current and potential receptacles, are inaccessible from the front of the board, and the live parts of these receptacles are recessed so that accidental contact with them is difficult. Grillework screens afford protection against accidental contact with live parts in the rear of the board. Hinged doors provided with spring locks are placed one on each side of the grillework, making it impossible for anyone other than an authorized person holding the key to enter the space at the rear of the switchboard.

Disconnecting switches are used between all oil circuit-breakers and busbars, and provide convenient and rapid isolation, without hazard of the breakers from the bus for inspection, changing oil or repairs. Instead of the usual calibrating switches back of the panel this board is equipped with front-of-board calibrating receptacles that permit safe and convenient calibration of instruments and meters from the front. The board is also equipped with removable fuse receptacles of the screw-plug type, which provide for a replacement of secondary-potential transformer fuses from the front of the switchboard without the danger of contact with live parts. The live parts of the field switches are mounted on slate bases back of the panel and are connected to operating handles on the front of the board by rods and bell cranks. With this mounting, it is impossible for the switchboard attendant or the instruments to be injured by the arc, as sometimes happens with the live-front type. When switches are required for arc or incandescent circuits, they are of the dead-front style.



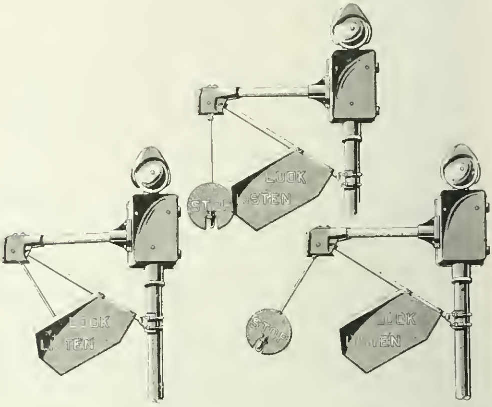
DEAD-FRONT SAFETY SWITCHBOARD

* * *

Closed-Circuit Automatic Flagman

The growing demand for visual warning signals (commonly called "automatic flagmen") for railroad grade crossings has led the Union Switch and Signal Co., of Swissvale, Penn., to develop a type that embodies many of the safety principles of automatic block railway signals—notably, reliance on a closed electric circuit to hold the signal at clear, so that in any trouble the caution warning is exhibited.

Under normal conditions this flagman indicates the approach of a train by swinging a red banner on which appears the word "Stop" and displaying a red light attached to the banner. When no train is approaching, the banner is held to one side between two screens, upon which is painted "Look and Listen," and the lamp suspended from the banner is not lighted. If the circuit through the holding magnets is broken, but the apparatus is otherwise in good condition, the banner will swing irrespective of the approach of a train. If the circuit is broken through the operating magnet, but not through the holding magnet, the banner will be retained in its extreme position between the screens until a train approaches, when it will be released and ultimately assume a vertical position with the banner stationary, but fully displayed. If current is totally cut off the mechanism or if the operating parts become disconnected, the banner will also assume the vertical position and be fully displayed.



LOCKED, WORKING AND DEAD POSITIONS OF UNION GRADE-CROSSING SIGNAL

The operating mechanism is inclosed in a weatherproof case and consists essentially of an operating magnetic mechanism for driving the swinging banner, and of holding magnets for retaining the banner at one end of its arc of travel. This flagman is designed to operate normally at 10 volts, direct current. It requires an average of 0.4 amp. for swinging the banner, and 0.4 amp. for the 5-watt 12-volt banner lamp, making an average of 0.8 amp. drawn from the battery while the banner is swinging. The holding magnets require normally only 0.01 amp. when the flagman is latched in the clear position. The control of this flagman is so arranged that it is unnecessary to break the operating circuit through relay contacts. The only current passing through these contacts is that required for holding the mechanism in its latched position.

The flagman can be equipped with a bell and with either an oscillating or a fixed lamp. If desired, the fixed lamp can be arranged to burn oil and to give alternately red and white flashes of light as the banner swings to and fro, and a white light when the banner is latched clear. The control of the flagman can be effected by any of the well-known automatic or nonautomatic methods in general use, and the flagman itself adapted to any ordinary condition of highway protection.

Engineering News

VOLUME 76 DECEMBER 28, 1916 NUMBER 26

Flushing Streets from Trolley Cars at Worcester, Mass.

Trolley-car street flushers have been in use in the cities of Worcester and Springfield, Mass., for over a year. Worcester was the first city in the country to introduce street-car sprinklers, and in 1915 it was the first to introduce the new street-car flushers. A. T. Rhodes, Street Commissioner of Worcester, from whom the following data were obtained, states that these machines are operated throughout the entire season with great satisfaction—so much so that during the present year (1916), the older methods of street cleaning have been abandoned on all paved streets where there are electric-railway tracks.

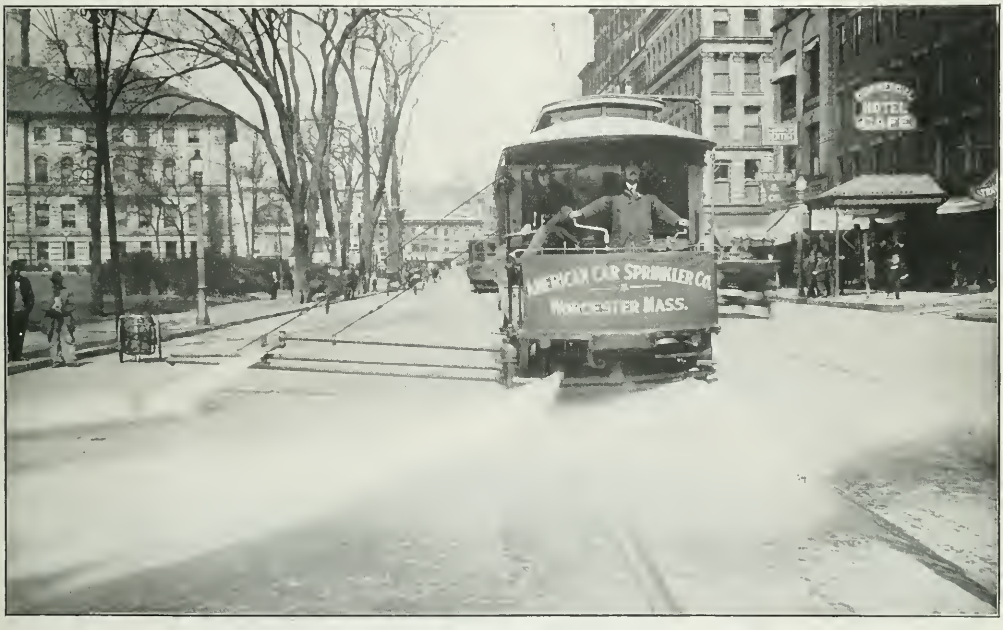


FIG. 1. STREET-FLUSHING TROLLEY CAR AS USED AT WORCESTER, MASS.

The flushing machine used is a trolley car, containing a tank with a capacity of 2,900 gal. The tanks are filled from subsurface hydrants placed between the rails or tracks of the trolley system, and accessible by removing ordinary sewer manhole covers. The temporary connection is made by flexible leather pipes.

The pressure for flushing is obtained by a centrifugal pump having a maximum capacity of from 500 to 600 gal. per min., a speed of 2,600 r.p.m., giving a normal working pressure of 80 lb. per sq.in. The pump is driven by a 45-hp. electric motor. The pump discharge is equipped with a bypass, enabling the operator to cut down the nozzle pressure to as low as 30 lb. per sq.in. The operation of the car and flushing apparatus requires a crew of three men.

On the wide streets there are five nozzles pointing in the direction the car is going, three on the car and two on the swinging arms (see Fig. 1). One of the three nozzles on the car, on a double-track street, catches the refuse lying on the paving between the two tracks and throws it to the opposite track, then the return trip in the opposite direction catches the material and flushes it to the gutter.

Sprinkling within an hour ahead of the flushing has been found to be essential for the best results. For this purpose the older sprinkler type cars are economically used. The sprinkling softens up any deposits which are stuck down on the pavement and makes it easy to remove them with the flusher. The new flusher cars have the original sprinkling attachments, both on the car and on the swinging arm, so that the same car can be used for both sprinkling and completing the work with the flushing nozzles, if so desired.

With preliminary sprinkling a car flusher will cover about 10.5 mi. of street per night. The average eight hours' work for a car doing both sprinkling and flushing is about 9 mi. of street varying from 25 to 75 ft. between curbs. During eight hours' use the car flusher distributes approximately 95,700 gal. of water. One tank of water is sufficient to sprinkle a street 38 to 45 ft. wide between curbs a distance of about one mile. The same tank of water will properly flush between one-quarter and one-third of a mile.

Previous to the adoption by the city of the method of flushing at night, the streets were sprinkled by trolley cars during the day. Under the day sprinkling system the water simply laid the dust, and the other refuse which had accumulated upon the street surface remained, forming a greasy, slippery scum on the surface, extremely dangerous to vehicular traffic. Night flushing has made it possible to discontinue sprinkling during the day.

When the day sprinkling was in operation three car sprinklers, making several trips over each street every day, covered the same area now covered by two flushers, making one round trip nightly, for sprinkling and flushing combined. The flushers work eight hours, and the sprinklers under the old method worked 14 hr. per day. The amount of water used under the flushing system is about 60% of that used under the old style sprinkling, while the present combined sprinkling and flushing requires about 85% of the former amount.

Previous to the installation of this system two machine broom squads were worked at night, covering these paved streets from two to three times per week. This work cost $14,000 yearly and was not very satisfactory. Moreover, it was difficult to keep track of the labor during the night hours. This has been discontinued entirely; the only cleaning necessary is taken care of by pushcart men, the first thing in the morning. They clean up the gutters, and owing to the fact that the streets are absolutely clean when they reach them, their labors have not been increased nor is there any additional expense incurred.

The cost of catchbasin cleaning has been just about doubled on streets which are flushed. The average cost per catchbasin per year for cleaning was $1.95, and on streets flushed this has been increased to $3.90.

The street-car flushers and sprinklers are operated under contract with the American Car Sprinkler Co., of Worcester, which in turn makes the contract with the street railway company for use of tracks and for power.

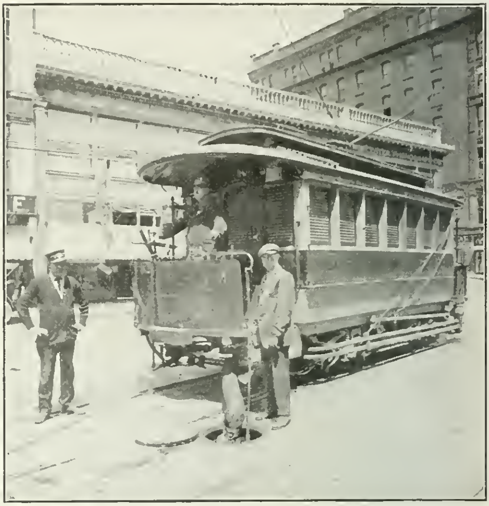


FIG. 3. FILLING CAR FROM SUBSURFACE HYDRANT

Each car is equipped with "Servis" recorders, as a check on the mileage covered. The accompanying tables give the contract prices for flushing and for sprinkling. The assesments against abutting property for street cleaning vary by ½c. per lin.ft. for each 5 ft. in width of street from 3½c. for a 25-ft. street to 10c. for an 80-ft. street. The American Car Sprinkler Co. has similar contracts with Malden, New Bedford, Springfield and Somerville, Mass., Manchester, N. H., and Syracuse, N. Y.

Similar methods have been employed in Worcester by using motor-truck flushers and sprinklers. The two

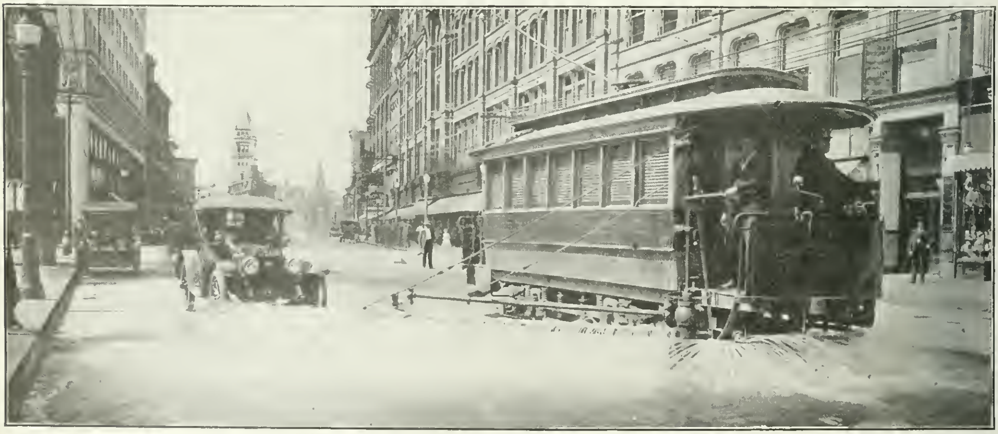


FIG. 2. FLUSHING CAR USING SPRINKLING APPARATUS

trucks now in use there average together about 5 mi. of streets per night, but in addition the trucks do some sprinkling and flushing to help out the trolley work. There are not enough paved streets without trolley tracks to make their independent operation economical.

TABLE 1. CONTRACT PRICES OF WORCESTER STREET SPRINKLING AND FLUSHING

Street Sprinkling		Street Flushing	
Width of Street, Ft.	Cost per Mile	Width of Street, Ft.	Cost per Mile
25	$396.00	25	$448.80
30	464 64	30	552 72
35	533 28	35	596 64
40	564 96	40	633.60
45	596 64	45	670 56
50	665.28	50	749 76
55	733 92	55	823 68
60	929 28	60	1,045 44
65	997.92	65	1,119.36
70	1,129.92	70	1,272 48
75	1,198.56	75	1,346.40
80	1,261.92	80	1,420 32

TABLE 2. ASSESSMENT PER FRONT FOOT ON ABUTTING PROPERTY

Width of Street, Ft.	Per Lin Ft. Cents	Width of Street, Ft.	Per Lin.Ft., Cents
25	3½	60	7½
30	4	65	8
35	4½	70	9
40	4¾	75	9⅓
45	5	80	10
50	5½	100	11⅝
55	6		

* * *

Bottom Driven Concrete Piles on Government Job

By C. S. Howell*

Reinforced-concrete piles of the Giant type. that is piles which are driven by a temporary follower against projections on the pile point (see *Engineering News*, Mar. 2, 1916), are being successfully used on a new Federal building at Wilmington, N. C., under conditions which it was considered precluded the use of piles entirely. A typical pile section and location is shown in the accompanying drawing.

The site of this work was formerly covered with buildings which were razed to make way for a new Custom House, Appraiser's Stores and Court House. The old foundations were left below the surface of ground practically intact. Under these, the earth is generally a mixture of fine blue sand mixed with clay, and in places heavy beds of a substance resembling asphalt have been encountered. The consistency of the earth penetrated is such that excavation is extremely difficult, due to adhesion to the excavating implements, and the earth has refused to yield to enormous water pressure applied through jets.

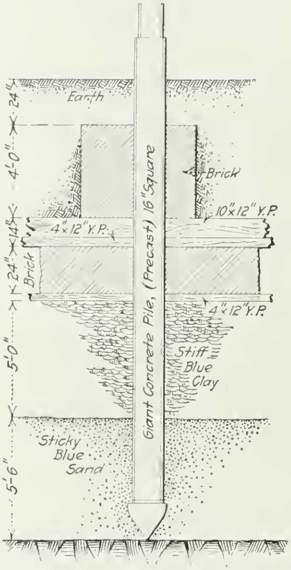
The piles are driven in an average time of eight minutes, actual driving, to refusal upon the underlying coral rock.

The work involves 710 piles, with an average depth of 25 ft. They are driven with a No. 0 Vulcan steam hammer, weighing 17,500 lb. and delivering 1,800,000 ft.-lb. per min. The piles are 16-in. square and contain four ¾-in. square deformed bars which are looped or hooked through the cast-iron point and tied at intervals to maintain uniform spacing.

Why Not Design Piles for Loads?

In connection with this work it has occurred to the writer to inquire why concrete piles should not be proportioned to the load they must carry. With wooden piles natural restrictions made it quite general to load without regard to the size of the pile, probably because there did not exist any great variation in size with regard to ratio of end diameters to length. The introduction of concrete piles did not involve this fixed condition but opened the way to proportioning size to imposed loading. Yet it is notable that little use of this important fact is now resorted to. Concrete piles are placed without regard to the individual capacity of the pile selected. By means of the method described by the writer in *Engineering News*, Apr. 27, 1916, it is possible without difficulty to apply the Wellington formula so that the load capacity is obtained, accordingly leaving no good reason for not selecting any particular pile upon the basis of its suitability and its cost per ton of load carried rather than by the haphazard manner most generally followed.

The pile shown in the sketch herewith is good under the New York building regulations for about 65 tons safe load, which is in full accord with the usual conservative practice regarding stresses allowed in superstructures subjected to vibration and other sources of danger not involved to the same degree in substructures. As a quite general thing in foundation work it will be found that plans are prepared for a fixed number of piles, and the type of pile as well as its load capacity are given little consideration in competition upon cost, whereas a consideration of the simplicity of work in adopting piles to foundation layouts would involve more exact competition both upon cost and merit.



SECTION OF GROUND THROUGH WHICH WILMINGTON, N. C., PILE WAS DRIVEN

Building regulations are striving to regulate rule-of-thumb methods, as in New York City where 500 lb. per sq.in. of cross-section is allowed upon precast piles and 350 lb. upon cast-in-place piles, and also where average cross-section applies in case of tapered piles. Aside from such regulations, the custom largely prevails of using so many piles upon customary centers more according to footing areas than to the capacity of the piles.

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*Civil Engineer, 550 W. 171th St., New York City.

Rainfall Data Interpreted by Laws of Probability

By Thorndike Saville*

SYNOPSIS—Presents enough theory, with examples, to make the probability method available to those not proficient in the use of least squares. Indicates practical applications not in general use.

The interpretation of physical observations may be greatly enhanced by the application of the laws of probability. This method is one not in general use by engineers, due possibly to the limited extent of adequate knowledge regarding it. The writer presents herewith an outline of the method and computations involved in its application to the rainfall data of Hartford, Conn.

Mean of a Series of Observations

The method finds its basis in the general laws of probability which may be found in any textbook on least squares. In any series of recorded observations having equal weight and upon the same quantity, it is mathematically true and has been generally assumed that the most probable value is the average or mean of the observations. Where $M_1, M_2, M_3, \ . \ . \ . \ M_n$ represent n single observations of equal weight on a single quantity (such as yearly records of rainfall) the most probable value of that quantity is $\dfrac{M_1 + M_2 + M_3 + \ldots\ldots M_n}{n}$. Thus in Table 1, column 1, the most probable value of the annual rainfall at Hartford is about 44 in. This, or any, most probable value is more or less probable, according to the number and frequency of the observations. The probable error of the mean is explained in the following section. The lower the probable error, in general the more accurate the series of observations, and the more probable the mean of the series.

Variations and Probable Error

The amount by which any observation in a series differs from the mean is called the residual or "variation," and is expressed by v. Thus if M_1, M_2, M_3, etc., represent any series of observations and P represents the mean of the series, then $P - M_1 = v_1$, $P - M_2 = v_2$, $P - M_3 = v_3$, etc. The variations of the annual rainfall at Hartford from the 47-year mean are given in Table 1, column 2.

The calculation of the variations may be considerably shortened by taking the mean to the nearest even inch, and subtracting each individual observation. The error introduced is not appreciable in rainfall computations. (See King's "Elements of Statistical Methods," page 149).

By the laws of probability, the mathematical deductions of which are here omitted, "in measurements of equal precision the most probable values of observed quantities are those which render the sum of the squares of the residual errors (variations) a minimum."[1] Hence the term "least squares." The squares of the variations for the Hartford data are tabulated in Table 1, column 3.

The most probable value of a series of observations of equal weight upon a single quantity is then the arithmetic mean. Thus if

Z = Most probable value of a term in a series of observations;
n = Number of observations;
M = Any observation:
v = Variation of a single observation from the mean;
r = Probable error of a single observation;
R = Probable error of the mean;
Σ = Sum of.

Then, omitting mathematical proof,

$$Z = \frac{\Sigma M}{n}, \quad r = 0.6745\sqrt{\frac{\Sigma v^2}{n-1}},$$

$$R = \frac{r}{\sqrt{n}} = 0.6745\sqrt{\frac{\Sigma v^2}{n(n-1)}}$$

The quantity $\sqrt{\dfrac{\Sigma v^2}{n-1}}$ is called the "standard varia-

TABLE 1. STUDY OF RAINFALL DATA, HARTFORD, CONN.

Yearly Rainfall in Inches in Order of Magnitude	Variations from the Mean	Variations Squared	Percentage of Total for Plotting
33.64	10.34	106.92	0.0106
34.11	9.89	97.81	0.032
34.78	9.22	85.01	0.053
35.74	8.46	71.57	0.074
36.02	7.98	63.68	0.096
36.88	7.12	50.69	0.117
36.91	7.09	50.27	0.134
37.04	6.96	48.44	0.160
37.68	6.32	39.94	0.180
38.25	5.75	33.06	0.201
38.95	5.05	25.50	0.224
39.16	4.84	23.43	0.245
39.45	4.55	20.70	0.266
39.73	4.27	18.23	0.288
40.17	3.83	14.67	0.309
40.75	3.25	10.56	0.330
41.09	2.91	8.47	0.351
41.53	2.47	6.10	0.372
41.56	2.44	5.95	0.394
42.07	1.93	3.72	0.415
42.07	1.93	3.72	0.436
42.20	1.80	3.24	0.457
42.42	1.58	2.50	0.478
43.60	0.40	0.16	0.499
43.66	0.34	0.12	0.522
45.35	1.35	1.82	0.543
45.37	1.37	1.88	0.564
45.54	1.54	2.37	0.585
45.62	1.62	2.62	0.606
45.83	1.83	3.35	0.627
46.32	2.32	5.58	0.650
46.81	2.81	7.90	0.671
47.13	3.13	9.80	0.692
47.29	3.29	10.82	0.713
48.47	4.47	19.98	0.735
48.71	4.71	22.18	0.756
49.22	5.22	27.25	0.777
49.26	5.26	27.67	0.798
50.25	6.25	39.06	0.819
50.29	6.29	39.56	0.840
51.66	7.66	58.68	0.861
52.00	8.00	64.00	0.882
52.69	8.69	75.52	0.903
53.59	9.59	91.97	0.924
55.12	11.12	123 65	0.945
55.81	11.81	139.48	0.967
56.36	12.36	152.77	0.990
$\Sigma M = 2,067.95$		$\Sigma v^2 = 1,722.17$	
$\frac{\Sigma M}{n} = \frac{2,067\ 95}{47}$ = 44 00 The Mean		$R = 0\ 6745\sqrt{\frac{\Sigma v^2}{n(n-1}}$ = 0 6020 Probable Error of the Mean	$\sqrt{\frac{\Sigma v^2}{n-1}}$ = 6.119 Standard Variation

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*Assistant in Geology, Harvard University; and Field Assistant in Surveying, Thayer School of Engineering at Dartmouth College.

[1] "Textbook on the Method of Least Squares," by Mansfield Merriman.

tion," and the ratio of the standard variation to the mean, that is, $\dfrac{n\sqrt{\dfrac{\Sigma v^2}{n-1}}}{\Sigma M}$, is called the "coefficient of variation." The first term is simply the expression for probable error of a single observation with the constant 0.6745 omitted. The coefficient of variation indicates the frequency of departure of single observations from the mean, and serves as a means of comparing similar data from different localities. The application of this coefficient to the interpretation of rainfall data has been presented by Allen Hazen in *Engineering News*, Jan. 6, 1916. The following remarks are taken from his article on "Variation in Annual Rainfall":

> The coefficient of variation is lowest on the Atlantic coast. That means that one can count on getting more nearly the normal rainfall each year; and on the Atlantic coast the coefficient does not range through wide limits. . . . As one goes west, the coefficient in annual rainfall increases; that is to say, the chance of a very dry or a very wet (relatively) year is increased. . . . At New York the coefficient of variation is 0.15; at San Francisco it is 0.30. This means that on the average the relative variations in annual rainfall at San Francisco are twice as great as at New York.

The coefficient of variation for Hartford, as computed[2] from the data in Table 1, is thus from the formula above $\dfrac{47\sqrt{\dfrac{1,722.17}{46}}}{2,067.95} = 0.139$, which does not vary greatly from that at New York.

When used in the interpretation of rainfall data it is evident that the quantity called here the "probable error" is not an expression of error, but an indication of the annual variations from the mean, although observational errors are also included in the adjustment. It represents, let us say, the error of nature in not providing a constant annual rainfall. This annual deviation and its frequency is best expressed by the coefficient of variation, although, as can be seen from the formula, this latter is dependent upon the probable error, so called. The relation between these two quantities is indicated in the table below, a low probable error producing a low coefficient of variation.

From these figures it is evident that individual observations of rainfall extending over long periods of time do not necessarily tend to depart less from the mean than they do in certain shorter time records. Frequency of departures from the mean are dependent upon location of the place and the governing meteorological conditions, and are indicated by the magnitude of the coefficient of variation. Thus at Hartford, with a 48-year record, the annual rainfall varies less from the average than does that at Boston with a 96-year record. To be comparable, however, the observations must be of equal precision, and whether they are so in the cases cited the writer is unaware.

TABLE 2. STUDY OF HARTFORD, BOSTON AND NEW BEDFORD RAINFALL DATA

Place	Years of Record	Probable Error of Single Observation	Standard Variation	Probable Error of Mean	Coefficient of Variation
Hartford, Conn.	48	4.127	6.119	0.6020	0.139
Boston, Mass.	96	5.458	8.092	0.5571	0.178*
New Bedford, Mass..	100	4.468	6.624	0.4468	0.143*

*"Rainfall in New England," by X. H. Goodnough, Jour. New Eng. W.-W. Assoc., Vol. XXIX, No. 3, 1915.

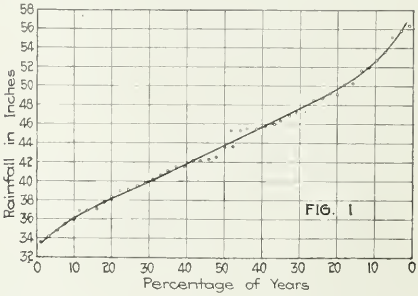

FIG. 1

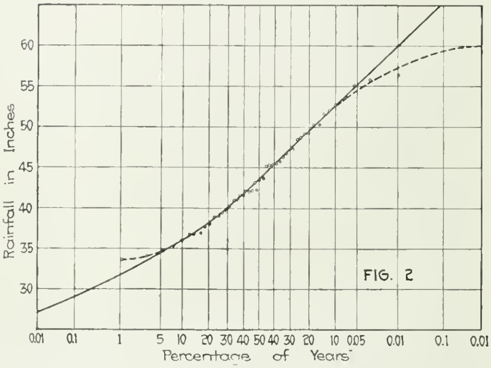

FIG. 2

FREQUENCY OF RAINFALL AT HARTFORD, CONN., 1868 TO 1914, INCLUSIVE

Time = 47 Years

Per Cent. of Time	Equivalent Years	Equals Once in	Rainfall in Inches of
25	11.8	4 yr.*	39 or less, or 48 or more
10	4.7	10 yr.	36 or less, or 53 or more
1	0.47	100 yr.	34 or less, or 56 or more
0.1	0.047	1,000 yr.	29 or less, or 65 or more

*It is at once evidence that the frequency of occurrence of a rainfall of any given magnitude is obtainable at once from the curve by the simple relations that

$$\text{Frequency} = \frac{100}{\text{Per cent. of time}}$$

Many communities in New England will in the next decade or so have 100 years of rainfall record. When this record extends over a period greater or less than 100 years by not more than 5 years, the probable error of a single observation may be obtained nearly enough by multiplying the probable error of the mean by 10. The standard variation is then found by dividing by 0.6745. Thus for New Bedford,

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[2] For purposes of illustration, and to indicate how expeditiously all the quantities mentioned may be found, the following computations for the Hartford data are presented. Reference should be had to Table 1 and the formulas.

```
log  Σv²  (1,722.17) = 3.23621
log  n(n-1)  (2,162) = 3.33486
                      -------
extract square root 2)1̄.90135        log n (47) = 1.67210
                      -------        log √n     = 0.83605
                       1̄.95062
log 0.6745           = 1̄.82898
                      -------
                       1̄.77960 = 0.6020 = R
log √n               = 0.83605
                      -------
                       0.61565 = 4.127 = r
log 0.6745           = 1̄.82898
                      -------
                       0.78667 = 6.119 = standard variation
log n (47)           = 1.67210
                      -------
                       2.45877
log  ΣM  (2,067.95   = 3.31555
                      -------
                       1̄.14322 = 0.139 = coefficient of variation
```

With care, the quantities may be computed accurately enough for most purposes by the slide rule.

$$\textit{Probable error of mean} = 0.4468$$

$$\textit{Probable error of single observation} = 0.4468 \times 10 = 4.468$$

$$\textit{Standard variation} = \frac{4.468}{0.6745} = 6.624$$

$$\textit{Coefficient of variation} = \frac{100 \times 6.624}{4{,}646.85} = 0.143$$

PETER'S FORMULAS FOR PROBABLE ERROR

There are simpler formulas for obtaining probable error known as Peter's formulas. These are somewhat easier of application in that they do not necessitate computing the squares of the residuals. They are based, however, upon slightly different reasoning than the standard formulas presented above, and unless the observations follow the probability curve fairly closely the results obtained from using these formulas will differ from those obtained by use of the standard formulas. Peter's formulas are given below:

$$R = 0.8453 \frac{\Sigma v}{n\sqrt{(n-1)}} \qquad r = 0.8453 \frac{\Sigma v}{\sqrt{n(n-1)}}$$

$$\textit{Coef. var.} = 1.25 \frac{\Sigma v}{\sqrt{n(n-1)}} \times \frac{n}{\Sigma M}$$

From these the following approximations are evident:

$$R = 0.85 \frac{\Sigma v}{n\sqrt{n}} \qquad r = 0.85 \frac{\Sigma v}{n} \qquad \textit{coef.var.} = 1.25 \frac{\Sigma v}{\Sigma M}$$

While, as stated, these formulas are considerably easier of solution than the standard formulas, they should be used only when it is known that the observational data follow the probability curve fairly closely. Ordinarily in computations involving rainfall data where comparison is likely to be made with figures obtained at other places, the chief value in these approximations lies in applying them as an independent check to computations made with the standard formulas.

Peter's formulas are presented here only from their utility as a check method, and because they have been suggested at times as offering a much simpler method of finding the probable error. Space does not permit of a discussion of the relative merits of the several formulas, but the standard formulas are those which are commonly used in scientific work.

THE MEDIAN OBSERVATION

If the series of observations be arranged in order of magnitude as in Table 1, column 1, that observation which has as many observations greater than it as there are less than it, is called the "median." In this case the median is 43.60 in. while the mean is 44 in. When there are a few very large or very small (relatively) observations entering into the calculation of the mean, the median is a better expression of the most frequent observation. When the median approaches the mean in value, as occurs in the Hartford data, it is commonly an indication that the series of observations follow closely the laws of probability. In such cases Peter's formula might be used as the shorter process. Both the median and the mean should be computed in all studies of rainfall data.

If a series of observations be arranged in order of magnitude and plotted against the frequency of their occurrence, and if they conform at all to the laws of probability, they will fall along a curve of the general form shown in Fig. 1. The Hartford rainfall data fall along a curve which closely approaches the theoretical in shape. Such a curve is defined as a "frequency curve."

In plotting such a curve as that in Fig. 1, the horizontal distance along which the abscissas will lie is divided into 100 parts. The observations, arranged in ascending order of magnitude, are plotted as ordinates, and the per cent. which each term is of the whole number of terms is plotted as abscissas. *The latter is plotted cumulatively.* Thus in Table 1, column 4, as there are 47 observations, each observation is $\frac{100}{47} = 2.128\%$ of the whole. The abscissa for the first observation is at the middle of the distance representing 2.128%, or on the 1.06% line. The next largest observation is plotted at a distance 2.128 greater than this, or on the 3.2% line; the next on the 5.4% line, etc. Hazen[3] states that the decimal position of the mth term in a series of n terms is $P = \frac{2m-1}{2n}$. In numbering the vertical lines the numbers have for convenience been made to run from 0 to 50 and back to 0 on the bottom of the diagrams, and from 0 to 100 on the top. Thus on the 80% line it is seen that 80% of the time a rainfall of 48.8 in. or less occurred, and that 20% of the time a rainfall of 48.8 in. or more occurred. It is the extreme value, however, which is of the chief utility, as is evident from the following paragraph. For convenience in computation the percentages are calculated from 0 to 100 as in Table 1, column 4.

When observational data fall along a curve of this general type so closely as in this instance, the probability of occurrence of a rainfall of any magnitude may be found at once from the curve. The method of using the curve is evident from the data given beneath Figs. 1 and 2.

THE STRAIGHT-LINE FREQUENCY CURVE

At times observational quantities when plotted do not lie smoothly along such a curve as that in Fig. 2, nor does the curve so nearly approach a straight line. In such cases, by varying the spacing of the ordinates in accordance with changes in the value of the probability integral, and by varying the spacing in the same proportion on each side of the 50% line, the ends of the curve may frequently be straightened and the data made to lie more nearly on a straight line. This line may then be produced beyond the limits of the observed data and the probability of occurrence of extraordinary phenomena predicted. The method of plotting is the same as for Fig. 1 and is illustrated in Fig. 2. The full line indicates the probable trend of the observations, while the dotted lines at each end follow more closely the plotted points. At the ends these points represent such infrequent phenomena that they are not of great value in determining the slope of the line.

At times the nature of the data is such (though rarely in rainfall studies) that the curve departs considerably from a straight line even on probability paper. Sometimes, in such instances, if the data be plotted to a logarithmic instead of to an arithmetic scale, a better curve will be obtained.

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[3] "Storage To Be Provided in Impounding Reservoirs for Municipal Water-Supply," by Allen Hazen, Trans. Am. Soc. C. E., Vol. LXVII. December, 1914. Tbis article treats in considerable detail of the application of the laws of probability to data relating to flow of streams and storage. It explains the method of using the probability curve from such data, and also the manner of constructing probability paper.

The writer has attempted in the foregoing discussion not only to present certain applications of the laws of probability to the interpretation of rainfall data, but also by formulas and tables to make plain the utilization of such data by those who are not versed in the theories of least squares. The value of the methods indicated lies in their applicability to the interpretation of rainfall statistics and their relation to the compilation of data pertaining to freshet conditions, storage, design of spillways, sewers, culverts, etc. Thus it might be allowable to design a sewer that would likely be flooded once in 100 years, while a sewer that would be flooded once in 10 years would be undesirable.

The formulas and methods outlined herein are of wide applicability, and opportunities to utilize them will be readily apparent. In many instances in engineering work, in addition to the interpretation of rainfall data, the utilization of statistical information according to the laws of probability, and the precision discussion of results, will be found of the utmost value. A recent article in the Journal of the Franklin Institute[4] presents briefly some of the more important applications of this method, and mentions its use in statistics relating to death rates, to the number of bacteria in water and milk, to sand analysis, to filter effluents, and to precision determinations of the free and albuminoid ammonia in water. The application of the methods of least squares to a precision discussion of tests on cement and sand briquettes has been previously indicated by the author.[5]

Acknowledgment is due Prof. G. C. Whipple, of Harvard University, for certain suggestions concerning the applicability of computed data to engineering practice, and to Prof. S. L. Ruggles, of the Thayer School of Civil Engineering at Dartmouth College, for review and criticism of the manuscript.

Hydraulic Hopper Dredge with Unloading Machinery

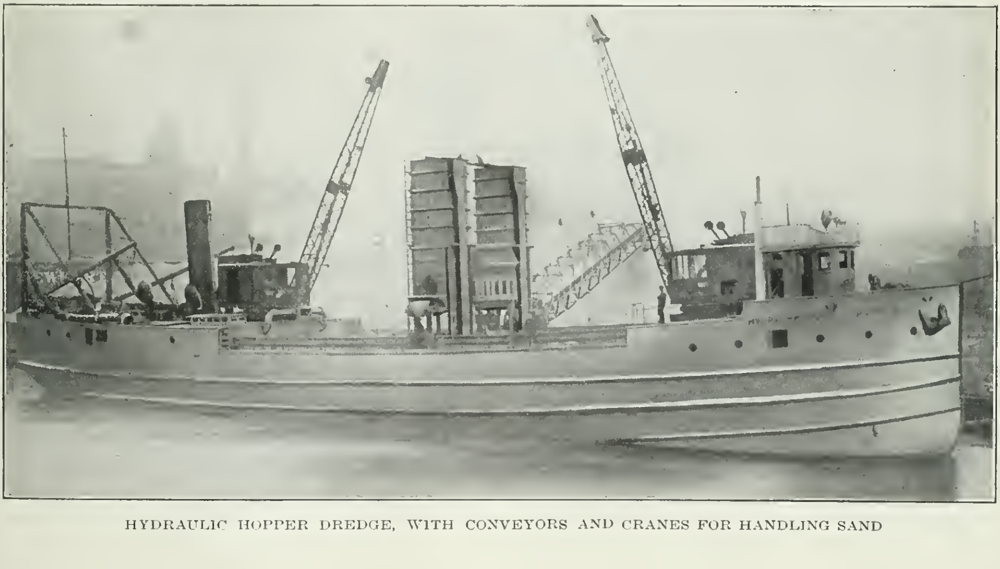
For dredging and transporting sand to be used in concrete and building construction, and also for filling, the Hydraulic Sand and Transit Co., of Chicago, has a large "sand-sucker," or suction dredge, with hopper capacity for 1,500 tons and with special equipment for putting the material ashore. This vessel—the "Hydro"—was built and equipped by the Manitowoc Ship Building Co., of Manitowoc, Wis.

This steamer is shown in the accompanying illustration. It has a steel hull 180 ft. long, 40 ft. beam and 19 ft. deep, with a draft of 10 ft. light and 14½ ft. loaded. Its displacement is 2,100 tons, and the two hoppers in the hold have combined capacity for 1,500 tons of sand. The propeller is driven by a triple-expansion engine of 650 hp.

There are two 12-in. suction pumps and pipes, and each pipe has a hinged outboard section of 12-in. rubber pipe 25 ft. long, from its connection to the fixed pipe, and having the mouth fitted with jets and teeth for loosening packed sand. These pipes are handled by booms guyed from a gallows frame at the stern of the vessel, and are swung on deck when not in use. They can dredge to a depth of about 20 ft.

If the sand is to be used for filling, it can be pumped ashore through a delivery pipe; but for storage it can be handled dry by means of grab buckets and belt conveyors. In the former case the necessary amount of water is delivered to the hoppers by means of a large force pump.

For unloading in dry condition, there are two McMyler revolving cranes, each with its own engine and boiler. These are mounted on the deck, and each handles a 1½-yd. grab bucket with a 45-ft. boom having a reach of 25 ft. for delivering the sand direct. Ordinarily, however, the grab buckets dump their contents into a hopper, beneath which runs a transverse belt conveyor. This feeds a 30-in. belt conveyor on a boom or frame 75 ft. long, which is hinged at the side of the vessel. The vessel can fill the hoppers in 1½ to 5 hr., and can discharge its load in 2½ to 4 hr. Its speed, when loaded, is about 12 m.p.h.



HYDRAULIC HOPPER DREDGE, WITH CONVEYORS AND CRANES FOR HANDLING SAND

The Element of Chance in Sanitation," Prof. G. C. Whipple, Jour. Franklin Inst., Vol. 182, Nos. 1 and 2, July and August, 1916.

[5] "Effect of Iron and Calcium on Concrete Sand," Thorndike Saville, "Engineering News," Vol. 74, No. 26, Dec. 23, 1915.

Side Lights on Depreciation Problems of Utilities--II*

By Harry Barker†

SYNOPSIS—Review of schemes for computing annual depreciation of utility property and making the annual compensation approximate the annual decrement in value. Theory of steady fixed charges advanced as controlling. Compound-interest computations shown as a means of approach. How effect of increasing operating costs and decreasing capacity are taken into account. Complementary to earlier article defining depreciation and discussing the collection of compensation for it.

The hard problem in practical depreciation studies is not to find out whether it is wear-deterioration or natural dilapidation or functional antiquation that will fix the life of various parts of plant before they have to be retired. The greater problem is, once the probable term is accepted, How shall the total loss of value most fairly be distributed over the years? It can be shown that this is secured by following the theory that a steady aggregate of annual fixed charges is a normal economic phenomenon, or rather would be in the absence of fluctuating cost of materials and labor. Before that theory is presented, however, it is best to approach the subject by looking at some of the older attempts to make compensation for depreciation (defined as "retirance" in the previous article) follow the loss of value.

Maintenance Plan

The oldest and the simplest attempt to saddle renewals on customers was by charging them for all the repairs and renewals of the year. This had the unfortunate effect in some cases of placing an extreme burden of retirance on some years and practically none on others, with the result that rates were too far below true cost at the start and the company was in financial straits at the end. Such was particularly apt to be the situation in those utilities where the property items were long lived—like water and gas works. It has worked out best in the case of utilities whose plant was composed of a multitude of parts of short life—like telephone systems and some railroads, though the latter have to resort to "expedients" when expensive long-lived fixtures like stations and bridges give way.

It is hard to distinguish between upkeep of old property and new extensions, so that one result of the direct-replacement or maintenance scheme in some cases has been to make additions out of earnings. A certain amount of such manipulation often may be sanctioned, but too much of it hides the true cost of service and may cause a company's stockholders to earn unduly on property which the customers and not the investors paid for.

The actual value of an established property in equilibrium administered after this scheme is only from 60 to 85% of the investment (plus appreciation). This 15 to 40% depreciation is lost to the company, according to the Knoxville decision (cited on this point in the previous article), through neglect to collect. The plan gives no adequate knowledge of the annual depreciation and it is assuming less and less importance each year.

Appraisal Plan

A second plan that has been tried is the subtraction from earnings of sums which an examination of the property shows represent the loss in value. This is better in theory than in practice—due to certain human limitations and to one inherent defect. Changes due to depreciation are not well disclosed by annual examinations because of but slight changes in appearance from year to year—differences which, however, become more noticeable as the period between appraisals lengthens. Then the mind of the appraiser may change from year to year, or, more likely perhaps, the appraisers themselves may change and bring a radical change in standards of comparison.

This sort of depreciation levy must be dangerous, in view of the Knoxville decision. It gives weight largely to superficial evidence of past deterioration, while the worth of the property, from the point of view of the integrity of investment, has been further impaired by the accrued liability for renewals on account of probable obsoletion. It will not do to say that the depreciation compensations secured from rates relate absolutely to the past loss—to what can be seen to have definitely happened. Retirements of obsolete equipment must come in the future, it is true, but when they do come they must be paid out of past earnings or future economies, to accord with the Knoxville decision. This means that the utility has an increasing liability each year for obsolescence and that each year something must be secured to compensate for the annual increment of this liability.

Straight-Line Scheme

The most obvious way of distributing the burden of retirement over the life of service is to divide the cost by the years of life and set out the resultant quotient from each year's earnings. Such money can be held by the utility owner as he sees fit against the day of replacement. If the accumulated reserves and the time passed be plotted as a mathematical graph or "curve," the form will be a straight line of course—hence the engineer's term "straight-line scheme" which has mystified most laymen and some attorneys.

One difficulty is that in spite of a superficial plausibility in the straight-line plan, there is no logical reason to expect that simple depreciation necessarily accumulates in direct proportion to the age—that the value of a machine is half gone at half its expected life. Indeed when property having a very long life, like cast-iron pipe, which is good for 60 to 100 years, is considered—the value is seen to be not inversely proportional to the age. In fact the pipe at 30 years is worth 80% instead of 50%—because of the importance of interest element in affecting worth. Moreover, during the early period of operation, the load is apt to be light and the unit costs high anyway, so that the development of the business would be hampered by large retirance factors in rates.

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†Associate Editor, "Engineering News," New York City.

However, on the other hand, if the utility property largely consists of a great number of short-lived items, as is the case with most telephone systems, railroads and some electric railways, then the straight-line scheme has an attractive simplicity and the discrepancy between actual depreciation and retirance secured cannot be appreciable. Straight-line schemes here have an advantage over the actual-renewal or maintenance basis for utilities whose properties may not show anything approaching equilibrium between depreciation and maintenance.

Sinking-Fund Annuity Plan

The most popular scheme of computing the annual depreciation of a property item is to consider that it follows the growth of a sinking fund sufficient to extinguish the cost at the end of the probable life. Now, as is well known, a sinking fund grows through the payment to it of an annuity or annual contribution and by the investment of the sums so contributed, so that there is an annual sum for interest which is retained in the fund. The annuity or annual contribution is made of such size that it will, if invested at compound interest, with the interest accumulations equal the cost of the property item after a given number of years, representing the life of such item. Therefore, in order that the annual retirances which must come from the rate payers may closely approximate the annual depreciation increments, *they must in each year equal the annual contribution to a sinking fund plus the accumulations of interest,* and this furnishes the basis for the Stearns, or equal-annual-payment plan, subsequently described.

The general practice, however, is to include directly in the sums to be earned as retirances only the annuity or annual contribution to the sinking fund, which is a much smaller sum; and if the discrepancy were not provided for in the earnings somehow, a great injustice would be done the owner, for it is only through the rates that the entire depreciation can be made good and the investment kept unimpaired. This discrepancy between annuity and required retirance, in practice, is compensated for by allowing the owner of the property to include in rate-basis worth the undepreciated value of the property—even though it may have lost considerable value through depreciation. Part of what should have been accounted for as direct retirance is recovered under guise of interest.

It is a serious defect of the sinking-fund-annuity plan, in view of the principles underlying the Knoxville decision, that it is necessary in order to preserve equity to use the undepreciated value of property contrary to the requirements of law as interpreted in this famous case. There is danger that the law, as it stands interpreted so far, may prevail against equity for the older utilities working with sinking-fund annuities as pseudo-retirances. The injustice will come to those concerns which in good faith have used sinking-fund annuities to provide retirance. The situation is brighter for those who have been constrained by government to form sinking funds, for they may charge that confiscation has begun, unless they receive full value. The remedy for these dangers seems to be the abandonment of the sinking-fund annuity as the measure of retirance and the substitution of the larger sum numerically equivalent to a sinking-fund annuity plus the interest accumulations of the year.

A good part of the popularity of the sinking-fund-annuity plan has possibly been due to a vague feeling that somehow the depreciation was being cared for adequately at much less expense than by any other scheme. Such a view savors a bit of the old "some-thing-for-nothing" ideas that are so persistent and so often attractive.

This plan carries with it, in some cases and always in some people's minds, the implication of a distinct reserve fund invested in outside securities. However, in the great majority of cases, seemingly, the allowances so secured are put into the property in place of money that would have to be raised from outside sources. Investing reserve funds inside the business complicates the scrutiny of accounts and operating results, but it tends to reduce slightly the cost of service or product—something which is desirable.

No matter whether the retirance funds are invested inside or outside of the business, for the scrutiny of rate facts it seems essential to remember that reserves made up of sinking-fund annuities must earn for their own aggrandizement in order to provide full amortization. Therefore they are not to be regarded as free capital in studying the business, no matter how the owner chooses to handle them in the interests of daily operation.

It needs to be emphasized perhaps that in the great majority of concerns, up to the present, the sinking-fund method of figuring retirance in rates has been merely an attempted process of arriving at a fair and proper burden on the customers. The money once secured has been looked on simply as company property with no strings hitched to it. Unless the degree of regulation is severe, there is not apt to be dictation as to how the retirance moneys shall be invested. The public is protected when the utility uses these repaid moneys in well-defined and safe ways.

The complication and confusion of thought introduced into the scrutiny of utility business by the "sinking-fund" plan have led some to go back to the scheme of directly apportioning the cost of an item over the expected years of life, but not uniformly as in the regular straight-line scheme. Instead they have variously decreased it in the early years and increased it toward the end of the expected-life period of the piece of equipment in question. Usually this has been done arbitrarily and empirically.

Annual Cost of Service and Actual Depreciation

It is not mere age, nor yet service-ability drop that discloses annual depreciation, nor it is general appearance; but it is reasonable to expect that there should be some fairly logical basis of computing the probable annual real decrement. If the annual depreciation be assumed to start high, then the early retirance must be heavy and in the later years light; the fair value (rate basis, Knoxville-case standard) of an item would be low in later years and the fixed charges (interest and retirance) would greatly fluctuate. If now operating costs have not risen (excluding the effect of rise in price of labor and materials) and the service is well maintained, steady fixed charges may be regarded as a normal economic phenomenon. Fluctuation of service cost would be due to fluctuating cost of labor and supplies. That is to say, given a probable life of equipment where the fixed charges are large in proportion to the operating costs and where the deterioration or inadequacy will not seriously change the operating costs until very near the expected time of retirement, the real annual depreciation is such that the fixed charges (interest and retirance) continue steady year after year.

For example, assume that a water pipe costing new $1,000 and having an expected life of 50 years had been in use 25 years. The interest at 6% and retirance would be for the first and twenty-fifth year, straight-line plan:

1st year interest	$60 00
1st year retirance	20 00
1st year fixed charges	$80 00
25th year value	500 00
25th year interest	30 00
25th year retirance	20 00
25th year fixed charges	$50 00

If it were assumed that there was no depreciation up to 25 years, as the pipe was giving good service, the comparison would be:

1st year interest	$60 00
1st year retirance	
1st year fixed charges	$60 00
25th year value	$1,000
25th year interest	60 00
25th year retirance	40.00
25th year fixed charges	$100 00

Following sinking-fund computations, the same pipe would show these figures:

1st year interest	$60 00
1st year retirance	3 44
1st year fixed charges	$63 44
25th year retirance fund	188 97
25th year value	11 08
25th year interest	8 66
25th year retirance (on $811.03)	14 78
25th year fixed charges	$63 44

It is obvious that the $80 and $50 given by the straight-line plan for fixed charges during the first and 25th year and the $60 and $100 given by the inspection plan are extremely abnormal and uncommercial, while the $63.44 for both years by sinking-fund computations is economically desirable and reasonable.

Where the operating expenses go up materially due to the deterioration of the equipment, then the depreciation increases more rapidly than otherwise and may approach the straight-line basis, as shown later.

"Equal-Annual-Payment" Scheme for Computing Retirance

An ingenious and scientific plan has been developed by Frederic P. Stearns for his engineering practice. (The simpler elements were discussed in 1914, in the progress report of the special Committee of the American Society of Civil Engineers on Valuation for Utility Rate Making.) It may be regarded as a modification of the straight-line plan, but with the annual allowances fixed in such a way that the aggregate of dominant factors in rates would tend to be constant year after year.

The calculations leading to equal annual fixed charges in the preceding example were spoken of as "sinking-fund computations." They follow the standard sinking-fund tables as to the amount of depreciation in the property at the beginning of the twenty-fifth year, though the amount of retirance adopted for the twenty-fifth year is not the sinking-fund annuity but the increase in the amount of the sinking fund during the year, consisting of annuity plus interest accumulations. When the sinking-fund computations are used in this way, the equal-annual-payment scheme of compensating for depreciation is evolved. As each year's retirance by the equal-annual-payment plan is equal to the annuity under the sinking-fund plan, plus the amount of the interest accumulations of the sinking fund during the year, the larger sum thus represented by the equal-annual-payment plan is the sum which the company is entitled to earn as an offset to the depreciation of its property to keep investment intact.

It may seem at first that the equal-annual-payment plan, providing as it does a larger retirance for each year after the first than the annuity of a sinking fund, would be opposed to the interests of the rate payers and would give larger earnings to the company. This, however, is not the case when both systems are applied in an equitable manner. The company should be permitted to earn a retirance equivalent to the amount of depreciation; and if the retirance is figured to be the inadequate sum represented by the sinking-fund annuity alone, there must be a further allowance from the rate payers to cover the interest accumulations of a sinking fund during the year. As shown already, it commonly masquerades with interest on full undepreciated value of plant. The assumption, contrary to the facts, that the property has not depreciated in value, is wholly for the purpose of making up for the inadequacy of the retirance when it is assumed to be equal to the sinking-fund annuity alone.

By the equal-annual-payment plan substantially the same results can be secured as with the sinking-fund annuity and full-value scheme—but quite in harmony with the Knoxville decision. The equal-annual-payment plan will be seen to be the simplest case of what the writer has called for convenience a group of "concave-curve" plans all closely related to it and all springing out of complicated practical conditions discussed in a later paragraph.

Retirance, figured by this plan, is declared not to be in any sense a reserve. It is an immediate and direct compensation for property value lost by deterioration and liability incurred for retirement of equipment. The retirance is immediately available for canceling obligations or, what is equivalent, for reinvestment in replacements, additions, improvements, etc. When retirances are so reinvested they enter rate-basis worth on a par with extensions paid for by fresh accessions of capital.

Interest is allowed only on the diminished worth (unreturned investment) of each item; where the retirance sums are reinvested, those new property items so purchased earn like all the other items, and retirance is collected each year for them also. Obviously, the annual interest on unrepaid investment in each item of property goes down steadily, but the retirance aggregate goes up correspondingly. The annual payments for retirance and interest on continuing investment then can have a constant annual aggregate when the rate of interest and the rate for retirance computations are the same.

Depreciation Under Increasing Operating Costs

Where the cost of operation goes up materially because of the deterioration of the equipment, then of course the equalization of annual fixed charges alone is not a proper criterion. Rather it would appear to be proper to hold that the sum of fixed charges and of operation-cost increase should remain constant. Under these conditions the real depreciation may more nearly approach the unmodified straight-line apportionment. It may disclose a depreciation more rapid than that given by the straight-line scheme for the length of life first assumed to hold.

For instance, take the case of a small water-works pump. Suppose that it was a new departure in design and was expected to have a life of 10 years; suppose that in service it was found that slip and increased friction increased the cost of operation $4 each year. (This is a hypothetical situation purposely taken for illustration.)

To find the actual depreciation under these conditions, the capitalized excess cost of operation is deducted from the figures for nominal value and considered as repaid to the investor. The remaining value is repaid during the 10 years according to equal-annual-payment plan; the depreciation (and the retirance) is the sum of each year's capitalized excess cost and the other annual factor. The computations are shown in the accompanying tables.

When the output has decreased with age, the unit cost has increased. The multiplier is the reciprocal of the decreased capacity—if the output is only 0.9 of the initial then the unit cost is 1.11 times the initial value. The total cost of the original output, if the deficiency was made up by other machines of similar type, would be increased by use of the same multiplier; that is, an excess cost results which can be studied exactly as was the extra cost of operation. If the annual operating expense of the hypothetical pump already noted was, say, $800, a gradual drop of capacity, without increase of gross operating expense, to 95.3% in these 10 years would mean an increase in excess cost of 5%, or $40. Table 2 therefore applies.

TABLE 1. ANNUAL RETIRANCE AND FIXED CHARGES BY THE EQUAL-ANNUAL-PAYMENT PLAN

End of Year	Diminished Value	Interest	Annual Retirance (or Deprec'n Increment)	Aggregate Retirance (or Depreciation)	Interest plus Retirance
0	$1,000 00				
1	924 13	$60 00	$75 87	$75 87	$135 87
2	843 71	55 45	80 42	156 29	135 87
3	758 46	50 62	85.25	241 54	135 87
4	668 10	45 51	90 36	331 90	135 87
5	572 32	40 09	95 78	427 68	135 87
6	470 79	34 34	101 53	529 21	135 87
7	363 18	28 26	107 61	636 82	135 87
8	249 10	21 79	114 08	750 90	135 87
9	128 18	14 95	120 92	871 82	135 87
10	.. .	7.69	128 18	1,000 00	135 87

TABLE 2 ANNUAL RETIRANCE AND FIXED CHARGES FOR EQUAL FIXED-AND-EXCESS COSTS: RISING OPERATING EXPENSE OR DECREASING CAPACITY

End of Year	Excess Operating Cost	Total Capitalized Excess Repaid	Sinking-Fund Increment	Annual Depreciation or Retirance	Aggregate Retirance or Depreciation	Diminished Value	Interest on Value	Retirance, Interest and Excess Cost
0	.	.				$1,000.00		
1	$4 00	$66 67	$25 29	$91 96	$91 96	908 04	$60 00	$155 96
2	8 00	133.33	26.81	93.48	185 44	814.56	54 48	155 96
3	12 00	200 00	28 42	95 09	280 53	719 47	48 87	155 96
4	16 00	266 67	30 12	96.79	377.32	622.68	43 17	155 96
5	20 00	333 33	31.93	98 60	475 92	524 08	37 36	155 96
6	24 00	400 00	33 85	100 52	576 44	423 56	31.44	155 96
7	28 00	466 67	35 88	102 55	678 99	321.01	25 41	155 96
8	32 00	533.33	38 03	104 70	783 69	216.31	19 26	155.96
9	36 00	600 00	40 31	106 98	890 67	109.33	12 98	155 96
10	40 00	666 67	42 73	109 40	1,000 07	—0.07	6 56	155 96

TABLE 3. ANNUAL RETIRANCE AND FIXED CHARGES FOR EQUAL FIXED-AND-EXCESS COSTS: INCREASING OPERATING EXPENSE WITH DECREASING CAPACITY

End of Year	Excess Cost	Total Capitalized Excess Repaid	Annual Depreciation (or Retirance)	Aggregate Retirance	Diminished Value	Interest on Value	Retirance, Interest and Excess Cost
0		. .	.		$1,000 00		..
1	$8 00	$133 34	$133 34	$133 34	866 66	$60 00	$201 34
2	16 00	266 66	133 34	266 66	733 34	52 00	201 34
3	24 00	400 00	133 34	400 00	600 00	44 00	201.34
4	32 00	533 34	133 34	533 34	466 66	36 00	201 34
5	40 00	666 66	133.34	666 66	333 34	28 00	201 34
6	48 00	800 00	133 34	800 00	200 00	20 00	201 34
7	56 00	933 34	133 34	933 34	66 66	12 00	201 34
8	64 00	1,066 66	66.66	1,000 00	0 00	4 00	134 68
9	72 00	1,200 00	....	. .	...	0 00	
10	80 00	1,333.34	....	......	.. .	..	

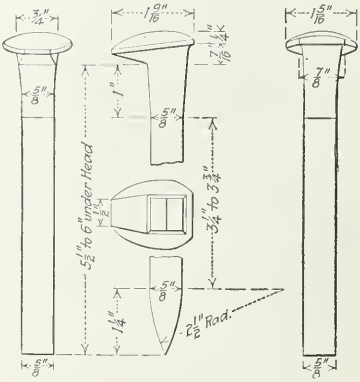
Should the two actions be combined, then the result would be as in Table 3. The only change over Table 2 is that caused by doubling the excess cost, and capitalized excess cost. This amounts to the original cost of the $1,000 item by the eighth year, so that there is no need of attempting to retire the item by introducing any equal-annual-payment-plan factor.

In theory the excess costs may rise less regularly than shown, but attempts to find how they go probably are no closer estimates than assuming a uniform increase.

New Track Spike

The modified design of cut spike or drive spike for railway track, shown in the accompanying drawing, has been proposed by a committee of the American Railway Engineering Association in connection with its standard specification for spikes.

In this design, as described in the "Proceedings" of the Association for 1916, the head is designed to take the blow of the hammer directly over the axis of the spike, and thus minimize the damage to spike heads and the danger of breaking off the head during very cold temperatures. The tilting downward of the nose gives a stronger construction, and assists in giving an easier clearance in making the spike. It also permits the pulling of the spike more readily with the clawbar.



IMPROVED DESIGN OF TRACK SPIKE

The reinforcement is symmetrical. That on the back of the neck was used originally (as it now is with many roads) to force the spike forward against the base of the rail when driving. The reinforcing of the front of the neck is in order to give additional metal to withstand rail wear and necking of spikes.

* * *

The Cost of Railway Passenger Terminals in large cities is emphasized in an argument made by Henry W. Bikle, Assistant General Counsel of the Pennsylvania R.R., before the Pennsylvania Public Service Commission on Nov. 24, in the matter of fares for suburban passengers entering Broad St. station, Philadelphia. The railroad proposed to establish a minimum rate of 10c. per passenger for 50-trip tickets to all stations within seven miles of the Broad St. station. Mr. Bikle stated that the actual cost of handling each passenger at Broad St. station, without taking into account any haul over the road, or any interest on the railroad company's investment in the property, has been found to be 8c. In addition to this cost of handling the passenger in the terminal, there must be added the cost of operating the road through the suburbs. Short-distance commuters using the Broad St. station ride over some of the most costly stretches of railroad in the world. Portions of these lines represent investments of millions of dollars per mile, because they are built in the heart of a great city where rights-of-way are expensive and construction most difficult and costly. Travelers who use such expensive stretches of track should in fairness pay somewhat higher rates per mile for the service than those carried over track which represent ordinary expense. In the handling of suburban traffic also there is a great deal of empty car movement necessary. A suburban train leaving Philadelphia, for example, must have cars enough to accommodate the passengers who wish to ride to the nearest station. These cars even though half filled or empty, however, must be hauled to Paoli or Westchester, as it is not feasible from an operating point of view to drop off cars en route.

New Municipal Dock at St. Louis

The City of St. Louis recently awarded a contract for the construction of the first section of a municipal dock to be built at the foot of North Market St. Aside from being one of the first large municipal docks on the middle Mississippi, there are a number of unusual features in connection with the location and construction.

At the point where the dock is to be built the harbor line is a considerable distance out from the present shore line, so that all the construction must be done in water.

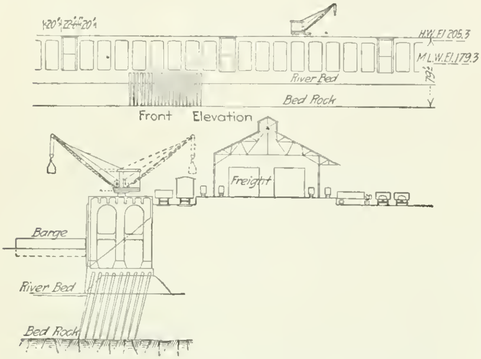


FIG. 1. GENERAL LAYOUT OF CONCRETE DOCK FOR MUNICIPAL DOCKS AT ST. LOUIS

The range of water in the Mississippi is about 42 ft., and the dock had to be designed for satisfactory operation at all stages within these limits. The main features of the design are shown on the accompanying drawing, which is taken from the plans.

The general characteristics of the dock can best be described by the consecutive order of steps that will be taken during construction. Plank mattresses will be woven on a barge held in place by cables, and sunk by weighting down with riprap. Foundation piles will be driven at a batter of 2½ in. horizontal to 12 in. vertical, which will place them parallel with the resultant of the weight and bank pressure, thereby eliminating all tendencies of the dock to slide forward toward the river. The tops of the piles will stop at zero stage on St. Louis gage.

As the river bed at the dock site is about 12 ft. below zero, the upper 10 ft. of the foundation piles will be surrounded by heavy riprap, extending up to 2 ft. below zero on the gage, and leveled off on the top to receive a monolithic slab of concrete 4 ft. thick, covering the entire area of the dock site.

On top of this footing slab the dock structure will consist of a reinforced-concrete viaduct 36 ft. wide, 40 ft. high, bents 20 ft. c. to c., spans T-beam and slab construction. At the back or land side of the dock wall a curtain wall or concrete bulkhead will extend down 12 ft. below the dock floor for the entire length of the structure, and below that the fill behind the dock wall will be permitted to slope under the dock to meet the footing slab at the water's edge. This slope will be heavily riprapped.

On the dock there will be placed eight 80-lb. T-rails, each rail spaced a standard gage distance of 4 ft. 8½ in. from the next rails, in order that locomotive cranes or cars may be placed in any one of a number of positions on the dock floor. Although a locomotive crane is shown on the plan, that is intended as merely the beginning of the equipment to be provided. The rails in the dock floor will be arranged to accommodate overhead traveling gantry cranes, as well as locomotive cranes, and in addition the dock structure will permit the installation of numerous vertical elevators and inclined conveyors under the dock floor.

As now designed the structure will be built of five units each 160 ft. long with spaces about 22 ft. wide between the units. In these four spaces there will be installed elevators about 18 ft. wide and 25 ft. long, with a capacity sufficient to handle the largest automobile trucks from street level to boats, or vice versa, in addition to which, of course, the elevators can be used for many other purposes.

Attention is now being given to the suggestions of some steamboat men that additional elevators be installed in the dock face at intervals of 60 ft. instead of 180 ft. as now contemplated.

The dock wall is the cheapest permanent structure that has yet been considered. For a length of 890 ft. a bid of $187,250 was received—that is, about $205 per lin.ft.—which, however, includes the cost of two timber dikes and a timber fender, so that the actual cost of the concrete structure will be considerably less than $200 per running foot.

This does not include the filling or tracks for warehouses behind the dock, which will be accomplished by other contracts and arrangements. It is proposed to get as much fill as possible by sedimentation from the river, induced by temporary dikes that will be constructed above the dock, and to get as much fill as possible on top of that sedimentation from the city refuse.

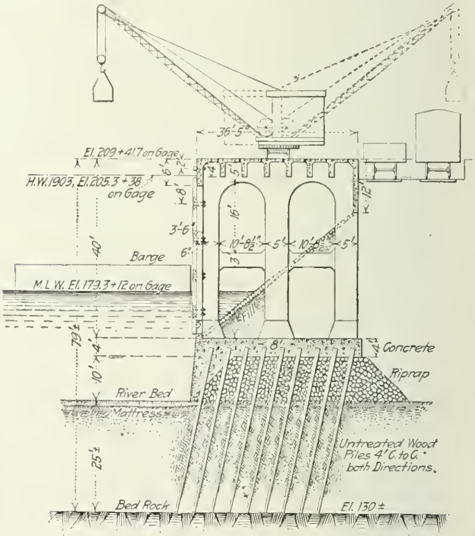


FIG. 2. DETAILS OF DOCK WALL AT ST. LOUIS MUNICIPAL DOCKS

This work is to be done under J. A. Hooke, Director of Public Utilities for the City of St. Louis. C. E. Smith, of St. Louis, is Consulting Engineer for the Department of Public Utilities.

Street-Railway Track Without Spikes or Bolts

A street-railway track in which no spikes or bolts are required as fastenings has been introduced by the United Railways Co., of St. Louis, Mo., in the reconstruction of the Grand Ave. line between Lafayette Ave. and Arsenal St. The new track (of 4-ft. 10-in. gage) has 6-in. 100-lb. T-girder rails on steel ties 6 ft. 8 in. long, weighing 100 lb. each and embedded in concrete. These are spaced 4 ft. c. to c., with an extra tie at the joints, which are laid opposite. The joints are welded electrically. The track is paved with granite blocks grouted with cement. Information as to this track construction has been furnished to us by C. L. Hawkins, Engineer of Maintenance-of-Way, United Railways Co.

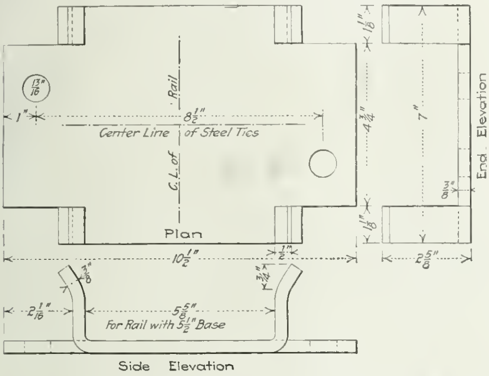


FIG. 1. STEEL TIE-PLATE WITH LUGS TO BE HAMMERED DOWN ON THE RAIL AS FASTENINGS

The ties are of the Carnegie type, of H-section, and each has riveted to its top flange a pair of Vaughn steel tie-plates 7x10½ in. This work is done at the railway company's shops. The plates, shown in Fig. 1, are of soft steel, ⅜ in. thick. At each corner the plate is slit, and the strips are bent upward, forming four upstanding lugs 1⅛ in. wide and about 2 in. high. When the rail is in place, these lugs are hammered down upon its base. Fig. 3 shows how this is done, a spiker with ordinary spike maul striking another maul that is held on the lug. A third man holds up the tie with a bar in the usual way.

Since 1912, these tie-plates and fastenings have been used on white-oak ties with 100-lb. T-rails (A. R. A. section) in paved track with concrete foundation. On some pieces of track where the paving was not laid the exposed tie-plates and fastenings appear to be as tight as when placed originally. On sections of track opened for installing special work, etc., the rails are found to be tight, and the condition of the pavement in general indicates that there is no appreciable loosening. The specifications require that a plate or specimen must bend 180° cold, flat upon itself, without cracking on the outside of the bend.

To make room for the new steel ties, alternate wood ties are removed. Many of these are pulled out when the old rails are broken with a rail-breaking machine. Mr. Hawkins states that in a large amount of repair work which has been done on the old track, the old hook-head spikes were removed and screw spikes installed to prevent the vibration of the rail and the destruction of the pavement. Almost all the ties where screw spikes were used are removed when the rail is broken. Other ties are removed by picks and bars.

To assist in the removal of ties, holes are drilled with compressed-air drills on one side of the ties that are to be removed, and small charges of dynamite are placed in these holes. These are fired after a flat-car provided with hanging sideboards reaching to the street pavement has been pulled over the holes to be fired. This dynamiting loosens the concrete so that the labor required for the entire removal is greatly reduced.

On some other work done during 1916, trenches were cut in the concrete (between the old wood ties) to receive the steel ties. Fig. 2 shows the concreting train used in the reconstruction work described above. To reduce the traffic over this work, the cars of some routes were turned back on reaching Grand Ave.

The old track laid in 1907 had 112-lb. 9-in. Trilby grooved-girder rails on cypress ties 6x8 in., 6 ft. 8 in. long, spaced 2 ft. c. to c. on a concrete base. Steel tie-plates were used, and the rails were fastened with hook-head spikes, while tie-rods were placed at intervals of 6 ft. Cast-weld rail joints were used, and the tracks were paved with granite blocks.

As to the durability of ties embedded in concrete, the cypress and oak ties taken out of the concrete track foundations laid at various places during 1905 and 1906 show that the concrete keeps the ties water soaked. No rotting has been found. Tests made last year on ties to determine the distance from old hook-head spike holes which would be required for satisfactory holding power of screw spikes, showed that the old ties were water soaked. When the spike was pulled out by the testing machine, water was squeezed out of the tie. The ties used on these tests had been taken out of a concreted track (laid during 1906) two days before the test was made.

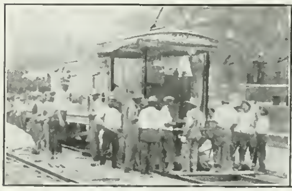


FIG. 2. CONCRETING TRAIN AT WORK ON ST. LOUIS RAILWAY TRACK

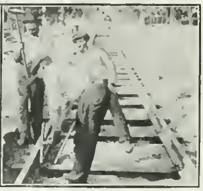


FIG. 3. HAMMERING DOWN TIE-PLATE LUGS

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Reinstatement of Three Boston Engineers in the Public Works Department of that city has been given further support by the action of a State Supreme Court Judge who has confirmed the reinstatement order of the lower court. It is expected that Mayor Curley will appeal to the full bench of the Supreme Court, in which case the final argument will be made in March, 1917. The engineers involved are Frank A. McInnes, division engineer in charge of sewer and water service, Storrs L. Durkee, superintendent permit department paving division, and Bliss W. Robinson, superintendent main drainage system. The decision of the lower court in this case was summarized on p. 45 and commented upon on p. 35 of "Engineering News," July 6, 1916. Of the 14 other engineers removed last January by Mayor Curley nine had been restored to subordinate positions in the city service by midsummer. An account of the decapitation of the 17 engineers was given on p. 193 and editorial comment was published on p. 184 of "Engineering News," Jan. 27, 1916.

Cost Records of Monolithic Brick Pavements

By William Robert Paige*

SYNOPSIS—Detail records are given of organization, material and labor costs on a paving job where the brick was laid directly on the green concrete.

Carefully compiled cost records are an interesting feature of the monolithic brick pavement constructed by the writer at Marshall, Ill., as described in *Engineering News*, Nov. 23, 1916. The construction work was under the direct supervision of the writer, who had full charge of the inspection, and a very accurate account of the labor and materials used was kept each day, together with record of the amount of work done. The figures were carefully compiled and the results tabulated.

In keeping the account of labor costs the work was divided into three parts or sections—the mixing and placing of the concrete base and mortar cushion; the bricklaying, and the slushing or grouting. The overhead charges comprised the pay of a foreman, a timekeeper and a water boy, who were all allowed straight time. The water boy looked after the lights and barricades for the nights and Sundays and was paid for seven days' work. His time was figured for seven days and divided by six working days. The total overhead charges per day were added together and divided by three, charging each section with one-third of the cost.

The usual crew employed in mixing and placing the concrete and mortar cushion was 1 engineman for the mixer, 1 subforeman for placing and leveling the concrete and looking after the grade of the concrete, 4 gravel wheelers, 4 shovelers, 9 on the mixer and 3 mortar mixers. The engineman, subforeman and laborers were paid on a separate scale of wages. The exact time of the men and the number of square yards laid each day were kept. The cost per square yard was determined by the following equation:

$$\frac{E \times e + F \times f + L \times l + C}{Y}$$

= *cost of concrete per square yard for labor*

where

E = Time of engineman in hours per day;
e = Rate of wages per hour paid engineman;
F = Time of subforeman in hours per day;
f = Rate of wages per hour paid subforeman;
L = Total time of laborers in hours per day;
l = Rate of wages per hour paid laborers;
C = One-third of total overhead charges;
Y = Number of square yards of concrete laid per day.

The usual crew for bricklaying consisted of 2 brick setters, 12 brick carriers, 2 rollers, 1 sweeper and 1 batter. The brick setters were paid a different scale of wages from the laborers. The cost per square yard per day for laborers was determined by the following equation:

$$\frac{B \times b + L' \times l + C}{Y'} = \textit{cost of brick laid per square yard for labor}$$

where

B = Total time of brick setters in hours per day;
b = Rate of wages per hour paid brick setters;
L' = Total time of laborers in hours per day;
l = Rate of wages per hour paid laborers;
C = One-third of the total overhead charges;
Y' = Square yards of brick laid per day.

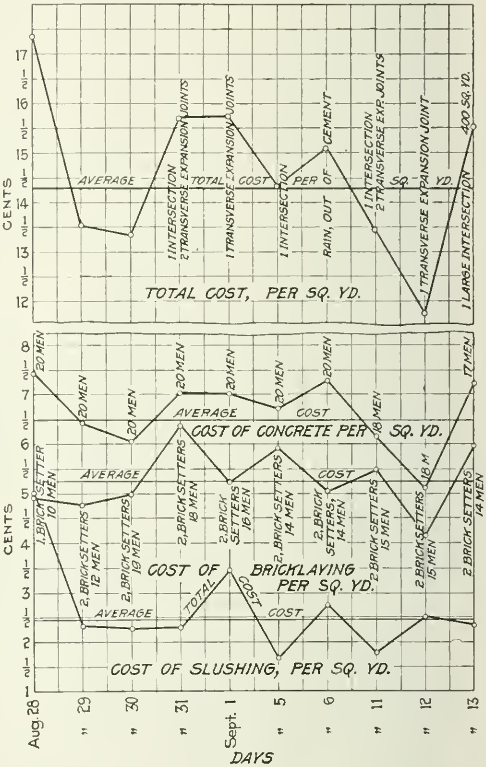

DIAGRAM OF COST OF MONOLITHIC BRICK PAVING AT MARSHALL, ILL.

The usual crew used for grouting was made up from the mixing crew or the brick crew. The cost of grouting was:

$$\frac{L'' \times l + C}{Y''} = \textit{cost of grouting per square yard for labor}$$

where

L'' = Total time of laborers in hours per day;
l = Rate of wages per hour paid laborers;
C = One-third of the total overhead charges;
Y'' = Number of square yards of slushing per day.

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*Civil and Consulting Engineer, Terre Haute, Ind.

The actual time used in spreading sand over the completed pavement was also kept; but this time being small, the cost per square yard was determined for the whole amount of the pavement.

The results obtained on West Main St. are graphically presented in the accompanying diagram. The heavy vertical cross-section lines represent the different days, and the heavy horizontal cross-section lines the costs in cents. The lower resultant line shows the cost of grouting per square yard for labor, the next line the cost of bricklaying per square yard for labor, the next line the cost of mixing and laying concrete and mortar cushion per square yard for labor. The upper line represents the total cost of the pavement per square yard for labor. The horizontal line drawn through each curve represents the average cost per square yard for the entire work.

It is interesting to note the fluctuations in the cost of each day's work and to speculate on the probable causes. For instance, the first day's cost for all, except the bricklaying, was the highest. This was due probably to starting the monolithic work, which was entirely new to the contractor and to his men, and it took a greater portion of the day to become accustomed to this new method of laying the concrete. In the bricklaying, however, there was practically no difference in the methods used for monolithic over the ordinary sand-cushion pavement.

The second day the cost of the work was materially decreased, the most difference being in the cost of the slushing. The third day shows a slight decrease in the total cost, there being a slight decrease in the cost of the concreting, and a slight increase in the cost of the bricklaying, with a very slight decrease in the cost of slushing.

On the fourth day the cost increased, this being due to building the first street intersection. It will be noticed that the cost of bricklaying increased more than the other sections. The cost of laying the concrete also increased over the cost of the preceding day, being largely due to the fact that the intersection had to be shaped by hand. It will also be noticed that two transverse expansion joints were placed that same day. On the fifth day the total cost was very slightly increased, the cost of laying the concrete being slightly decreased and the cost of bricklaying being materially decreased, but the cost of slushing materially increased.

On the sixth day another intersection was placed, and the cost of bricklaying increased somewhat, while the cost of laying the concrete and slushing decreased, with the result that the total cost decreased over the preceding day. The day following, the total cost again increased, the cost of concrete and slushing increased, while the cost of bricklaying decreased. The only cause for this was that the work was stopped by rain and by shortage of cement.

On the eighth day another intersection and two transverse expansion joints were laid, with a decrease in the total cost of the pavement, with the bricklaying slightly increased. On the ninth day the total cost of the pavement reached its lowest point, and this is attributed by the writer to the almost perfect organization of the work and also to the fact that there were no intersections laid that day.

The last day the cost increased, due to a very large intersection and to connection with the old pavement. The slushing shows a variation, the cause of which probably was due to using first the mixer crew and then the brick crew.

A summary of the cost of West Main St. is given herewith:

Total number of square yards in the improvement		5,841
Labor Cost	Total	Per Sq.Yd
Concrete base	$379 08	$0 0649
Bricklaying	306 69	0525
Slushing	142 74	.0244
Sand top	6 38	.0011
Total	$834 89	$0 1429

Since the cost of labor, both skilled and unskilled, varies at different times, the writer has compiled the results in time per square yard required for skilled and unskilled labor for the different divisions of the work. This is given in Table 1. The cost records for labor were obtained under very favorable conditions.

A record of the total amount of cement used for the concrete and for slushing was kept each day, and in this way the inspector was enabled to determine whether the correct amount of cement was used in the work. An account of the cement required in slushing was obtained for 4,131 sq.yd., and from this the average amount per square yard for the entire work was determined.

TABLE 1. DISTRIBUTION OF TIME ON BRICK PAVING

Total Paving Laid, 5,841 Sq.Yd.	Total Hr.	Hr. per Sq.Yd.
Concrete Base and Mortar Cushion:		
Laborers	1,346½	0 2305
Engineman	89¼	0 0154
Subforeman	80½	0 0138
Bricklaying:		
Laborers	1,035	0 1772
Brick setter	132½	0 0227
Slushing, laborers	512½	0 0877
Spreading sand	28¼	0 0048
Overhead time:		
Timekeeper		0 0171
Foreman		0 0171
Water boy		0 0171

TABLE 2. RECORD OF CEMENT USED IN BRICK PAVEMENT

	Total Cu.Ft	Cu.Ft. per Sq.Yd.
Slushing, 4,131 sq yd. of paving	594	0.144
Slushing 5,841 sq yd. (at 0 144 cu ft)	840	0 144
Total used on West Main St. work	4,390	
Used in base	3,550	0.608
Required for 4-in. base of 1 : 6 gravel concrete		0 500
Required for ½-in. mortar cushion, 1 : 2		0 094
Required for concrete rest under expansion joints, each 24x3 in., 33 ft. long		0.004
Total required in base, computed		0 598
Excess cement used	58	0 01

TABLE 3. MATERIALS USED PER SQUARE YARD OF BRICK PAVING

	Cu.Ft. per Sq.Yd
Cement in 4-in. base, 1 : 6 concrete	0.500
Gravel in 4-in. base, 1 : 6 concrete	3 000
Cement in ½-in. mortar cushion, 1 : 2	0 094
Sand in ½-in. cement cushion, 1 : 2	0 188
Cement for slushing, 1 : 1	0 144
Sand for slushing ½-in. top covering	0 188

Table 2 gives the total amount of cement used, made up from the daily records, and shows its distribution on different portions of the work. Table 3 gives the quantities of different materials per square yard of paving.

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The Mississippi River Freight Line, known as the Kansas City Missouri River Navigation Co., organized by the merchants and public spirited men in Kansas City in 1909 to operate a freight line on the Missouri River between St. Louis and Kansas City, handled a tonnage of over 18,000 tons inbound and outbound freight over the municipal wharf in Kansas City the past season. This is an increase of 10% over the inbound freight hauled in 1915 but there was a falling off in outbound freight due to the embargo and freight congestion on Eastern lines. This winter the company is trying an experiment in hauling freight between St. Louis and New Orleans instead of laying up its equipment. So far they have obtained all the freight they could handle. The transportation is done in weatherproof, fireproof steel barges and tow boats, and high-class freight is especially solicited. There is no other freight line on the Mississippi River competing for this class of freight.

Tunneling in Firm Clay with Compressed Air

Using 15-lb. compressed air in firm clay at 76-ft. depth below water and working without a shield, an interesting piece of soft-ground tunneling has been done during the year. Though the tunnel is only 582 ft. long, its shell, or lining, is of mixed construction—concrete-block invert and brick arch, and in a few places mass concrete either with or without reinforcement. For a short portion of the tunnel this lining was laid up inside solid ring-timbering of wooden cants (sawed ring-segments); for most of the length, however, it was placed directly against the clay soil.

The tunnel crosses under the Cuyahoga River on the line of Central Ave., in Cleveland, Ohio, to carry a water main, and was built by the Water Department of the city by force account, under direction of C. P. Jaeger, late Commissioner.

Hazardous conditions surrounded the construction of the tunnel. They made trouble in sinking one of the two shafts, but by wise and lucky selection of the level at which the tunnel was to go through, the tunnel itself was kept out of all difficulties and was completed without serious incident or interruption.

Though the original intention was to excavate the tunnel at atmospheric pressure, compressed air was used throughout. It was not needed to hold out water, as the clay was absolutely tight and no sand streaks were encountered, but the air pressure acted to support the clay face and tunnel excavation until the lining could be placed.

Nature of the Clay Soil

Slow squeezing of the clay under the pressure of superincumbent earth and water is a general phenomenon in tunneling in this soil in Cleveland. The rapidity and amount of squeezing vary with the softness or hardness of the clay. In the hardest clay the squeeze is practically negligible, and it has been found possible to let a 10- or 20-ft. length of tunnel and the face stand open, untimbered and unsupported, for days without noticeable change. A slight reduction in hardness, however, allows squeezing of considerable amount—several inches radially inward—to develop in the course of a day or less. Few places of this kind were encountered in the Central Ave. tunnel, and where they occurred the only difficulty produced was that a small amount of extra trimming had to be done when setting the lining blocks or laying up the arch masonry.

The tunnel is shown by Fig. 1 in profile, plan and section, but the drawing fails to show the stagger of the successive rings of lining blocks, which was employed to bond the brick arch to the concrete-block invert. All work was prosecuted from the east shaft.

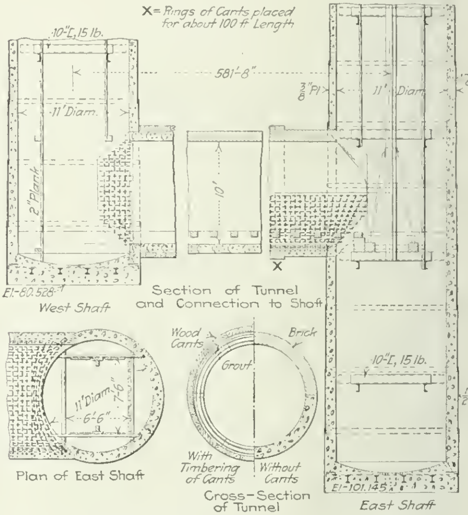
When the shaft was bottomed, an air lock was built on the top of the shell, and the eye of the tunnel was cut through under protection of 20 lb. of air. A small spring was struck near the shaft, but it was readily controlled by piping it to the shaft sump. Later it was grouted through the tunnel shell, starting about 30 ft. away from the shaft and working back.

As the drawing shows, the end portions of the tunnel are of mass concrete, reinforced to hold the nearly straight cheek pieces. Just beyond, the invert was made of mass concrete and the arch of brick; concrete blocks for the invert were not used at this stage because the blocks could not readily be passed into the tunnel through the shaft air lock and there was no erector crane to set them in place.

A lock was built into the tunnel itself at 35 ft. out; the shaft was fitted with an elevator and used thereafter as an open hoistway. The lock was formed by building two timber bulkheads with doors into 5-ft. gaps left in the lining; it had no steel shell, and for resistance to bursting pressure it depended on the bearing power of the surrounding clay. As the work got farther from the shaft, the pressure was held generally at 15 lb., with only occasional raises to 20 lb.

Tunnel Excavation

The tunnel excavation was handled with semicircular draw-knives, as in all similar work in the Cleveland and Detroit clay regions. An exceptional feature was that a low bench was carried, the 12-ft. face being divided into a heading about 7 ft. high and a bench of about 5 ft. The city's lake tunnel, of the same size, in similar material and under generally similar conditions, is run without a bench.



CENTRAL AVE. PIPE TUNNEL UNDER CUYAHOGA RIVER AND SKETCH OF LINING CANTS

The force at the face comprised two excavators and two muckers in the heading and the same at the bench. Small cars, $\frac{1}{3}$ cu.yd., were run on a track extending to the front edge of the finished lining. The muckers carried the slabs of clay cut down by the draw-knives back to this point, loading direct into the cars.

Excavation was ordinarily carried forward to such a length that a 12- or 16-ft. section of lining could be laid up. This would allow a succession of two lining shifts, respectively block laying and bricking.

For the first 100 ft. the excavation was lined with wood cants. These (see the drawing) were made of 6x6 and 4x6 material, to give rings of 6-in. radial thickness. Each is 2 ft. 8¾ in. long outside, sawed out of a stick 6 in. wide and the waste segment spiked on the outside, as indicated in the sketch. Two 3½-in. holes in each segment provide for spiking to the preceding ring. The wood was yellow pine and maple. A 10-in. spike ⅝ in. square with chisel point was used for the 6-in. cants, and a 7-in. spike for the 4-in. cants. They were driven by pneumatic hammer.

The original plan for the tunnel was based on putting the whole tunnel through at about 100-ft. depth (believed from the borings to be a safe level) without the use of compressed air. The temporary lining of cants was to be put in as the excavation proceeded; the permanent masonry lining was to be laid up in a single operation after excavation was completed. The conditions encountered in sinking the shafts, however, made it seem advisable to provide compressed air in the tunnel and also to line with masonry in short sections, so as not to leave open any long section of excavation. Under these circumstances and as the clay proved very firm and stable, the cants were abandoned after the first 100-ft. portion.

The stability of the clay was well shown at one period in February, 1916, when some difficulty with the bricklayers kept the excavation open two days, in which time the clay showed no squeeze or other trouble. The air pressure during this period was raised from the normal 15 lb. to 20 lb. to give additional support and later was slowly dropped back to 15 lb.

CONCRETE-BLOCK LINING

The interlocking concrete blocks used for the invert in this tunnel (but used for the entire ring in the city's new West Side lake tunnel) are of a new design, different from other concrete blocks hitherto proposed or used. They were evolved in the city water department under C. F. Schulz, Commissioner and Engineer until 1916. There are six blocks to the ring, or three for the invert of the Central Ave. tunnel. Each block is about 5 ft. long and weighs 1,200 lb.

In laying, the blocks were handled by a light steel erector gantry supporting a chain hoist. When the three blocks of the invert had been set—being held to true position partly by the interlock with the preceding ring and partly by blocking against the tunnel wall—the half-ring was grouted from springing-line level after packing the forward edge of the space between the block and the tunnel wall with clay.

At the end of a block-setting shift the wooden centers for the arch were put up, and the following shift laid the arch brickwork. The latter was carried up tight against the clay roof and sides, to avoid having to pack fill back of the masonry.

Making connection with the west shaft proved comparatively simple in spite of the many possible difficulties in bringing a tunnel under air pressure up against the steel shell of a shaft under atmospheric pressure, with shaft bottom only a few feet below. From a distance of 20 ft. away the tunnel was carried up against the shell of the shaft as a top heading. After the center line of the tunnel had been tied in with the center line of the shaft by resurvey, the bench excavation and the masonry shell of the tunnel were carried forward in very short sections until within about 6 ft. of the nearest point of the shell. Removal of the remaining portion of the bench was done very carefully, and the excavation, as fast as opened up, was lined with wooden cants (set outside the masonry line). The joints of the cants were also sealed with cement mortar so as to make the temporary lining tight against small air leaks while the pressure was kept on. Finally, when the temporary lining was completed up to the shaft shell, the air pressure in the tunnel was slowly reduced to atmospheric without trouble developing. Then the shaft shell was cut through, the concrete shaft lining was broken away, and the reinforced-concrete end section of the tunnel was placed.

DANGER FROM GAS A FACTOR

The known presence of gas occluded in pockets or disseminated in the clay and the actual striking of a quantity of gas in the east shaft made it necessary to take strict precautions against gas dangers. No open lights, matches or other sources of flame were allowed. A safety lamp (Koehler No. 2) was kept burning in the tunnel to give warning of the presence of gas. The air supply was unusually ample, to minimize the risk of gas accumulation even at the cost of a little extra coal.

John W. Dolman was engineer in charge of the tunnel work. Otto Scholz was in charge of surveys. Charles Vandevelde was superintendent.

The Central Ave. tunnel shafts were started in the fall of 1915. The tunnel was begun about the first of January, 1916, and was connected with the west shaft by the end of June, making six months for the tunnel work itself. On completion of the work, the springs in the bottoms of the two shafts were finally grouted, an operation that after some difficulties was successful. The tunnel at no time developed any leak; as previously mentioned, only the east end was grouted, and this simply because of a spring giving trouble while concreting was going on. The cost of the tunnel work, including shafts, was about $87,000

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The Price of Railway Supplies has increased on the average about 60% during the past year, according to a circular just issued by the New York, New Haven & Hartford Railroad Co. to its employees. The circular enjoins upon all responsible for expenditures the need for the greatest economy in the use of material, and says: "Repairs should be made instead of complete renewals in all cases where practicable, even where under normal conditions it might be better to renew than to repair." The circular is accompanied by the following table showing the percentage increase in price of various important supplies during the 15 months from April, 1915, to July, 1916:

Increases Ranging from 10 to 85%

Acids	47	Files	70
Air hose	38	Fuel oil	42
Angle bars	33	Fuses	33
Antimony (babbitt metal)	42	Gaskets, air-hose	11
Axles, car and tender	48	Nails, wire	61
Axles, driving	30	Pipe covering, all kinds	33
Axles, engine-truck	63	Pipe, galvanized	17
Belting, axle	33	Pipe, malleable	59
Belting, leather	59	Piston rods	15
Bolts, machine and carriage	40	Roofing	17
Bolts and nuts	67	Rope, manila	61
Brass (bar sheet and spring)	54	Sheathing	38
Bridge timber	44	Springs, coil	74
Castings, grey-iron	13	Springs, elliptic	51
Chains, all kinds	62	Steel, bar	77
Claw bars	30	Tamping bars	65
Copper (bar and sheet)	56	Tamping picks	26
Couplers	18	Ties, cross	13
Crankpins	12	Ties, switch	18
Drills, all kinds	64	Tires	55
Ferrules, flue	36	Track spikes	77
		Waste	78

Increases Ranging from 85 to 250%

Castings, brass	167	Steel, structural	91
Castings, steel	[illegible]	Steel, boiler	226
Cement	86	Steel, firebox	195
Gasoline	118	Steel, tank	142
Iron, bar	95	Track bolts	115
Journal bearings	89	Tubes, boiler	94
Rivets, boiler	132	Tubes, brass	105
Rivets, structural	140		

Potash Becomes a Valuable Cement-Mill Byproduct

By Arthur C. Hewitt*

The great nuisance of portland-cement manufacture has been converted into an asset of the industry by the Cottrell fume-precipitation process[1]. This was first successfully applied to the suppression of dust at the cement plant of the Riverside Portland Cement Co., in California, but not until about the beginning of the European War was the real value of the recovered dust recognized. The first Cottrell plant built exclusively for the recovery of potash has recently been completed by the Security Cement and Lime Co. at its cement plant near Hagerstown, Md. This precipitation plant will be discussed in the appended paragraphs.

The Cottrell process of dust precipitation is very simple in theory, but somewhat difficult to put into practice. The scheme is simply to pass the dust-laden gases through an intense electrostatic field, where precipitation of the dust takes place upon the positive and negative electrodes of the electric circuit; this is essentially the same thing as takes place when a pith ball attached to the end of a thread is attracted to an electrified piece of rubber or glass. In putting this theory into practice, the difficulties encountered are principally in the generation, insulation and maintenance of the high-powered uni-directional electrostatic field. The insulation of the high-voltage circuit under temperatures ranging from atmospheric up to 1,200° F. is one of the things that calls for special consideration. The material finally used for this purpose is a so-called marble from Catalina Island, off the coast of California; many other materials have been tried, but none have given anything like the satisfaction that this has.

In the first studies the electrodes were plates between which the dust-laden gases passed, but these have been superseded by pipes with central wires. The pipes extend from a top header, which is the floor of an upper receiving chamber into which the kiln stacks discharge, to a lower header, in which is the ceiling of a chamber from which the cleaned gases are led off. Dampers control the entrance of gases to all or either half of the pipes, so that the idle electrodes may be periodically cleaned of the accumulating dust. For this both pipes and wires are mechanically rapped. The dust falls down into hoppers from which it is drawn into bags.

In November, 1915, John J. Porter, vice-president and general manager of the Security Cement and Lime Co., had experiments, tests and analyses made to determine what economic results might be secured if a Cottrell plant

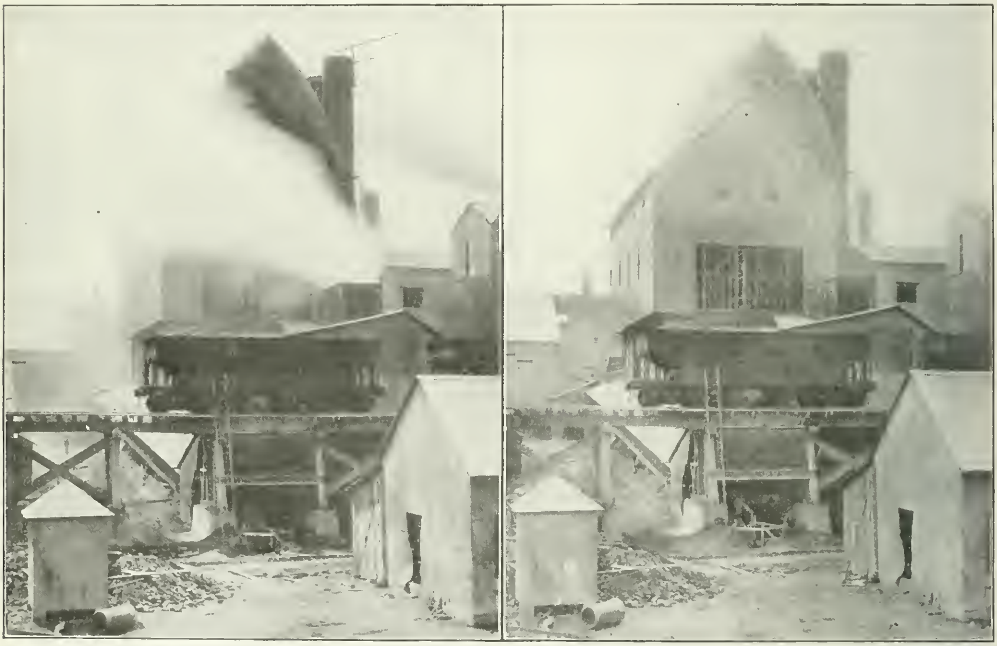

FIG. 1. CEMENT-DUST PRECIPITATION PLANT OF SECURITY CEMENT AND LIME CO.

At the left, kiln gas discharged with current off. At the right, current on; the only evidence of discharged gases is the slight hazing of the view of treater building and gooseneck flues were installed at the Hagerstown cement mill. The results were so promising that in December, 1915, the directors sent Mr. Porter to California to study the Riverside plant first hand. He spent a week there and on his return recommended that the Security company build a similar plant—but purely for the recovery of the valuable potash in the cement dust.

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*Chief Engineer, Security Cement and Lime Co., Hagerstown, Md.

[1] See "Engineering News," Oct. 26, 1911, p. 495; Oct. 31 1912, p. 803; Oct. 9, 1913, p. 716.

The directors accepted his report, and negotiations were begun with the Western Precipitation Co., owner of the patent rights for use of this process in cement plants. The plans were rushed through, the markets for material studied and the contract signed Feb. 8, 1916. The final drawings were received Feb. 23 and the contracts for steel and equipment let in the next few days. It was desired to push the work with all possible speed to secure maximum benefit of the war prices on potash but many construction difficulties had to be overcome, as noted later. The first trial run of one unit commenced June 15, and the other three units were completed by the middle of July.

DESIGN OF SECURITY PLANT

The accompanying views and sketches show the general layout and more important details. It will be noticed that there are four treaters being used to precipitate the dust from five kilns. This is because two of the kilns are smaller than the others, and the gases from the two small ones are combined in a common flue. The large stacks connecting with the treaters are 7 ft. in outside diameter and are lined with 4-in. of firebrick to a point just below the Y-connection.

The treater building is 72x36 ft. over all in plan and 76 ft. high. In this building there are approximately 200 tons of steel; 50,000 rivets and 30,000 bolts were used in field erection alone. Practically the whole treater building is made up of light-weight angles and 10-, 12- and 16-gage plates. The treaters were designed for a gas velocity through the electrode pipes of 3.5 to 4 ft. per sec.

Louver dampers extend across the intake chambers at right angles to the roof, so that one-half of each unit can be closed off for shaking down the collected dust into the hoppers. The dampers are operated by compressed-air cylinders controlled from the ground level. The hoppers are connected by cross-passages to a longitudinal chamber of much the same general shape as the hoppers. Flop dampers (worked by compressed air) close off the connection from the hopper of each half-unit when the tubes are dropped down.

The flue connecting the treaters and the fans was made as cheaply as possible by using a wood frame with No. 25 gage black-steel sheets nailed on the inside of the frame. Strips of asbestos paper insulate (for heat) the steel from the wood frame. The space surrounding the fans was housed with a wood-frame corrugated-iron-covered building. This space is used for storing the potash dust while analyses are being made prior to shipment.

The electrode pipes were made of 16-gage steel and have loose flanges put on in the field, after which the pipe ends were hammered over the flanges. By bolting to the crown sheet, the tube and the sheets are brought into direct bearing. The electrode pipes, in addition to being held together by the upper and lower header plates, are fastened together in pairs by means of an iron plate bolted to T-bars that are riveted to the pipes, as shown. Swinging hammers hang so that, when swung by rods from a lever on the ground floor by the operator, they strike these iron plates and shake the precipitated dust loose from the interior of the pipes. Some of the flue dust, it is found, accumulates on the wire electrodes, although these are the positive electrodes. This is removed by occasional rapping. The hammer mechanism may be seen in Fig. 3: it consists of a cast-iron cylinder, chain-hung from a hand lever on the upper inspection platform. The connection between the lever and high-tension frame is made through a paraffined-maple stick insulator.

The central wire electrodes are suspended from a pipe frame above. This frame rests on Catalina marble insulating supports, as shown in Fig. 3. The wires have to closely approximate their central position at all times, and to this end they are guided by each passing through a sleeve in a light steel frame grid that rests on the weights attached to each wire. As shown in Fig. 3, this frame is allowed free vertical motion by being guided by a crossbar supported on Catalina marble slabs.

A novel scheme was employed to secure even distribution of gas through the electrode pipes; 2x2-in. angles were laid loose, corner up, across the 3x3-in. angle frame extending across the floor of the inlet chamber above the high-tension frame for the wire electrodes.

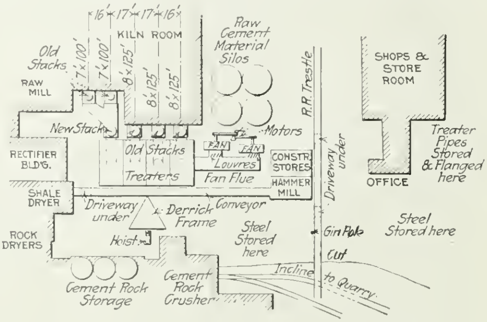

FIG. 2. GENERAL LAYOUT OF POTASH PLANT IN SECURITY MILL

A reinforced-concrete structure, 33x40 ft. in plan and 20 ft. high, was built for housing the electrical machinery and is known as the rectifier building. Here are housed all the transformers, rectifiers and switching apparatus for the entire potash plant.

The electrical equipment consists of two 7.5-hp. 5-kw. motor-generator exciter sets; four 15-hp. 10-kv.-a. 220-volt single-phase 60-cycle 1,800-r.p.m. motor-generator sets, each directly connected to the shaft of a rotary rectifier; four 220- to 70,000-volt 60-cycle 10-kv.-a. transformers of special construction; and all necessary switchboards and accessories.

The scheme of operation in the rectifier building is as follows: The power supply is 440-volt three-phase 60-cycle current; this comes in through a meter on a distributing switchboard and is used to drive the exciters, motor-generator sets and fans. Each of the four units of the treater is supplied from its own individual motor-generator, transformer and rectifier. The motor is driven by the 440-volt current, and the coupled generator produces 220-volt 60-cycle single-phase current that goes to the transformer, where it is stepped up to 70,000 volts. From the transformer the 70,000-volt leads go direct to

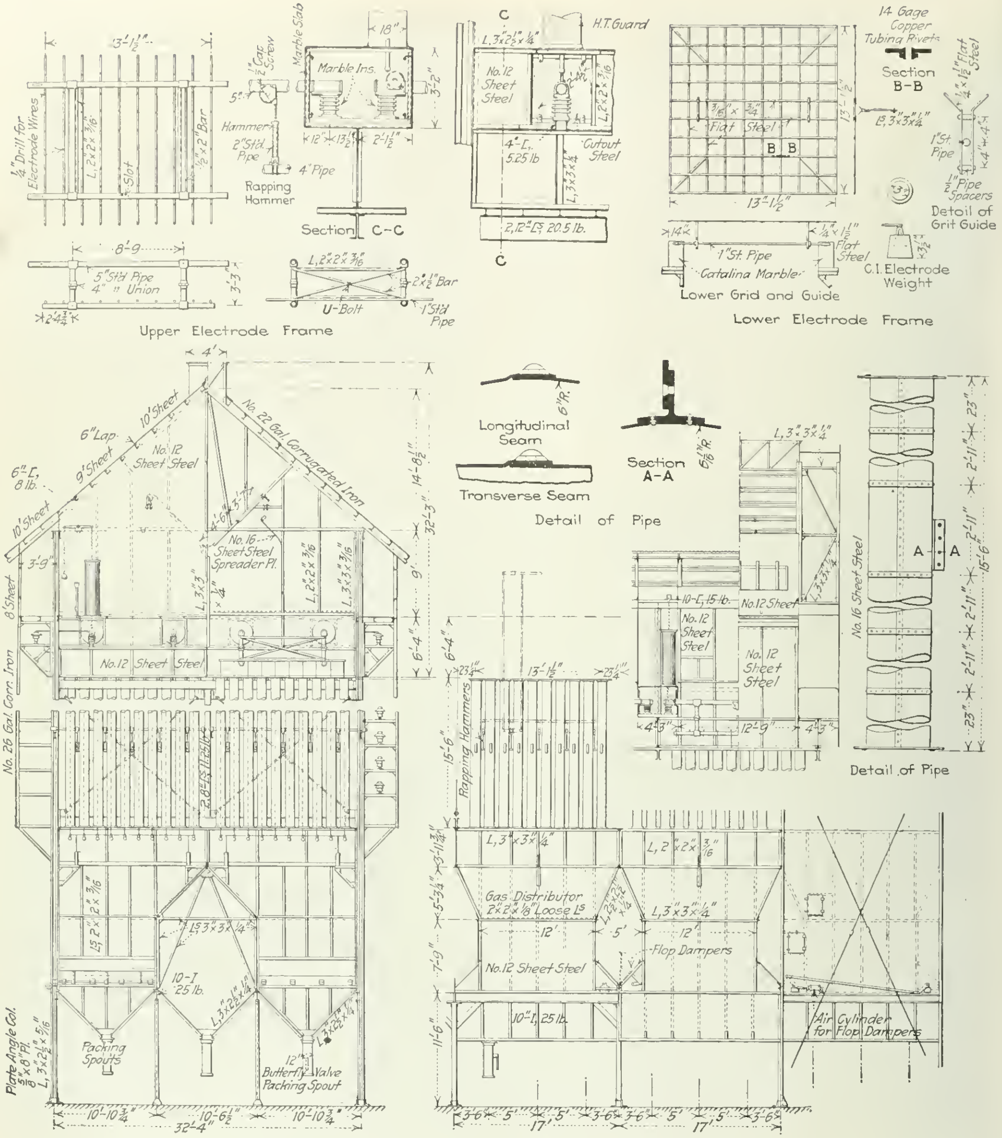

FIG. 3. DETAILS OF POTASH PLANT CONSTRUCTION
Security Cement and Lime Co., Hagerstown, Md.

the connection on the rectifier. The bottom connection to the rectifier is grounded (as is also all exposed metalwork in the building). From the top connection on the rectifier a wire goes toward the ceiling to a disconnecting switch. From this switch a line goes to the north end of the rectifier building, where are located high-tension switches so connected that it is possible to connect or disconnect either or both sides of any individual treater. All disconnecting switches are equipped with grounding clips, so that when the switches are open, the dead side is automatically grounded.

Throughout, on all the high-tension circuits 70,000-volt four-petticoat pin-type porcelain insulators are used. Inside the rectifier building ⅜-in. pipe is used for all high-tension lines.

From the distributing panel in the rectifier building a three-phase 440-volt circuit is taken to the north end of the treater building to operate the two fan motors. The fans were rated as taking 26 hp. each when operating at full rated load, and 35-hp. variable-speed (600 r.p.m. synchronous speed) motors were installed. Each fan is belted direct to its driving motor. The fan wheels are Siroccos, 10½ ft. in diameter by about 4 ft. wide. The fans each have a full-load rating of 100,000 cu.ft. per min. (temperature, 800° F.) at 125 r.p.m. when working against a suction of 0.5-in. water head. In addition to being able to control the speed of the fans, louver dampers were placed in the suction side of each fan. The fans have e-vase (expanding) chimneys to reduce the power consumption. The determination of fan capacity could not be made with accuracy because of unknown maximum temperature.

CONSTRUCTION DIFFICULTIES

The contract between the Security and Western Precipitation companies was signed on Feb. 8, 1916. But prior to actual signing the engineers of the Western company had been engaged on the general design, and the writer had been scouting around steel-fabricating plants so that when the plans should be received they might immediately be submitted to shops best able to push the steelwork through at maximum speed. Best results appeared to be probable from Buffalo over Baltimore, Philadelphia, New York and Pittsburgh. Market conditions were extremely bad. The price of raw materials was jumping by leaps and bounds, and it was very hard to get any company to accept a contract to construct the plant in the time desired. It was found absolutely necessary to pay liberal premiums in order to get quick deliveries. Labor conditions also were very bad, and only three days following the signing of the contract for steelwork a strike took place in Buffalo. This, however, was handled admirably and did not seriously delay things.

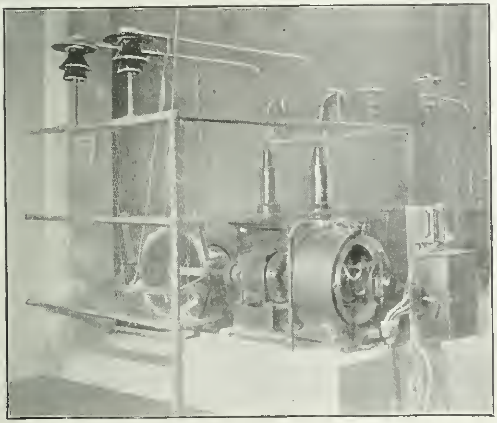

FIG. 4. ONE OF THE MOTOR-GENERATOR TRANSFORMER-RECTIFIER SETS

In operation; the four splashes of light around the rectifier disk are the high tension arcs where the 70,000-volt alternating current is broken in being made unidirectional

It was very difficult to get reasonable deliveries of the special-size 16-gage steel sheets for making the pipes; these had to be rolled specially and shipped from Youngstown to Brooklyn, N. Y., where the pipes were made up. The actual manufacture of these steel pipes (there were 800 of them, 1x15½ ft.) was one of the most difficult pieces of work encountered. They had to be true to diameter and length and be free from projections on the interior surface. It developed that establishments on the Pacific Coast were more fully equipped and more experienced in handling this class of work than were the plants in the East. However, a contract was made with the American Spiral Pipe Works, of New York City; the actual manufacturing of the pipes was sublet to a shop in Brooklyn operating under the firm name of Hindley & Pendleton.

The Security company undertook the construction of the potash plants under the following separate contracts: Excavation, concrete, fans, steelwork, steel pipes, castings, stacks and flues, erection of steel, stacks, dampers, flues, castings and electrode wires, transformers and electrical equipment. The Western Precipitation Co. furnished the design, but shop drawings for the steelwork were made by the Lackawanna Bridge Co., of Buffalo, which concern furnished the fabricated steel. Other details were designed by the Guarantee Construction Co., of New York City, which company erected the steelwork and the various other mechanisms and helped in the purchasing of materials. The electrical equipment was installed by the Spangler Electric Co., of Hagerstown. Excavation, concrete and brickwork were done by W. H. Angle, of Hagerstown. Steel stack and flues were furnished by the N. Y. Central Iron Works, Hagerstown. The entire work was carried on under the direct supervision of the writer.

ERECTION DIFFICULTIES

The difficulties encountered during erection in the field were caused by very limited space both for storing material and erecting. Also, considerable trouble was had with labor because of the dust from the cement plant. On windy days it was very disagreeable, to say the least, for the workmen to stay at their work. Almost ideal weather was encountered, and only a very few days were lost on account of rain.

After one unit was completed and placed in operation, the steelworkers let it be known that they would not work on the other units of the building while 70,000-volt current was being transmitted along its side. However, there were only a few of the men who left the job because of their fear of danger with the current on. In order to protect the workmen from the high-voltage wires, small-mesh wire netting was used for guards surrounding them. Danger signs were placed at every point along the building where there was any possibility of a workman's coming in contact with the wires. The men were all warned personally of this danger and told to keep as far away from the circuits as possible.

From the general layout of the cement mill and potash plant, Fig. 2, it will be observed that a derrick frame and hoisting engine were placed close to the middle of the dust treaters and on the east side. This was a stiff-leg derrick with a 60-ft. boom, and it was placed on a platform 30 ft. above the ground. By means of this it was possible to lift into place almost all the steelwork. It developed before placing the flues on top of the building that the boom of the derrick could not be used for setting them in permanent position, because the derrick frame was too close to the building and, therefore, could not reach over far enough. The cost of erecting the derrick was considerable, but it more than paid for itself. The space available for storage of steel was very small, but proved to be large enough as erection took place about as fast as the material was received.

Before erection was completed, the speed at which the men were worked began to tell upon them; and consid-

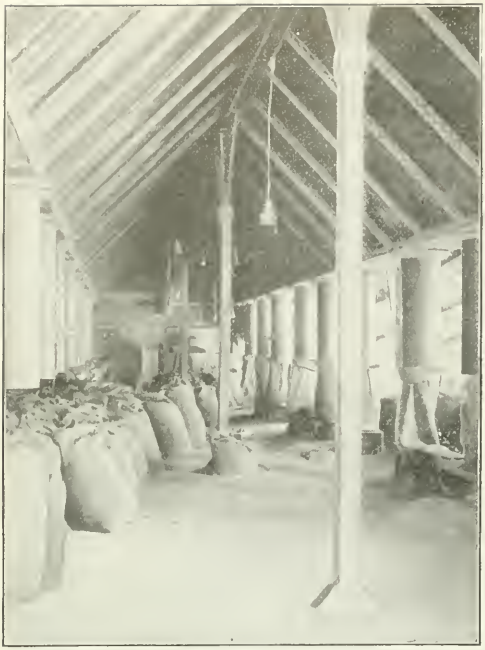

FIG. 5. BENEATH DUST-TREATER BUILDING
Showing method of bagging dust coming through spouts from hoppers

erable trouble was experienced in keeping them at work continuously. The erection crew worked from 10 to 12 hr. a day and 7 days per week, except as the weather interfered. A night crew was used part of the time. Efforts were concentrated upon one unit of the treater, so that operation might be begun at the earliest possible moment in order that the experimental stage, which comes inevitably with any new enterprise, could be covered with one unit while the others were being completed.

Potash-Plant Operation

The views of the plant in Fig. 1 show the relative appearance of the gases discharged with current on and off. The operation of the plant has been profitable from the beginning, but experiments are still being carried on to determine the exact conditions under which the maximum amount of potash can be produced simultaneously with the maximum production of cement clinker. These experiments have opened up an unlimited field of investigation, which gives every promise of being the means of increasing the production and quality of the cement entirely aside from the production of potash.

At the present time, with two kilns 7x100 ft. and three kilns 8x125 ft., the production of potash dust averages from 20 to 25 tons per 24 hr., containing from 5 to 10% pure K_2O, which is present in the form of potassium sulphate (K_2SO_4) and is equivalent to approximately 10 to 20% of the sulphate. The dust is in a very finely divided state, which is highly desirable for use as a fertilizer. It collects in the lower hoppers of the steel treater structure and is drawn off regularly into burlap bags (see Fig. 5) containing some 100 lb. net. The bags are weighed and sampled before shipment.

The gas volume handled averages approximately 180,000 cu.ft. per min. and 900° F., when measured at the base of the kiln stacks. These figures may be compared with the 100,000 cu.ft. and 800° estimated in advance. A single fan, however, has no difficulty in maintaining draft under this load.

The operating labor required for the plant is a very small item, as one man during the day and one at night are all that are required to care for the treaters and electrical apparatus. A third man acts as general foreman both for the operation of the treaters and packing the material. The labor for doing the bagging is additional. The power consumption for the entire plant averages about 1,000 kw.-hr. per 24-hr. run, and this includes power for precipitation, fans and a small compressor that supplies air for operating dampers, etc.

Some of the factors affecting the successful operation of the plant are: Regularity of shaking down the dust, temperature of gases, fuel analysis and fuel economy for the kiln, rate of flame propagation in the fuel-air mixture, volume and velocity of gases treated, and gas distribution in the electrode pipes.

It has been found that if the dust was not shaken down from both electrodes at regular intervals, but allowed to collect on the wire electrodes, it resulted in burning off the wires and causing short-circuits. Also under certain conditions the dust would form in lumps at nodes on the wires and cause flash-over at those points. This was a very serious difficulty during the early stages of operation; but after the cause was discovered and steps taken to rectify it, no further difficulty was experienced.

The temperature of the gases has been one of the hardest things to control, as the operators of the kilns were not accustomed to watching the kiln pyrometers, which had just been installed. Of late this has been partly overcome, and temperatures have been greatly decreased. This was brought about by reducing the amount of coal fired into the kilns and by controlling the draft at the proper places so as to get the combustion to take place inside of the kiln and not have some unburned fuel carried over into the treaters. It was found that certain kinds of coal burned at a much slower rate than others, and with the slow-burning coal considerable difficulty was had with high treater temperatures. The volume and velocity of gases treated can be controlled to a certain extent. However, this must be watched closely in connection with production of properly burned cement. The proper distribution of gases in the electrode pipes has been brought about by properly balancing draft pressures in the treater by means of distributors made of pieces of upturned angle iron, already noted.

Cement Production Improved

The effects on the production of cement are very noticeable. The operation of the potash plant has been the means indirectly of increasing the production of cement clinker and also the fuel economy. It has been the means of getting more continuous operation of the kilns because of requiring much better attendance on the part of the kiln operators. This automatically brings about a better quality of cement clinker because, by watching the kilns more closely, the quality of the clinker will be more nearly constant. Moreover, it is found that the best recovery of potash is secured coincident with the best burned clinker.

Binghamton Builds Interceptor with Four River Crossings

By A. L. LaRoche*

The City of Binghamton, N. Y., is building a 1½-mi. 12- to 54-in. intercepting sewer with four river crossings. This is being done to prevent the highly polluted summer condition of the Susquehanna and Chenango Rivers, which join in Binghamton. During dry summer seasons both streams drop to a very low point, and the velocities decrease accordingly. The sewage of the city empties into these rivers through nine separate trunk-sewer systems, and therefore a highly polluted condition has existed in the streams during that part of the year when it would be most objectionable. The work now under construction is intended to prevent pollution of the rivers only when they are in a fairly clean condition. During spring freshets or excessive general storms the rivers already carry a heavy amount of foreign material, which would not be appreciably increased by the addition of the city's sewage.

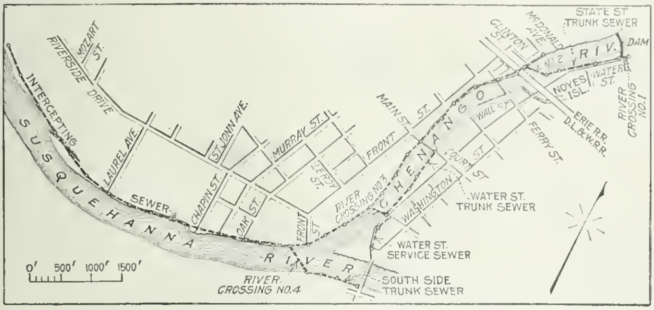

FIG. 1. MAP OF BINGHAMTON INTERCEPTING SEWER

The complete plan contemplates the construction of an intercepting sewer picking up the flow of trunk sewers at or near the outfalls and carrying this sewage to a disposal plant for treatment. The existing sewer system is chiefly of the combined type, and figures for the design of the interceptor were based upon an adjustment between the dry-weather flow and that portion of the storm water which on the average came when the rivers were lowest.

Stream gagings taken for a number of years were used in determining this relation. The dry-weather flow figures were obtained by gagings on each trunk sewer, but the gages used were of a type that gave only the maximum dry-weather flow for each day. Actual water consumption in each sewer district was therefore also obtained. A comparison and adjustment of these quantities gave a resultant daily-flow curve assumed to be close to the present actual conditions. Each district was then considered from a viewpoint of future development, and figures were prepared showing the estimated flow in 1940. The estimated future flow was increased by 30% to care for the surface water that would come before the streams would rise and so prevent a pollution from the first runoff. The design of the interceptor was based upon these figures with a limiting minimum velocity of 2½ ft. per sec. The work of constructing this sewer is divided into two sections. Section 1 picks up all the outfalls in the city and has a length of approximately 2 mi.; Section 2 runs from the end of Section 1 to the proposed site of the disposal plant, a distance of approximately 2½ mi. The route of this sewer closely follows the shore line of both rivers, in some places being entirely within the dry-weather bed of the streams. The soil encountered is a mixture of river silt underlain by a layer of gravel with occasional showings of shale rock above the invert elevation.

The construction of Section 1 is now under way. The pipe being used for sizes from 12 to 24 in. inclusive is vitrified tile, in 3-ft. lengths, double strength where available. The 36-, 42- and 48-in. sewer is of reinforced-concrete pipe, cast in 4-ft. lengths at three plants distributed along the route, and delivered by the pipe manufacturers close to the line of the work.

Vitrified pipe is laid with bituminous joints except where a surrounding concrete protection is placed. At these points cement-grout joints are being used. In laying this pipe the trench is unwatered to within 6 in. of

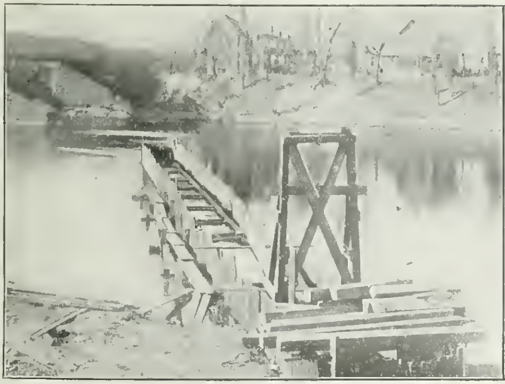

FIG. 2. COFFER-DAM FOR CROSSING 2, BINGHAMTON INTERCEPTOR

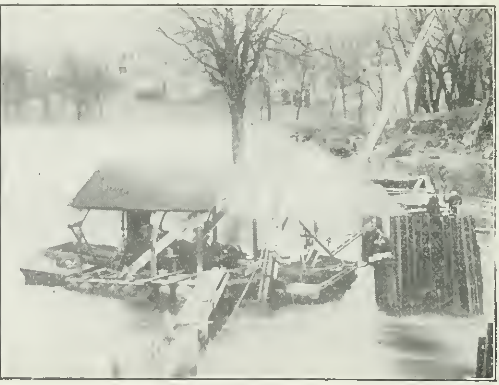

FIG. 3. SECOND COFFER-DAM AND CONTRACTOR'S PLANT FOR CROSSING 3

the invert. A recent test of 250 ft. of the bituminous-joint construction on 24-in. pipe showed one small leak.

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*Deputy Engineer, Binghamton, N. Y.

The method of protecting the vitrified-pipe sewer where its elevation brings it above the original surface is by driving steel sheetpiling on each side 6 in. from the pipe. The piling has an average penetration of 5 ft. and is driven by hand. After the pipe is laid and an earth-fill tamped into place between the lines of piling, a 6-in. concrete slab is cast over the top. Where the pipe is not above the surface of the ground, but is so close thereto as to be in danger from the scouring action of the heavy floods, it is completely embedded in concrete extending 9 in. beyond the pipe on each side and running down 12 in. below the invert with a thickness on top of 9 in.

Laying Concrete Pipe

Concrete pipe is laid with grout joints, the trench being entirely unwatered. During construction it has been necessary, on account of the excessive amount of water encountered in a gravel stratum near the invert, to use underdrains at certain places along the line. This consists of an 8-in. tile pipe, laid with burlap joints, placed along one side of the trench below the elevation of the bottom of the pipe. The pumping equipment on the 48-in. sewer is one 8-in. centrifugal working against a head of approximately 20 ft. This is placed in a sump at the lower end of the 48-in. section and unwaters the trench down to the invert. A 4-in. diaphragm pump, placed in the trench where pipe is being laid, discharges over a bulkhead into the sewer already laid and keeps the trench dry for pipe laying.

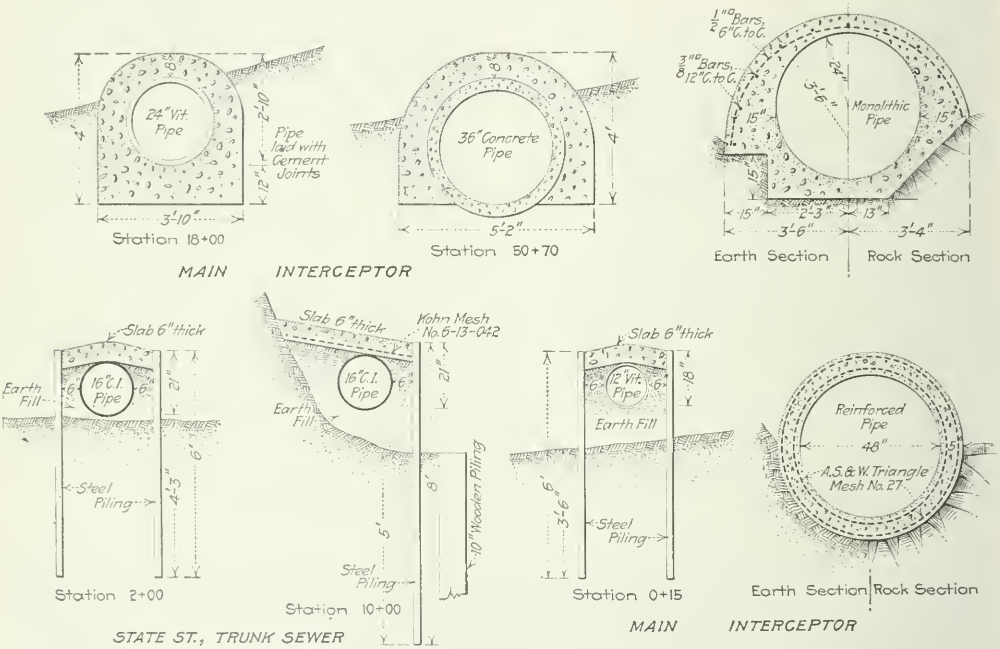


FIG. 4. TYPICAL SECTIONS, SHOWING BINGHAMTON INTERCEPTOR CONSTRUCTION

Where the interceptor meets with branch sewers situated on the same side of the river, regulating chambers will be constructed. These consist of a grit chamber on the trunk sewer, the outlet of which chamber empties directly into the interceptor. A bypass from the grit chamber cares for the excess surface flow beyond the capacity of the interceptor. This bypass is checked against a rise in the river by a check valve. When the river is at abnormal height, the interceptor will therefore be flowing full; and a sufficient head will be built up in the trunk sewer to force a flow through the check valve. The backing up in the sewer system will not, however, be greater than that experienced in the past.

Where outfalls are on the opposite shores of the rivers, inverted-siphon river crossings are being constructed. These are equipped with grit and regulating chambers at the inlet end similar to those mentioned above. The largest of these crossings (No. 3 shown in detail in Fig. 5) carries a present flow of approximately 4,800,000 gal. per day, and the estimated future flow is 12,200,000 gal. From the grit chamber the flow passes into the inlet siphon chamber. From here three 18-in. cast-iron pipes embedded in concrete carry the sewage under the bed of the river. Two of these pipes have the same inlet elevation, while the third pipe is raised at its inlet a height of 18 in. This arrangement permits the closing and cleaning of any pipe in the crossing, since a single lower pipe will care for the present flow, and the two lower pipes or one lower and the upper pipe will care for the future flow. All three pipes are equipped with sluice gates at both inlet and outlet ends.

Directly in back of the inlet chamber is the cleaning well, which is carried down below the bottom of the lowest part of the siphon. Into this cleaning well 18-in. return pipes are carried from T's placed in the main crossing pipes. Similar pipes and T's are placed also at the outlet end of the siphon, where a second cleaning well is constructed. The ends of the cleaning pipes are equipped with flap valves held tight by capscrews, and to these valves are attached standard fire-hose connections. From cleaning well to cleaning well there is a straight run in each crossing pipe. This arrangement permits both flushing and rodding the entire length of the siphon. At the outlet end all three pipes discharge at the same elevation, where they have a free fall into the interceptor.

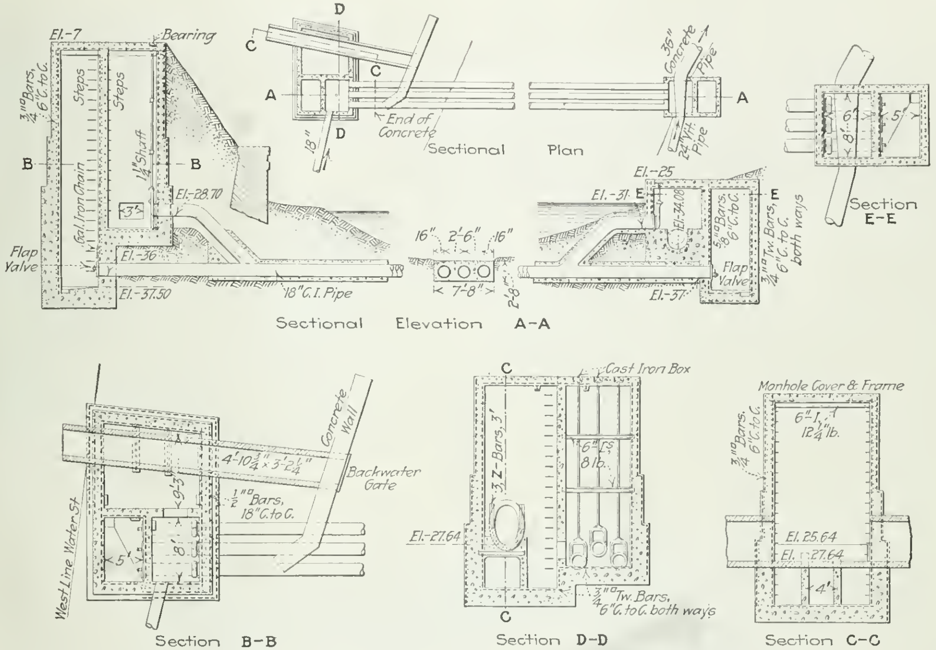


FIG. 5. DETAILS OF RIVER CROSSING NO. 3, BINGHAMTON INTERCEPTING SEWER

CONSTRUCTION WORK AT CROSSING 3

Construction of crossing No. 3 started with the excavation of the inlet chamber and the driving of a steel sheet-piling coffer-dam approximately one-fourth of the distance across the stream. The first coffer-dam was 86 ft. long and 9 ft. wide, and the lines for driving the sheeting and for maintaining a proper width were given by floating 8x10-in. timber frames into place, straddling the center line. These frames were in sections about 10 ft. long and permitted easy access for laying pipe without disturbing the crosspieces. The coffer-dam was unwatered by a 6-in. centrifugal pump and was kept dry by two 2-in. steam ejectors and one 4-in. gasoline-engine diaphragm pump. The average head of water on the outside was 4 ft., although at one time this was increased to 7 ft. by a sudden rise in the river. The ditch for these cast-iron pipes was excavated by hand in hard gravel, this material being removed by a clam-shell bucket.

The contractor's plant for driving coffer-dam and handling excavated material was carried on a wooden barge of sufficient size with its maximum loading to draw not more than 15 in. of water. The plant consists of a 9-ton hoist boiler, derrick and boom to carry the steam hammer or clam-shell bucket. At the derrick end of the barge, sliding spuds are let down to the river bottom and locked in position to insure stability and to hold the barge above water when the boom is loaded. The steam for driving the hammer was furnished from a boiler erected on the shore.

The shore end of this coffer-dam kept the inlet chamber dry, and concrete for this chamber was placed while the iron pipes were being laid. When the pipe laying here was complete, this first coffer-dam was pulled and a second one driven farther out in the stream and inclosing the ends of the pipe lines. It is intended to unwater this second coffer-dam by a pump placed at the shore end of the crossing pipes and by using these pipes as drains. This shore pump will be augmented by a second pump placed on top of the coffer-dam.

One similar river crossing (No. 2) is being constructed under the present contract. The first coffer-dam has been constructed for this crossing and is 170 ft. in length.

Excavation for the 48-in. concrete sewer is being done by No. 3 Keystone excavator. The maximum cut encountered is 14 ft.; and the machine is doing the entire excavating except for the bottom trimming, which is in soft shale rock and is taken out by hand. It is also used for backfilling by reversing the direction of the digging apparatus.

The Sewage Disposal and Water Plant Co., of Schenectady, is the contractor for Section 1. It is intended to continue with the construction of Section 2 of the interceptor and the disposal plant in 1917.

New Type of Concrete Floor on St. Louis Bridge

SYNOPSIS—Steel formwork introduced as simpler and cheaper than wood, and steel reinforcement made up in mats and unit sets of bars to facilitate placing. Concrete distributed by revolving dump-cars.

Construction methods and difficulties are not always apparent in the design of structures, and this fact is illustrated by some interesting features in the floor of the roadway portion of the east (Illinois) approach viaduct of the new municipal bridge over the Mississippi River at St. Louis, Mo. The wood paving is carried by a concrete slab resting on longitudinal steel girders and joists that are spaced 4.50 and 4.92 ft. apart and are framed between the transverse girders. The concrete is extended downward to inclose and protect the steel framing. Fig. 1 shows the steel formwork and reinforcement being placed.

The original design, shown at the left in Fig. 2, consisted of a flat slab with tapering ribs along the joists. The building and removal of wood forms for this flat slab and trough construction would have been costly and slow, especially as the removal would have had to be done from staging or falsework beneath the deck, at a considerable height above the ground.

To simplify the work and reduce the cost, a modified design was therefore prepared by the city's engineers in charge of the construction (which is being done by municipal forces). This consists in arching or curving the lower side of each section of the slab and supporting the concrete on a form of arched plates of thin sheet steel (No. 22 gage), which are fitted between the joists and rest upon their flanges (or upon shelf angles of the outside longitudinal girders). This formwork is left in place and will gradually rust away, having served its purpose as soon as the concrete has set. This modified construction is shown at the right in Fig. 2. The arch is of $18\frac{1}{8}$-in. radius in the main portion and $8\frac{11}{16}$ in. at the sides.

The steel sheets are pressed to shape. Each is about 22 in. long, with a $\frac{3}{4}$-in. corrugation at each end and in the middle to stiffen it and hold the shape. The end corrugations interlock. as the plates lap each other. For the sidewalks the width (6 ft.) is too great for arching the slab, and the steel sheets are pressed to channel shape, as shown. They are flat on top for about 5 ft., and the

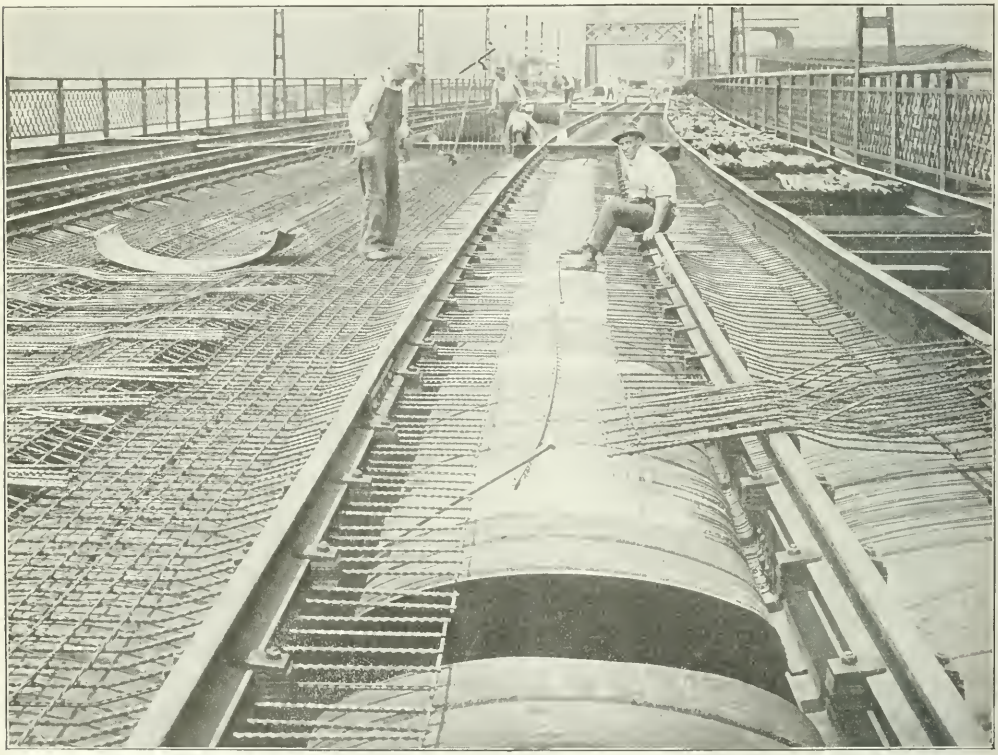


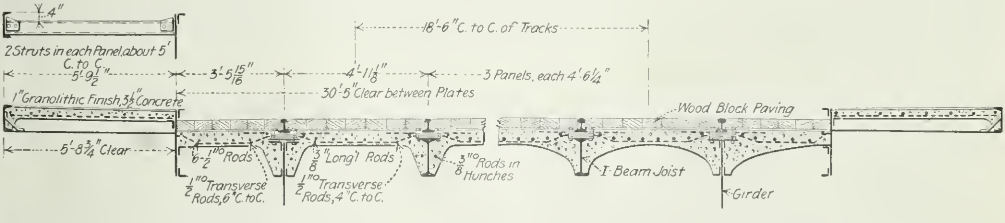
FIG. 1. STEEL FORMS AND REINFORCEMENT FOR THE CONCRETE FLOOR OF THE ILLINOIS APPROACH TO THE MUNICIPAL BRIDGE OVER THE MISSISSIPPI RIVER AT ST. LOUIS

sides slope outward to rest on the lower flanges of the sidewalk stringers. These wide form plates are stiffened by angles pressed to the same shape and welded to the under side. The steel forms were made by the Hydraulic Pressed Steel Co., of Cleveland, Ohio.

The steel reinforcement of the concrete floor slab consists of transverse bars and layers of heavy wire netting of special make. The original design provided for longitudinal rods, but with the great number of rods and the cost of labor, the placing of these would have been very slow and expensive. Instead, a special make of wire netting was used, the longitudinal strands of which were equivalent to the rod sections. No allowance is made for the diagonal wires as reinforcement.

To reduce the difficulty and cost of handling and placing the very large number of transverse rods, these are made up into sets of seven bars each, held together at the ends by light bars welded to the under side. They are held also at two intermediate points by spacers, which are flat strips of metal having lugs stamped out to be bent over the bars. These mats are 16 ft. 5 in. long and about 4 ft. wide, and each can be handled readily by two men. Similar mats 6 ft. long are used for the sidewalk slab.

The car-track rails formed an obstruction to the placing of the mats, as they are supported above their I-beams by chairs staggered in position (33 in. apart). For each side of the roadway there is a mat extending from the curb to the track, with its bars extending beneath the outer rail. A third and narrower mat is placed between the tracks, with its bars extending beneath the inner rail of each track. Loose bars are placed between the rails of each track and are wired to the projecting ends of the bars of the mats on either side (inside the rails). This wiring is done mechanically by the use of prepared wire loops that are set in place and then twisted by a hand tool with a revolving stem. This device is made by the Curry Manufacturing Co., of New York City.


4"
2 Struts in each Panel, about 5' C. to C.
5'-9½"
3'-5 15/16"
4'-11⅛"
3 Panels, each 4'-6¼"
18'-6" C. to C. of Tracks
30'-5" Clear between Plates
1" Granolithic Finish, 3½" Concrete
5'-8¾" Clear
6-½" ⌀ Rods
⅜" Long'l Rods
⅜" ⌀ Rods in Hunches
½" ⌀ Transverse Rods, 6" C. to C.
½" ⌀ Transverse Rods, 4" C. to C.
Wood Block Paving
I-Beam Joist
Girder

Part Section of Slab as Designed

Part Section of Slab as made with Steel Forms

FIG. 2. CROSS-SECTION OF ROADWAY, SHOWING ORIGINAL AND MODIFIED DESIGN OF CONCRETE SLAB

Fig. 1 shows the whole construction very clearly. In the center is one of the tracks with the arched form sheets in place. On each side of this is a panel with the form sheets and the welded sets of transverse rods, the ends of these rods projecting under the rails into the track space. In the panel at the left of the track the woven-wire mat is also in place, laid upon the transverse bars. Some of the form plates and the welded sets of bars are shown lying around, while in the middle of the track space is one on the spacing bars. At the right is the sidewalk framing (with no form plates in place).

The street-car tracks have 90-lb. T-rails (Am. Soc. C. E. section) supported on chairs with insulating strips and secured by bolted clips. These supports are 33 in. apart and are staggered in position, as noted above.

For concreting this roadway floor on the viaduct approach, two mixer plants were used, one at each end of the approach. The one at the higher or bridge end had elevated material bins in the usual way, while for the one near the lower end the materials were placed in stock piles and wheeled to the mixer. An 80-ft. steel elevator tower was used, high enough above the bridge deck to supply an inclined chute extending across the deck. For distributing the concrete the standard-gage car tracks were utilized, as shown in Fig. 3.

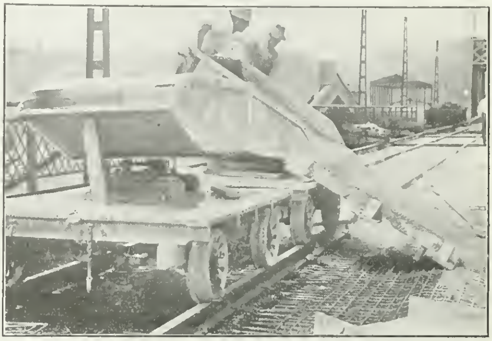


FIG. 3. PLACING CONCRETE WITH SMALL REVOLVING DUMP-CARS ON STANDARD-GAGE TRACKS

For each track there was a train of two or three cars operated by a Whitcomb 6-ton gasoline locomotive. The cars were of an improvised type, as standard-gage equipment of the small capacity desired was not to be had. Each concrete car is a railway push-car having mounted on it a 1-yd. steel dumping body or hopper. The body is carried by a revolving base, so that it can dump on either side or endwise between the rails. At first the trains were all loaded on the track nearest the elevator tower, but this involved an inconvenient amount of switching and interfered with the free movement of the trains. The temporary crossover was taken out, therefore, and the chute was extended across the roadway to serve both tracks, so that each train could be operated independently on its own track. In Fig. 3 one car is dumping at the side, while the other has the body in position for end dumping.

The work is being done by day labor under the direction of the Board of Public Service, of St. Louis, Mo. It is in charge of Clinton H. Fisk, Chief Engineer of Construction, and W. F. Collar, Superintendent of Construction.

Notes from Field and Office

Field methods for surveying subsurface structures in Milwaukee—Bridge piers in Carolina flood district broke at pouring joints—How a long-standing boundary dispute was settled; an excellent example of retracing survey methods

Surveying for the Milwaukee Intercepting Sewers

By Darwin W. Townsend*

For the purpose of obtaining information relative to the existing underground and surface structures over the routes of the proposed intercepting sewers in Milwaukee, Wis., three field parties were organized early in March, 1915. Each party consisted of a chief, a transitman and two rodmen. Preparations were made at the same time, by increasing the drafting-room force, to keep the notes plotted up to date, as they were received from the field-party chiefs at the end of each day.

Loose-leaf notebooks, with pages 7⅞x5 in. (see Fig. 2) were used in the field, and three pages were given to each city block. Page 1 showed property lines, curb lines, block distances and street widths, together with the location of all manholes, fire wells, etc., visible from the street surface. Page 1-a gave level notes of the elevations, top and bottom, of manholes, etc., and page 1-b showed cross-section sketches of all manholes investigated.

The first page for each city block had the property and curb lines sketched upon it before the page was handed over to the field-party chief. The curb and property lines from which the sketches were made were taken from the official quarter-section maps of the city, and one man was occupied in the drafting room the greater part of his time in the preparation of these notebook pages. The time spent upon the sketches proved its worth, however, time and again, as it always served as a check for tying in manholes between the intersecting streets.

Each field party operated as follows: All manholes in a block were first tied in to the curb lines; next, they were opened up and investigated, and a sketch was made. Last the elevations were taken upon the rims at the street surface. These notes were plotted to a horizontal scale of 40 ft. = 1 in., and a vertical scale of 6 ft. = 1 in. As soon as the notes were "cold," they were filed away in envelopes and indexed under their proper headings.

All records pertaining to gas mains were secured from the Milwaukee Gas Light Co., and the locations and sizes were transferred directly from their plans to ours.

By Aug. 1, 1915, all the routes, a total of 32 mi., were surveyed and plotted. While the major portion of the sewer routes were in city streets, as before mentioned, several miles were in practically undeveloped territory, necessitating topographic and location work. Soundings for proposed pressure siphons were also taken across the Milwaukee, Menominee and Kinnickinnic Rivers at 13 different places.

Fig. 1 shows a typical street intersection upon which is plotted all available information concerning the under-

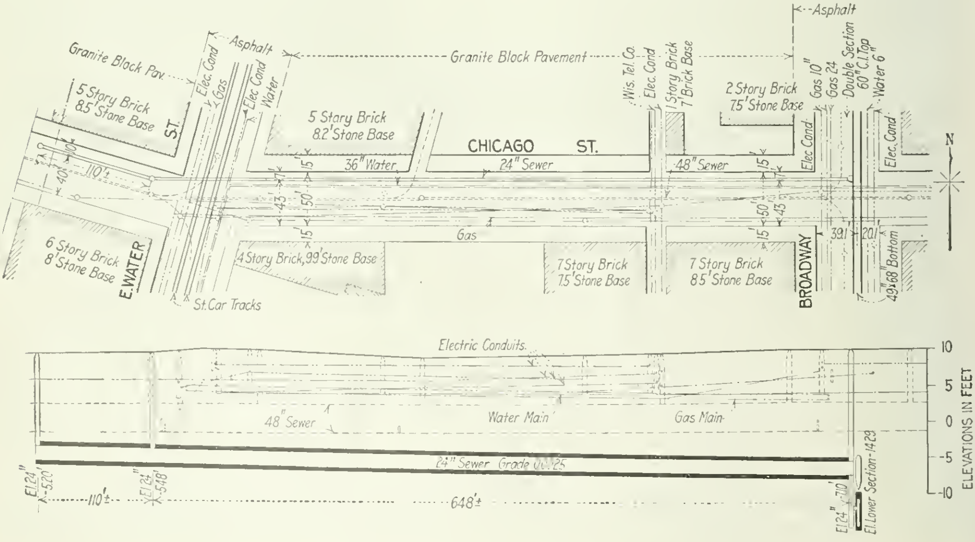


FIG. 1. TYPICAL STREET INTERSECTION, SHOWING ALL DATA OBTAINABLE

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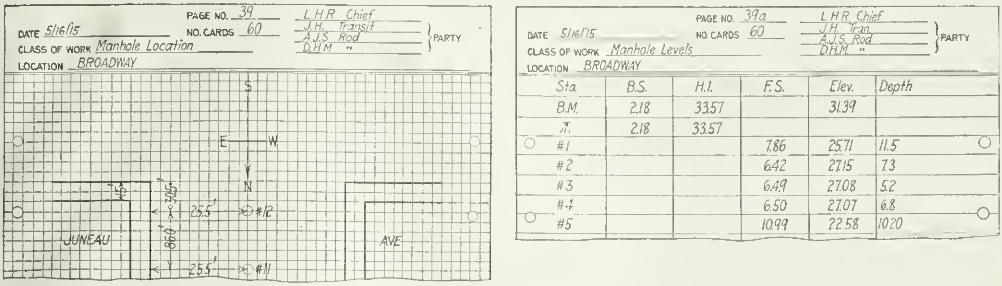
*Chief Draftsman, Sewerage Commission, Milwaukee, Wis.



PAGE NO. 39
DATE 5/16/15
NO. CARDS 60
CLASS OF WORK Manhole Location
LOCATION BROADWAY
L H R Chief
J.H. Transit
A.J.S Rod
D.H.M "
PARTY

PAGE NO. 39a
DATE 5/16/'15
NO. CARDS 60
CLASS OF WORK Manhole Levels
LOCATION BROADWAY
L.H.R Chief
J.H. Tran.
A.J.S. Rod
D.H.M. "
PARTY

Sta.	B.S.	H.I.	F.S.	Elev.	Depth
B.M.	2.18	33.57		31.39	
⊼	2.18	33.57			
#1			7.86	25.71	11.5
#2			6.42	27.15	7.3
#3			6.49	27.08	5.2
#4			6.50	27.07	6.8
#5			10.99	22.58	10.20

FIG. 2. TWO SIDES OF LOOSE-LEAF FIELD NOTES; MILWAUKEE SEWER SURVEYS

ground structures; but, as usual, structures of which no records were obtainable were encountered when the trenches were opened up for the construction of the intercepting sewers.

In locating the lines for the proposed sewers in the streets the path of least resistance was naturally adhered to in practically all cases, exceptions being made of course where this would involve needless expenditure, and a short-cut was deemed advisable to save grade.

Accurate time records were kept both in the field and the drafting room during the five months this work was in progress. The cost per mile for fieldwork was $42, and for drafting-room work $90, both exclusive of material and administration costs. The seemingly high cost of drafting-room work is due to the fact that not only were the field notes plotted, but practically all the designs for sewer and tunnel cross-sections, standard and special manholes, shafts, junction chambers, etc., were completed during these five months. This, of course, necessitated carrying sufficient drafting-room force for that purpose. No tracings were made, however, during this time.

The work was done under the supervision of the Milwaukee Sewerage Commission, of which T. Chalkley Hatton is chief engineer.

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Contractor Discusses Bridges Damaged by Flood

A prominent contractor, during a recent trip through the flood district of the Catawba and the French Broad River Valleys of North Carolina, studied the effect of the high water of July last on concrete-bridge foundations. From his observations he deduces some interesting conclusions regarding the stability of such structures.

The July, 1916, rainfall on the watersheds of these rivers was the heaviest recorded in the United States. At Altapass, N. C., the 24-hr. rainfall, July 14-15, is reported as 22 in. Altapass is the dividing line of the watershed of the Catawba River and the headwaters of the tributaries of the Tennessee River. The Catawba flows to the Atlantic Ocean, and the Tennessee River to the Gulf of Mexico through the Ohio and Mississippi Rivers. The Catawba is reported to have risen 48 ft. in 8 hr., the stage being 18 ft. higher than any previous record.

At Mt. Holly, N. C., the Catawba was spanned by three bridges in the following order—county highway, Seaboard Air Line Ry. and the Piedmont & Northern Ry. (electric line). These are only a few hundred feet apart. The county bridge was not a very heavy structure. The Seaboard bridge was a deck truss on stone piers and abutments, and the Piedmont Northern was a deck truss on concrete piers and abutments, built in 1911 and of heavy construction. As described by an onlooker, the Piedmont bridge was weighted down by 10 carloads of coal in an effort to hold it. The drift piled against the Seaboard bridge until this bridge finally gave way, the wreckage sweeping down against the Piedmont bridge, which was wrecked. The steelwork and cars were carried downstream from one to several hundred feet, while one 60-ft. girder span was carried into an adjacent field about 1,000 ft. from the bridge site.

Of the Seaboard bridge one of the stone abutments remained standing, but the piers were gone. The abutments of the Piedmont bridge remained intact; the flood washed out the dirt fill behind the abutments which, being built without wings, appear at a distance like piers. The first span from the abutment on the Mt. Holly side to Pier No. 1 is of 60-ft. girders. Between Piers 1 and 2 is the first deck-truss span. When the bridge went out, Pier 2 broke off a few feet above the foundation concrete and at a point where the pouring had stopped at some time during the construction of the pier. In falling, the pier broke again; and again the failure occurred where the pouring had stopped for a time. The two channel piers, with their foundations, turned over and broke in blocks right where the several pourings had stopped. The pier on the Charlotte side is intact, although about 12 ft. of coping on the pier went with the span, which was bolted to the coping (18x5 ft. by 18 in. thick). The bolt took the upstream portion of the coping, leaving about 6 ft. of the downstream coping on the pier.

The piers all seem to be broken where the pouring stopped for the day. The bonding stones of one-man size pulled out of the concrete. Except for these breaks the piers are undamaged; and if it were possible to handle the pieces, they could probably be fitted one on top of the other, just as they were before the flood.

This is very good evidence that there is little bond between successive pourings of concrete. It is questionable whether it would not be better not to bolt steelwork to concrete piers. The piers to which the trusses were bolted failed, while the abutments on which the steelwork rested unbolted remained standing.

Farther up the Catawba River there were a few highway bridges carried on steel cylinders filled with concrete, but they did not last long. At one point the concrete pier and abutments of a highway bridge stand, but there is no trace of the steelwork, the flood evidently having topped the concrete some 10 or 12 ft. At one point on the Southern Ry. a wing of a 12-ft. arch (approximately) broke on the downstream side and washed downstream about 40 ft.

On one of the tributaries of the Catawba, near Old Fort, N. C., a few concrete abutments for highway bridges with earth approaches and steel superstructures were washed away, but the concrete was not damaged. A concrete bridge at Biltmore across the Swannanoa River, completed a short time before the flood, was uninjured.

At Asheville, N. C., the Southern Ry. crosses the French Broad River on heavy reinforced-concrete piers about 25 ft. high and 30 ft. apart. Millions of feet of lumber piled against this bridge, which for several hours acted as a dam, but it was not carried out. Below Asheville were a couple of highway bridges finished a short time before the flood. They were carried on 36-in. round concrete piers tied together by a 12-in. concrete web. The steelwork of the bridges was washed down the river, while these piers, poured monolithic, stand intact, except where a pier broke loose from its anchorage in the granite river bottom. The broken piers look as if they might be put back in place and be as good as before.

Considerable damage was done to railway embankments, and the Southern Ry. is now building rubble-masonry walls for future flood protection.

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Retracing An Old Survey To Settle Boundary Dispute

After more than a century of controversy the boundary line between the states of Ohio and Michigan has been defined to the satisfaction of both parties; and of all state boundary controversies, of which there have been many, there is probably none that has a more interesting history than this.

Historical Summary

The whole trouble grew out of a misconception of the geography of the Northwest Territory at the time the famous Ordinance of 1787 was passed by the Congress of the Federation. It will be remembered that by this agreement the Eastern States of Massachusetts, Connecticut, New York, Pennsylvania and Virginia relinquished their claims to the Northwest Territory that new states might be formed from it. This Ordinance of 1787 described an east and west line drawn through the southerly bend of Lake Michigan until it intersected the shore of Lake Erie as the boundary between the two tiers of states it was proposed to form.

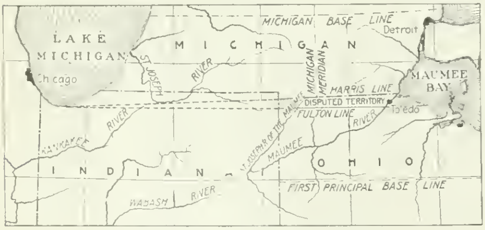


FIG. 1. BOUNDARY OF OHIO AND MICHIGAN WHICH WAS LONG A SUBJECT OF DISPUTE

All the early maps of this region showed the southern extremity of Lake Michigan north of where it should have been, so that it is assumed that the framers of the Ordinance of 1787 believed that they were fixing the northern boundary of Ohio Territory on Lake Erie north of Maumee Bay and even as far north as the mouth of the Detroit River. It was not suspected until 1802, when a convention was drafting the constitution of the State of Ohio, that the southern end of Lake Michigan was some miles south of the east and west line through the north end of Maumee Bay.

So a proviso was attached to this constitution, that if by a geographic determination the southern bend of Lake Michigan extended so far south that a parallel passing through it should not intersect Lake Erie, or should touch the lake east (and south) of the mouth of the Maumee, then with the assent of Congress the boundary was to be a direct line running from the southern extremity of Lake Michigan to the most northerly cape of Miami (or Maumee) Bay. Congress accepted the constitution, but neither accepted nor rejected the proviso. The governor and people of Michigan Territory subsequently insist-on a literal interpretation of the bounds described in the Ordinance of 1787 (and afterward incorporated in the act establishing Michigan Territory), while the new State of Ohio refused to give up its settlement and port on Maumee Bay (afterward the City of Toledo). One result of the controversy was to keep Michigan out of the Union for some time after it was entitled to admission as a state and until it tacitly agreed to relinquish its jurisdiction over the disputed territory. This was in 1837.

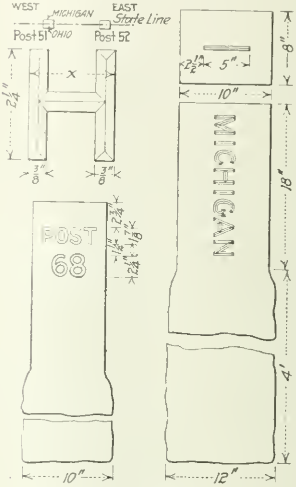


FIG. 2 OHIO-MICHIGAN BOUNDARY MONUMENTS

The disputed boundary was originally surveyed in 1817, according to the Ohio interpretation, for the surveyor commenced at the North Cape of Miami Bay and ran his line westward. Resurveys were made in 1837 and 1842 of portions of the reputed boundary in connection with the surveys of the United States General Land Office. During these resurveys 31 of the original 71 mile posts were found. Nothing further was done until 1915, when a Joint Boundary Commission was appointed and the work of permanently marking the boundary was accomplished.

Impossible To Locate Original Marks

A preliminary reconnaissance of the line in the summer of 1915 disclosed the fact that none of the original marks or posts, nor those set in 1837 and 1842, were in existence. The western terminus of the line, the northwest corner of Ohio, was identified by a boulder or "niggerhead" buried in the highway. The eastern terminus originally the northernmost cape of Maumee Bay, had long since been washed away. It was therefore decided to start at the western terminus and work eastward.

The notes of the original survey (1817) and of the public-land surveys (1837 and 1842) were available, and it was decided to reproduce this line (or lines) as nearly as possible. The usual methods employed in such work, of course, consist chiefly in finding and identifying the original marks; but as already stated, it was out of the question in this case. Therefore, the following scheme of operations was decided upon:

Program of Procedure

1. As nearly as might be, the line was to be relocated as originally staked out on the ground, and not necessarily run as a straight line from end to end.

2. Existing monuments, fences, highways and other marks, when agreed to by land owners on both sides as being on the state line, were to be so accepted.

3. Field maps of the survey were to be prepared on a scale of 400 ft. = 1 in., showing the preliminary line in red ink, and the location with reference to it of all existing monuments, buildings, highways, property lines and other topographic features (except relief) in black ink.

5. From this atlas of field sheets (one mile shown on each sheet) and the field notes gathered on the preliminary survey, the points where the boundary monuments should be planted were to be determined by a conference of the three commissioners.

6. The final positions of the monuments and the bearings and distances between were to be determined.

7. The latitude and longitude of all monuments were to be determined to the nearest 0.01″.

8. In general, monuments were to be planted at each highway and railroad crossing of the state line.

9. Intermediate monuments were to be planted 4 ft. into the ground, the bottoms to be surrounded with concrete 12 in. deep, 2 ft. square, half a sack of portland cement being allowed for each setting.

10. A special monument was to be set at the western terminus (a corner of the three states, Ohio, Indiana and Michigan).

11. No monuments were to be set in an east and west road unless the line made an angle at some point in the road.

12. Monuments were to be placed at all angles in the state line.

Methods—Instruments—Monuments

In most cases the only feasible method was to accept the General Land Office measurements of the connections made in 1837 and 1842 between the state line and the nearest section and quarter-section corners, north and south. Discrepancies in the figures were prorated.

In one instance the center of a highway for a distance of nearly two miles was taken as the boundary line, because it was so described by the survey notes of 1837, and had been so recognized since. The line as established by the methods employed elsewhere would have been from 71 to 116 ft. south of the center line. In another case a fence line accepted as a compromise in 1907 was taken as the boundary although it was 67 ft. and 75 ft. north of the section corners as determined from the General Land Office records. Two concrete posts on crossings of the Lake Shore & Michigan Southern R.R., which were reputed to be state boundary marks, and which agreed closely with the reëstablished line of 1837, were accepted as final marks.

The instruments used were a transit with 6-in. horizontal circles, graduated to 10′ and read by vernier to 30″, two 300-ft. steel tapes graduated to feet throughout, a 100-ft. steel tape, range rods, plumb bobs, etc. A double-centered transit line was run. Deflection angles were read twice, direct and reverse. This reference or random line was kept as near to, and as nearly parallel to, the original line as circumstances permitted. Distances were measured to the nearest 0.01 ft. with one of the two 300-ft. tapes. Distances were checked to the nearest foot by stadia readings. Azimuth determinations were made from Polaris near sunset.

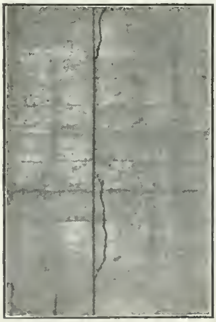
For marking the line the granite posts shown in the accompanying illustration were used. They were obtained from the Mount Airy quarry in North Carolina and cost $18 each, delivered. Each post weighs about 700 lb., but including the concrete setting; the weight in place exceeds 1,400 lb. A special granite monument with an appropriate inscription was erected on an offset (the actual point being in the center of the highway) from the Western terminus.

The boundary location was settled by three commissioners: C. E. Sherman, Inspector of the Ohio Topographic Survey; R. C. Allen, Director of the Michigan Geological Survey; and S. S. Gannett, of the United States Geological Survey. Mr. Gannett directed the fieldwork and computations. The completion of the fieldwork and the setting of the western monument were celebrated by appropriate ceremonies under the auspices of the Toledo Engineering Society at the site of the monument, Nov. 24, 1915.

The whole cost of the survey, 69.92 mi. long, did not exceed $7,200, or $102.95 per mi. An automobile was used to transport the field party of six men. The instruments used were loaned by the U. S. Government.

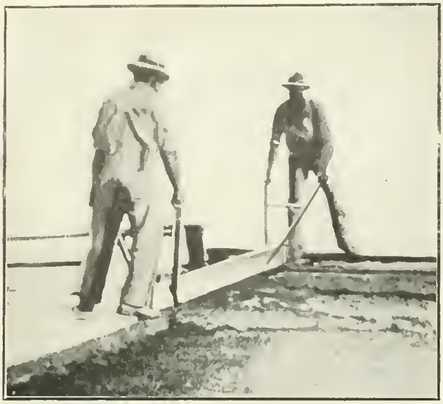
FINE AGGREGATE

Care Needed to Prevent Adhesion at Joints—That the separation on concrete at construction joints intended to localize cracks is not uniformly perfect can be observed in almost any finished piece of work. A typical instance is illustrated by the accompanying photograph. The retaining-wall whose face is represented has no crack or other developed defect in lengths of several thousand feet, except near some of the construction joints, which are spaced about 30 ft. apart. These joints were formed without interposing any paper or other separating material, by pouring one section after the adjoining section had set. No adhesion of any large amount should be obtained under these conditions, yet at places there seems to be a strong enough bond to break through solid concrete alongside the joint. On the wall shown in the picture, most of the joints have the shrinkage crack following straight down the V-groove formed at the face, but a sufficient number of meandering cracks occur to indicate that abnormal adhesion should be reckoned with.—F. S.



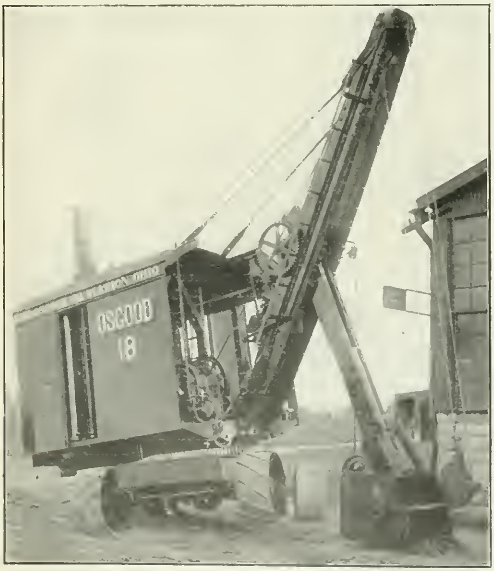
A SHRINKAGE CRACK

A Concreting Screed which is provided with plow handles at each end is used in concrete pavement practice around Pasadena, Calif. The plow handles make the control of the screed very simple and at the same time reduce the strain on the men doing the work. The view herewith is taken from a photograph of some paving work on the bottom of a reservoir at Pasadena.



PLOW HANDLES EASE UP CONCRETE SCREEDING

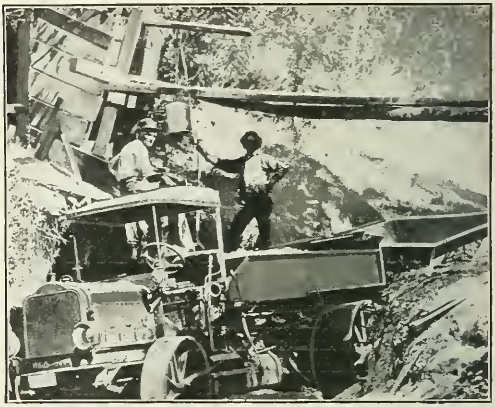
A Mired Shovel Can Lift Itself several inches off the ground so that planking can be placed under the wheels. This is done by dropping the dipper to the ground—as illustrated herewith—and starting the crowding or boom engines, and forcing the dipper handle in an upward direction. As the dipper is placed flat on the ground it is impossible to force it below the surface. Consequently, when the boom or crowding engines are started, the shovel is forced to rise off the ground.



SHOVEL LIFTING ITSELF SO PLANKING CAN BE PLACED

Dumping Rock Off High Trestles—G. P. Hawley, resident engineer of the Civic Investment and Industrial Co., Cedars, Que., asks for further information concerning the dumping of rock from high trestles (on the Southern Ry. relocation), as described in "Engineering News" of Nov. 16, p. 948, especially whether any end-dumping is employed. B. E. Chewning replies for the Sheahan Construction Corporation that the cars are not end-dumped, but that the 10-car trains are shoved out as far as possible, keeping the dinkey on the fill. Each car is dumped separately, a dog being used to hold the car on the rails. He states that the braces between trestle bents are constantly being broken during rock-dumping, but that this feature is not especially troublesome. Mr. Chewning goes so far as to say, "No successful dumping is ever obtained from end dumping from high trestles; whether dirt or rock. The pressure of the material will push the trestle legs out of place at the ground."

A Truck and Trailer Hauls 40 Tons per Day from the mine of the A. A. Haskins Dolomite Co., in San Benito County, Calif., to the railway located 10½ mi. away. The haul is through mountainous country with grades up to 10% and 1½ mi. long. The road is covered with dust from 6 to 8 in. deep. Prior to the present method the dolomite was transported by five 8-horse teams hauling 40 tons a day at a cost of $58.21. Now, a 5-ton White truck and a bottom-dump Troy trailer with rubber tires work on 24-hr. service, making four round trips with ten tons each day, at a cost of $28.71.



HOW TRUCK AND TRAILER ARE LOADED FROM HOPPER

Cleaning Old Ballast is done by the Kansas City Railways by means of a portable rotary screen made out of an old concrete mixer by substituting a revolving screen for the mixing trough and blades. The screen is 6 ft. long and tapers from 18 in. diameter at the motor end to about 3 ft. at the discharge end. The same gasoline engine that formerly drove the mixer now furnishes motive power for the screen. The machine is mounted on a portable steel-wheeled truck. In view of the present high cost of ballast rock, this device is a money-saver.

Contractor's Compressed-Air Regulations—In the harbor siphon tunnels of the new intercepting-sewer system at Milwaukee, Wis., the Western Foundation Co. is carrying on compressed-air work under unusually cautious rules. The following times are prescribed for decompression:

For Pressure (Lb.)	Time of Decompression (Min.)
20 to 24	16
25 to 30	20
31 to 36	24

The men are required to dry their clothes and drink hot coffee on coming out of the air, suitable facilities being provided. The two tunnels, worked from a joint shaft on Jones Island, are 52 ft. below river surface, and at present are carrying about 28 lb. air. They are in sand, which stands excellently under the effect of the air, so that open face work is done.

Editorials

Engineering News Prizes Awarded

In *Engineering News* of Oct. 26 the offer was announced of a first prize of $50 and a second prize of $25 for the best articles on each of four specified subjects, to be submitted to the editors on or before Dec. 10.

The articles submitted in competition for these prizes have been examined and the awards are announced as follows: For papers on the first subject, "Rebuilding with Permanent Surface an Old Macadam Roadway," the first prize is awarded to Charles A. Carruth, of Rochester, N. Y.; and the second prize to Theron M. Ripley, of Watertown, N. Y. For papers describing "Operating Methods in a Drill Sharpening Shop," the first prize is awarded to J. E. O'Rourke, of Granby, Mo.; and the second prize to Frank Richards, of New York City. For papers describing "The Dry Mixing of Concrete Material at a Central Plant," the first prize is awarded to H. F. La Brecque, of Brooklyn, N. Y.; and the second prize to Benjamin Wilk, of Chicago, Ill. For the papers written on the subject, "Adapting the Motor Truck to Its Work," the first prize is awarded to Clarence B. Montgomery, of West Philadelphia, Penn.; and the second prize to Edwin Hall Warner, of Los Angeles, Calif.

The prize papers will be published in early issues of *Engineering News*.

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American Steel Production and Business Prosperity

If one were to form a hasty judgment from the slaughter of prices which took place on the New York Stock Exchange last week, it might well be believed that the conclusion of peace would mean a financial panic in the United States and prolonged business depression. Those who hold such an idea fail to take into consideration the enormous demands which the world will make on all means of production to restore the ruin wrought by the years of war. They overlook the fact that while the war has been going on, the enterprises of peace have been stationary in nearly every country of the world. Houses, railways, mills and machinery have been wearing out and require replacement. It will require years to restore to normal condition the facilities for production in the industrial centers of Europe. To supply the needs of Asia, Africa and South America will make great demands on the productive capacity of the United States.

It is of interest in this connection to note the prophecy of one of the foremost figures in the American steel business, Charles M. Schwab, at a dinner given in his honor in New York City on Dec. 21. Mr. Schwab explained in detail what has been for some time known in a general way, that the Bethlehem Steel Corporation, of which he is the head, has planned a building and construction program involving an outlay during the next few years of about $100,000,000. This expenditure, however, is not chiefly in the enlargement of its great ordnance plant, which is already 50% larger, according to Mr. Schwab's statement, than the famous Krupp Works at Essen. The expansion will be chiefly in facilities for the production of steel for peaceful purposes. "When our plan of improvements is completed," said Mr. Schwab, "the 25 component parts of Bethlehem Steel will consist of only 1 part ordnance making, 4 parts ship building, and 20 parts the manufacture of steel for commercial purposes." The Bethlehem corporation is already building one-third of all the ships under construction in the United States.

As to the outlook for the future, Mr. Schwab said:

> When the war is over there will of necessity be a reduction in the demand for munition steel and there will be some recession in steel prices generally. But the domestic demand for steel rails, for buildings, and for numerous other purposes awaits only a more normal condition of trade to press forward for prompt satisfaction. Those domestic demands alone will absorb our steel capacity for many years. A period of depression will come some time and it may be severe, but it will not become acute, in my judgment, until at least three to five years after the war is ended.

Those who lugubriously picture the United States succumbing to the competition of European rivals after the war forget the terrible handicap of debt under which all productive enterprise in those nations must hereafter struggle. They forget also the vast advantage of the United States in its unrivaled natural resources, particularly in ore and fuel. In steel and iron production the United States has left all other countries far behind. The figures quoted by Mr. Schwab in his address are significant: In 1880 the total steel production in the United States was only 1,000,000 tons. When the U. S. Steel Corporation was formed, twenty-one years later, the annual steel production was 12,000,000 tons, and many believed that we were then at the zenith of the steel business. This year the United States will produce 40,000,000 tons of steel, and Mr. Schwab declared his belief that we are as far from the zenith today as we were in 1901.

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Water Purification Safer Than Sewage Treatment

A principle that is gaining daily in recognition by sanitary engineers is that a dollar spent in water purification goes much farther toward protecting a community from the dangers of sewage pollution in its potable water supply that a dollar laid out in sewage-treatment works. This and some important related principles are well stated in a recently published report on sewage disposal at Davenport, Iowa, by John W. Alvord, consulting engineer, Chicago:

> In general, the expenditures made for the purification of water supplies are much more effective in the protection afforded against epidemic diseases than the sewage-purification works established to protect the purity of the water-supplies. It is immaterial whether a city or private company operates the water-works. If the purification of a water-supply is rendered more difficult and more hazardous by reason of the fact that a city is dumping its sewage in close proximity to a water-works intake, and a water company is

> consequently put to additional expense in order to furnish the people with a pure supply, it is only fair that the people compensate the water company in rates for such additional expense. In reality, therefore, the people pay for either water purification or sewage purification. However, a city must not contribute to the pollution of its water-supply when it can be avoided with reasonable expenditures; if it does contribute it must also assume a larger measure of the responsibility of guarding the health of the community.

It is now incumbent on engineers to persuade city authorities to accept and act on these principles.

The time will come when cities downstream from the sewage outlets of other cities will ask that the upstream city bear part of the cost of purifying their water-supplies instead of demanding sewage-treatment works. Intelligent engineers seldom design sewage-treatment works with the idea of affording much protection to public water-supplies and no matter how they are designed, it is common knowledge among engineers that sewage-treatment works are rarely operated under bacterial control.

Another "Public Buildings" Raid on the Treasury

Every engineer knows that the cost of construction work, due to the great increase in prices of labor and materials, has reached an unprecedented level. Under these conditions, private investors and corporations alike are restricting their work to what is absolutely necessary. The New Haven R.R. Co., for example, recently issued a circular to all its officers, ordering that not only should no new construction work be undertaken but that maintenance work must be restricted to that absolutely necessary to preserve property from deterioration. Those in charge of municipal work also, in many cases at least, understand the importance of cutting down expenditures at the present time in order that work may be undertaken on a liberal scale when the tide has turned. At that time it will be possible to accomplish far more for a given expenditure and at the same time to give employment to labor, which may then need employment badly.

The Congress of the United States, however, is unmindful of these things. A House Committee has reported a bill appropriating $35,000,000 for the construction of public buildings in the United States and the purchase of sites therefor. The bulk of this money is to be spent for the construction of post-office buildings in small villages scattered throughout the country, many of them places of only 1,000 to 2,000 inhabitants.

The raid on the public treasury known as the Public Buildings bill began a number of years ago in a comparatively modest way; but it has rapidly grown bigger and more dangerous year by year. In the last dozen years something like $190,000,000 has been appropriated by Congress for the construction of public buildings. The pending bill is for about $35,000,000 and is likely to have $5,000,000 to $10,000,000 added to it by the time it passes out of the hands of the Senate. Every one of these Government buildings erected in a country town forms a foundation for demands upon the Congressman by rival towns in the district that similar buildings should be erected to ornament them.

In making the appropriations for these buildings, the scale of expenditure is not at all what is needed to properly accommodate the post-office business of the community, but is merely how large a sum can the Congressman secure.

This scandal was investigated in 1913 by a Public Buildings Commission which had among its members Secretary of the Treasury McAdoo, Attorney-General Reynolds, and Postmaster-General Burleson. This commission reported that the post-office buildings which the Government had erected in the smaller towns were so extravagant in cost compared with the rented buildings formerly occupied that the operating expenses of the building alone (to say nothing of the interest and depreciation) amounted to three or four times as much as it formerly cost for rent and care when the post office was in a rented building. This waste in public buildings therefore, means not only taking $35,000,000 out of the Federal treasury to construct buildings at a time when building is very costly but that the Government will be placed under a perpetual heavy expense to operate and maintain these buildings.

Congress proposes to undertake this outlay moreover in the face of the report of Secretary McAdoo showing that the United States treasury will face a deficit at the end of the fiscal year of $185,000,000, and at a time when the need was never greater for Government expenditure on projects of real national benefit.

At this time, too, the Government, like every other great business organization, has to face the necessity of increasing wages and salaries to enable those in its service to meet the high cost of living. Bills to accomplish this have already been introduced in Congress, and it has been estimated that absolutely necessary increases of this sort throughout the Government service will increase the nation's expenditures next year by $25,000,000. Surely, under these conditions an insistent demand should be made upon Congress from all parts of the country that the waste of the public funds in the distribution of "pork," either for public buildings or for river and harbor projects which cannot be justified by national need, must come to an end.

Practical Bridge Decoration

There has been much talk heretofore about introducing beauty into bridge construction. Pittsburgh will do more than talk. It will spend $60,000 in an effort to achieve an artistic result in the way of combining architecture with the work of the bridge engineer. As to the degree of success of the Pittsburgh effort, every one may form his own judgment from the drawings published elsewhere in this issue. Tastes differ; but even those whose taste is not suited by the Point Bridge portal design will concede that the serious purpose and well studied efforts of the architects in this instance merit more than mere recognition.

There is sharp contrast between the original design for monumental stone portals and the present design in bronze and cast iron. No doubt the taste of many would prefer the stone portal; on the other hand the question of making a harmonious combination of a great steel structure and heavy ornamental portals of masonry overshadowing the structure itself is difficult indeed. When we are further told that the stone portals would have cost very much more than the metal ornamental work now to be constructed, we are likely to agree with the decision of the art expert in favor of the accepted design.

Letters to the Editor

Monolithic-Brick Pavements

Sir—In a notice of the new specifications of the National Paving Brick Manufacturers' Association, on p. 945 of *Engineering News*, Nov. 16, 1916, it is stated:

> The following paragraph provides for the dry mixing of one part cement to three parts sand, and it is presumed that this mixture is applied dry to the foundation concrete, although the specifications do not definitely say so. The brick are laid, rolled and grouted as in ordinary practice.

I wish to call your attention to the fact that this point is covered in Item 5, Sec. 5, of the country road specifications, the second paragraph of which reads:

> In shaping the concrete deposited from the mixer, it shall be thoroughly spaded, settled and roughly surfaced immediately ahead of the double templet. A sufficient amount of dry mixture for the thin coating shall be supplied continually between the framed templets so that in the forward movement, the rear templet shall distribute the necessary film over the entire surface, producing the required smoothness.

It is here clearly stated that the dry mix shall be applied immediately to the green concrete. This process is further explained in the note included in Item 5, treating of the "Concrete Foundation," which definitely states how this film of dry mixture becomes an integral part of the concrete.

You also state that "the brick are laid, rolled and grouted as in ordinary practice." In Item 8, Sec. 6, we tried to state very definitely how the brick pavement shall be rolled and brought to the required surface. This process differs from the ordinary practice in that we use a hand roller weighing not less than 20 lb. per inch of length, the length required being approximately 30 in. Similar provisions are made in the city street specifications under different items and sections.

WILL P. BLAIR,
Secretary, National Paving Brick
Manufacturers' Association.
Cleveland, Ohio, Nov. 18, 1916.

Patents in Municipal Contract Specifications

Sir—For many years municipal contracts have contained a clause designed to protect cities against claims for patent infringements. The plan has been to require the general contractor to assume all responsibility for defending such claims and for any cost and damages arising therefrom.

The evident original intent of such clauses was to protect cities from any patent claims which were held by other than the guarantor and with which the city was not familiar. It is doubtful whether such a standard clause in specifications would cover a direct patent obligation unless prospective bidders are notified in advance what the patent fee is, so that it may be included in contractor's bids.

The Imhoff tank has been offered to the American public for very moderate royalty fees, based on the population tributary to the tanks. It would appear to be necessary for an engineer drawing his specifications, or for a city building Imhoff tanks, either to specify the amount of the fee in the specifications and to whom it shall be paid, and to demand a receipt from the contractor before settlement for the work is made, or else to eliminate the Imhoff royalties from the general contract and so state in the specifications, at the same time specifying that the city will pay the Imhoff fee direct. Obviously, if the city pays the fee for a recognized patent claim, as covered by the contractor's bid, it (the city) should have and hold the license to operate the patented process or apparatus—the city's interest in the matter not being protected in any way, otherwise.

Singer Building, S. FISHER MILLER,
President, Pacific Flush Tank Co.[1]
New York, Nov. 23, 1916.

Patents and War!

Sir—I have no patents and do not want any, but I think you treat inventors unfairly. You encourage the boys to poach on old men's ideas. The old engineers are in the scrap pile. Employers want fresh young hothouse graduates, directors' sons, who know not how to criticize, but can marvel at their superior's ability and laugh at his jokes. The old man built structures that stand and earn dividends. They like his work, but dislike to pay him. The kid can copy his plans and make a reputation for himself if the judge will only knock out patents.

They are your subscribers and you serve them well in chuckling as you do over every patent killed. In your last issue you were happy because a filter patent was invalidated at Minneapolis, and in the same paper you wish someone would invent a water-pipe joint to be knocked out! I would invent a pipe joint if I did not have to advertise, compete with the old joint, hire lawyers, experts and detectives to dig up and expose infringements.

No one is punished for this kind of theft. If he is caught, he only has to pay the regular royalty. Judges mistake public feeling if they do not give inventors the benefit of doubts and rely upon patent-office examiners rather than experts who do not care which side of a case they are on.

Last spring I sent you a patentable idea about range finding for artillery. I wanted it published only in the interest of my three boys and others who may be exposed to artillery fire, due to the lack of engineering knowledge in the army. But you refused, because you are a "pacificist"; and I hope the first hostile shell will fall on your desk.

There you sit on Manhattan Island, an engineer, and imagine yourself safe behind the disappearing guns. Can they be elevated for a maximum range? If not, is not the defect fatal? Do you think there is something mysterious that will bluff foreigners? It is your duty to expose the weakness of those guns and to advocate laws to reorganize the army, on the theory that war is engineering, far more so than was understood last spring. It is all artillery. Infantry is now only an adjunct. You would not reject my idea at this time, especially if you could see the October minutes of the General Staff, where they gave me a resolution of commendation for it and said it was successfully tried in the great war.

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[1] American and Canadian commercial representative of Dr. Karl Imhoff, Essen, Germany.

The future successful commander must be an engineer and rely almost exclusively on artillery. He must study topography more than an engineer ever has; he must figure trajectories and fix locations by trigonometry and drafting, must understand what explosive forces he controls, muzzle velocities, atmospheric resistance, must call out the coöperation of his subordinates and keep records and data as only an engineer can do.

Strength is not in men, but in engineering. The old idea of an army is long lines of glistening bayonets, but these are out-of-date and useless. In their place are picks, shovels and grenades to hold and herd the mobs at a distance from the batteries; and it is your place to say so.

Your brother journalists who are not engineers may be excused in thinking your guns with complicated casting support are safe in a pit, that the shells will come like beams of light, on a straight line, or that all the lives and ammunition that are wasted in France cannot be avoided by science. You ought to know better.

Denver, Colo., Nov. 15, 1916. A. M. HAYNES.

[We trust no large proportion of our readers have as peculiar ideas as to the editorial conduct of *Engineering News* as those so forcibly expressed by our correspondent. Their publication, however, affords an opportunity to correct misconceptions that may have been shared by others. *Engineering News* has no quarrel with patents on real inventions. Careful reading of our columns will show that our criticisms have invariably been aimed, not at legitimate patents on bona fide inventions, but at patents that have been issued for mere variations in design, such as could have been made and have, in fact, been made by other competent engineers and for which the grant of a monopoly right is not justified.

As to his reference to the young engineer as a supplanter of the old inventor, in nine cases of ten it is the "fresh young hothouse graduate" who tries to get a paper patent on some alleged invention and occasionally, by so doing, makes a deal of trouble for the old engineer, who knows that it is the business of an engineer to solve the new problems in design that come before him as part of the day's work and that it is against public policy and unprofessional to claim a monopoly in his solution of such a problem unless he has really made an important advance in the state of the art.

To take the pipe joint for illustration, it would be extremely difficult to invent anything in the way of a new pipe joint on which a valid patent could be obtained, in view of the hundreds and thousands of pipe joints already on the patent records. What is needed is not a new invention, but a thorough scientific study of past and present practice in making pipe joints and the development of such detailed methods and improved materials that it will be possible for engineers responsible for building pipe lines to produce a much higher grade of work.

Turning now to our correspondent's remarks on military engineering, it is to be hoped that every contribution that the editors of *Engineering News* find it necessary to return to the author does not provoke such lurid wishes toward us. At least he should be more considerate of our innocent desk neighbors.

We find no record of the receipt from him of any such contribution as he describes; but if it was received, it would have been of necessity returned under a rule of over 25 years' standing that new inventions are not described in these columns until they have been actually constructed and tested.

Further than this, *Engineering News* is obliged to set certain limitations to the field that it can cover, and it can devote little space to matters of military engineering, important though that is with respect to the national security. Notwithstanding his convictions as to our "pacific" tendencies, we take pleasure in congratulating him upon the compliment to his range-finder invention and express our hearty approval of certain of his criticisms with respect to weak points in our national defense.—Editor.]

Cost of Concrete and Other Permanent Pavements

Sir—In an editorial, with the substance of which the writer is in accord, published in your issue of Nov. 23, entitled "Blundering Road Legislation in New Jersey," you state that "with a minimum width of 18 ft., there would be at least 10,560 sq.yd. of paving to be laid per mile; and of the materials specified as permissible for the paving, concrete is the only one that could possibly be brought within this limit of expense." There is a previous statement that the permissible expenditure must be less than $13,000 per mile.

The inferences to be drawn from these statements are that an 18-ft. concrete road can be built for less than $13,000 per mile; and that if a road of any other type were to be built at this figure or under it, it would not correspond to the highest standard of construction recognized as essential to success.

The writer believes that neither of these inferences is correct. In the tenth annual report of the Board of County Commissioners of Wayne County, Michigan, just issued, the cost of a one-course road 18 ft. wide, 1.29 mi. in length, figures out at the rate of $16,120 a mile. A 15-ft. road (Canton Center Road) cost $17,380 a mile. A two-course road 3.8 mi. in length and 18 ft. wide cost $24,140 a mile, the greater cost in the latter case being attributed to the use of stone in place of gravel. In all these cases the costs do not include profit. In other words, they would undoubtedly have been greater if the road had been built under contract.

The tabulation of the bids received recently by the State Highway Department of New York, presumably based on a 16-ft. road, gives costs of from $13,000 to $20,600 and an average cost of $15,700 per mile, exclusive of overhead charges, which would bring the cost to about $17,300 per mile. A recent proposal received by the writer amounted to $19,900 per mile.

The "Tabular Digest of Some Concrete Pavements," by the Association of American Portland Cement Manufacturers, shows that the prices per square yard varied from $1.22 to $1.62, and the writer knows of a case where the price this summer has been as high as $1.74 per sq.yd. On the basis of 10,560 sq.yd. this would give costs of from $12,900 to $18,400 per mile, exclusive of the necessary grading, indicating clearly that, on account of the cost alone, concrete would have to be excluded from consideration rather than that it is the only pavement that may reasonably be considered.

The implication that other types of permanent pavement cannot be built for $13,000 or less is not justified if it is admitted that a bituminous pavement on an unyielding foundation comes within the requirements of the statute. The State Department of Highways of New York builds such roads quite extensively, and a tabulation of bids recently received gives prices ranging from $11,500 to $13,100 per mile on 36 mi. of roads. The writer has personally built many miles of permanent roads of a similar type, the cost of which did not exceed $13,000 per mile. EBERHARD J. WULFF.

Tarrytown, N. Y., Dec. 4, 1916.

[The New Jersey law referred to specifies that the roads are to be paved with "granite, asphalt or wood blocks, brick, concrete, bituminous concrete, asphalt or other pavement having a hard surface and of a durable character."

In the comment that our correspondent quotes, we did not say that these roads could be built and paved with concrete at an average cost of $13,000 per mile. We said, "of the materials specified as permissible for the paving, concrete is the only one that could possibly be brought within this limit of expense"—which is quite a different thing.

If $13,000 were spent solely on the paving of a road one mile long and 18 ft. wide, the average expenditure would be $1.23 per sq.yd. It is needless to say that paving of granite, sheet asphalt, asphalt block, wood block or brick cannot be laid at this price per square yard, and the only materials left are concrete and "bituminous concrete." According to the standard definition, "bituminous concrete" refers to a road pavement of bituminous materials and hard aggregate mixed together before placing on the roadway. Many of the roads paved with bituminous concrete by the mixing method have cost $1.50 to $2.00 or more per square yard. The cost of such roads has it is true been considerably reduced but it is doubtful whether it could be brought within the limit above stated.

The only remaining material specified is concrete. The cost data on concrete-road construction reported by a special committee to the Concrete Road Conference of last February showed average costs per square yard for concrete roads in 1915 in some of the states as follows: Connecticut, $1.13; Illinois, $1.03; Indiana, $0.98; Maryland, $1.08; Massachusetts, $0.95; Michigan, $1.10; Minnesota, $1.11; Missouri, $1.09; New Jersey, $1.23; New York, $0.98; Ohio, $1.02; Pennsylvania, $1.01.

Considering the abundance of good stone, gravel and sand in New Jersey and its nearness to the cement mills, good concrete pavements should be laid in New Jersey for about a dollar per square yard, under normal conditions in the labor and materials market, although not at the inflated scale of prices now prevailing. As stated in the article, however, other items in the cost of reconstructing the proposed roads would raise the cost per mile far above the $13,000 limit.—Editor.]

Long-Time New York Rainfall

Sir—The articles entitled "Long-Time New York Rainfall as Basis for Sewer Design," by O. Hufeland, in your issues of Aug. 31 and Sept. 7, 1916, have been read with interest. The precipitation record of the Central Park Observatory is of great value and *Engineering News* is to be congratulated for having made it generally available to the profession. The previous publication in the progress report of the Committee on Rainfall and Runoff of the Municipal Engineers of the City of New York[1] was unknown to many engineers, and somewhat difficult to obtain. Mr. Hufeland appears to have presented the data in somewhat more detail, and his diagrams are reproduced to a larger scale than those of the Committee. It is noticeable that he presents exactly the same formulas for intensity of precipitation of various frequencies as those reported by the Committee, yet makes no reference to the Committee or its report.

Mr. Hufeland's characterization of the analysis in his first article as the "average-rate" method, particularly in connection with his statements, seems to the writer unfair. He says:

> The reasoning on which these curves are based is that storms that have occurred but once in 45 yr. will probably not occur again in a shorter period; those that have occurred twice in 45 yr. may be expected to occur every 22½ yr., etc.

Everyone knows that the occurrence of extreme rainfalls is very erratic, and that three or four extreme storms might occur in a single year. If the intensity were not equalled again for a century, the (average) frequency might be 25 yr.; but this is only a relative statement, and a similar or equal storm may occur again at once.

Mr. Hufeland's argument for what he calls the "uniform intensity" method is not very convincing. It is seldom that storms of considerable intensity maintain a uniform intensity for any considerable time; but they do occur, and their effect must be allowed for in sewer design. According to Mr. Hufeland's argument, storms in which the intensities are not substantially uniform will be left out of consideration. It is probable that most storms in which the intensities are sufficiently uniform so that anyone would use the average, would have nearly as great an effect in producing runoff as absolutely uniform storms with the same average intensities, and it is conceivable that, with certain conditions of variation of intensity and shape and slopes of the drainage district, the non-uniform rain might produce the greater runoff.

It is significant to compare the maximum intensity curves given in Mr. Hufeland's two articles. As shown in the table below, the intensity for which a drain serving a district having a 20-min. period of concentration would be designed would be only half as great, and for a 60-min. district, only about a third as great as if the "average-intensity" method were employed.

COMPARISON OF MAXIMUM INTENSITIES OF PRECIPITATION AT NEW YORK ACCORDING TO TWO METHODS

	Intensity of Precipitation, Inches per Hour	
Period Minutes	Average Intensity	Uniform Intensity
5	11.81	12.00
10	9.30	6.55
15	7.90	4.50
20	6.85	3.42
30	5.43	2.32
40	4.48	1.76
50	3.82	1.41
60	3.33	1.18

Mr. Hufeland himself confesses that he has no substitute to offer for the so-called "average-intensity" precipitation curves when it comes to the actual use to be made of them; that is, he does not argue that the "uniform-intensity" rate curve should be substituted in design. If this were to be done, the sub-mains might be of ample size, but it seems obvious that the main drains would be woefully inadequate.

CHARLES W. SHERMAN.

Boston, Mass., Dec. 18, 1916.

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[1] Proc. Munic. Engrs., New York City, 1913, p. 373.

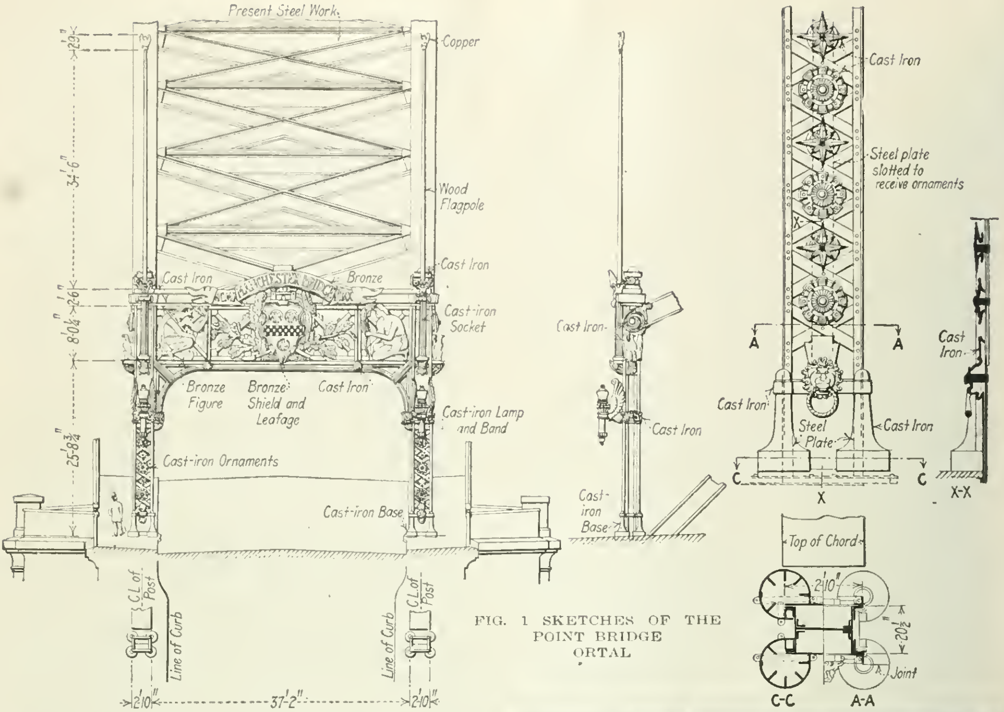

FIG. 1 SKETCHES OF THE POINT BRIDGE PORTAL

Elaborate Ornamental Portals for Point Bridge

Highly sculptured ornamental portals are to be added to the North Side Point Bridge, Pittsburgh, at a cost of about $60,000. Stone archway portals were designed for the structure originally, but for various reasons, principally that of cost, the stone design was abandoned. The new plans are the result of a year's study by the city's Department of Public Works, in coöperation with the Municipal Art Commission, whose approval was necessary. The general plans were shaped mainly by S. L. Roush, architect of the department, in collaboration with the sculptor selected for the work, Charles Keck, of New York City.

Several drawings and a photograph of a small-scale model of one portal are reproduced herewith. The steel portal to which the ornamental work fastens is already in place, being part of the original design. Though the bridge (two 515-ft. spans) is of regular curved-chord type, with inclined end-posts, a vertical portal was provided at each end, with posts footing over the end pins; and the top lateral system was extended out to this portal in order to deliver the wind shear to it. The steel portal was to form the central core of the ornamental stone portal, and the designers held the view that by actually transferring the wind forces to the plane of the vertical portal the stone portal would place true emphasis on a structurally vital element—namely, that which secures the stability of the bridge.

The stone portal would have concealed the steel portal, but the new cast-iron and bronze portal utilizes the

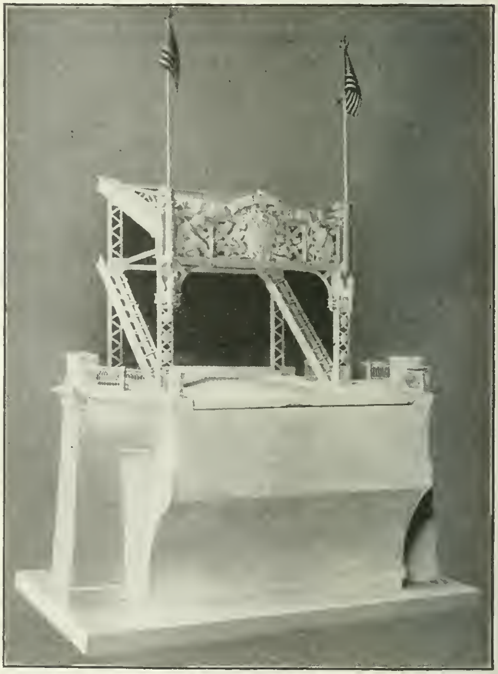

FIG. 2. PHOTOGRAPH OF MODEL MADE BY CHARLES KECK, SCULPTOR

general outline and appearance of the steel portal, with the addition of surface ornamentation. "It was the idea," states the architect, "to evolve an ornamental metal portal which would harmonize with the steel structure, all needed structural members to be shown and the ornamental parts made subordinate to them."

The evolution of the design by coöperative effort was about as follows: Sketches for various possible portals were prepared by the department and submitted to the Art Commission. The latter, after several conferences, selected the design that promised the most successful result. Fuller drawings were made for this design, and the development of the main ornamental elements was elaborated in conference with the sculptor; a ½-in. scale model was built up in the course of this work. The Art Commission passed on the model and suggested a few changes, after which contract plans were drawn up and construction contracts let. The further process will be to prepare quarter-size models for final criticism and revision, and then full-size models for the foundry's use.

The figures in the portals are intended to be based on local historical or industrial life. The finished work is expected to have not only artistic value, but also an educational effect.

The cost of the two portals is $45,100. Some changes in the present steelwork at the portals to receive the ornamental work will add about $15,000 to this figure.

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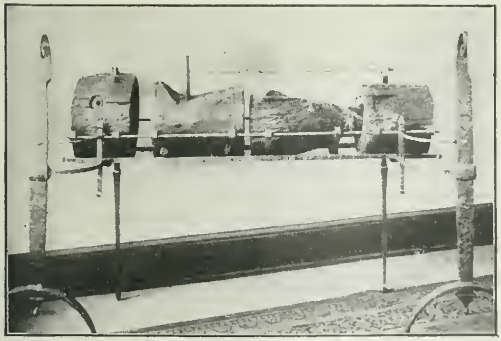
Early Water-Works Relics

Relics of New York City's early water-works continue to be unearthed in connection with the subway construction. The William St. subway, passing through the ancient part of the city, furnished the interesting relics illustrated herewith. The pieces from left to right are a service connection, a gate valve, and a bell-and-spigot joint. They were mounted as shown and presented to the Engineers Club of New York by F. J. MacIsaac, of Smith, Hauser & MacIsaac, Inc., contractors.

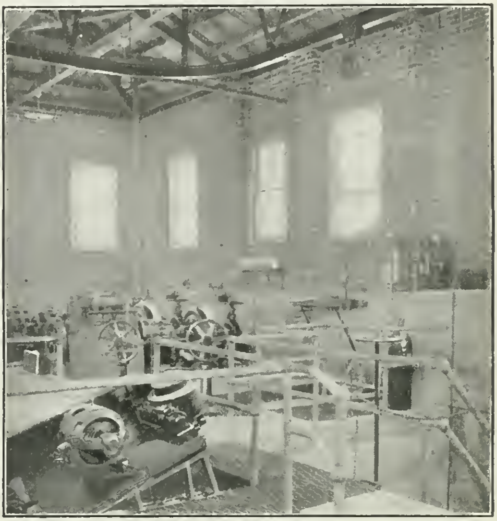

SERVICE-PIPE CONNECTION, GATE VALVE AND BELL-AND-SPIGOT JOINT ON OLD WOOD WATER PIPE

These are supposed to be relics of the water-distribution system of the Manhattan Co., and may have been installed in the last decade of the eighteenth century. There is a fair chance, however, that they are a part of the system of the first water-works company, which was in operation in 1776, with Christopher Colles as superintendent. This company ceased operation during the Revolution.

Screening and Disinfecting Wildwood Sewage

A plan for treating the sewage of Wildwood, a seaside town in southern New Jersey, has recently been put in operation. Fine screening followed by liquid-chlorine gas disinfection is employed. The effluent is discharged into Grassy Sound.

By treating the sewage while fresh and by a process that breaks down a comparatively small percentage of the solids, clarifies and then disinfects the sewage, it was possible to locate the plant near the cottages and other buildings served, and discharge the effluent into near-by water. This, of course, saves materially on the length of sewer pipe required.


INTERIOR OF WILDWOOD SEWAGE WORKS

Two Riensch-Wurl screens are used, each 10 ft. in diameter. The screen disks are of rolled manganese bronze, with specially cut slots for perforations $\frac{1}{16}$ in. wide by 2 in. long. The solids removed by the screens are automatically discharged into cans that are lifted by a hoist and conveyed by a trolley to a point outside the building from which they are carted away.

The sewage-treatment plant and the sewage pumps are housed in a small building, the interior of which is shown by the accompanying view. The pumping equipment consists of three 10-in. D'Olier centrifugal pumps, two of which are operated by direct-connected electric motors and one by a direct-connected gasoline engine.

The plans and specifications for the plant were prepared by Harry E. Weir, city engineer of Wildwood. James McLinden & Co., Anglesea, N. J., was general contractor. The screens were supplied and installed by the Sanitation Corporation, New York City.

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Wisconsin State-Aid Roads constructed during the present year amount to 1,158 mi., costing $3,631,026, according to A. R. Hirst, chief engineer of the State Highway Commission. Besides the roads there were 352 state-aid bridges, which cost $540,068, making a total expenditure of $4,171,094 for the season.

News of the Engineering World

Interesting Report on Ohio Topographic Survey

The recent completion of the topographic survey and map of Ohio, by the U. S. Geological Survey in coöperation with the state, marks the termination of the most extensive and rapid state topographic survey yet made in the Union.

The work was begun in 1900 and completed in 1916. The total area of the state, all mapped to the standard scale of 1 : 62,500, is 41,240 sq.mi., or more than the combined areas of Massachusetts, Rhode Island, Connecticut, New Jersey, and Maryland, which have previously completed similar topographic surveys. West Virginia has also been completely surveyed, but a large portion of its area is mapped to a scale of only 1 : 125,000.

The entire State of Ohio has been completed in 16 years. In contrast Maryland, the next largest state completed to the Government's standard scale, began coöperation in 1896 and completed the work in 1915. New York began a similar survey about 25 years ago and at the present rate will not be through for several years. Pennsylvania, which began coöperation before Ohio, is not much more than half done, while the other large states have done little more than make a good beginning.

The state's share in the coöperative survey of Ohio has for the past 15 years been under the direction of Prof. C. E. Sherman, who plans to get out a final report in four volumes.

Volume I, entitled "The Ohio-Michigan Boundary," is just out of press, and is a formal report for adoption at the forthcoming session of the legislature. The work of relocating and monumenting the boundary was done in 1915 jointly by the States of Michigan and Ohio, and the only action remaining to be taken is formal approval of the joint report now submitted by Michigan and Ohio.

Volume II, "Description of Surveying Marks and Monuments Used in Making the Topographic Survey of Ohio," will contain about 700 pages, and is printed up to page 500. This volume is a revised and edited compilation of the field notes gathered in the state by Government surveying parties, supplemented by similar notes from railroads and cities where they are sufficiently precise.

Volume III, "The Public Land Systems of Ohio," is in preparation. Since Ohio was the experimental ground for the Union in developing the present system of sectionizing public lands, the commonwealth presents more varieties of subdivision than any other state in the Union.

Volume IV, entitled "The Progress and Completion of the Ohio Topographic Survey" is planned as a popular description of the work. It will include chapters on origin of the survey, with a complete list of previous maps of the state; legislation, agreement, and expenditures; methods of surveying used; record of progress; uses of topographic maps; boundaries of the state; land and water areas, etc.

Without a single failure from the beginning to the end of the field work, the legislatures of Ohio have appropriated the necessary funds for coöperation with the Government, and the forthcoming session is expected to appropriate sufficient funds to complete the final report as above outlined.

Final Hearing on New York Motor-Truck License Law

The New York State commission appointed by the legislature to adopt and file a schedule of fees to be paid by the owners of motor omnibuses and motor trucks held a second and final hearing in New York City, Dec. 21. The first hearing at Albany, Nov. 21, was reported in this journal, Nov. 23. Little new or of interest was developed at the second hearing. The commission has seen fit to give no inkling of what the proposed schedule is to be, and the meeting was devoted largely to a repetition of the previous arguments against any special taxation whatsoever.

A. J. Slade, of the Society of Automotive Engineers, stated that this society had studied the problem of basing fees on the "time and extent of the vehicles' use of the roads and the relative wear and tear on the roads resulting from their use" (according to the definition of the law) on four separate occasions covering several years, and that each time the task had been abandoned as impracticable. A formula for computing fees on such a basis was possible but too complicated to be generally applied.

The principal feature of the hearing was the admission of prominent motor truck manufacturers that there must be a limit to motor trucks, weights and loads, at least under present conditions of highway construction. A maximum of 14 tons was mentioned as a practical limit for weight of truck and load combined. It seemed probable from the discussion that if any attempt is made to change the present $5 fee the legality of the commission's action will have to stand the test of the courts.

Volcano Develops 15000 Hp.

In Italy the price of coal at present varies from $40 a ton at seaports to $50 in the interior. In central Tuscany near Volterra this economic pressure has resulted in the erection of a large electric plant operated by subterranean steam from a volcano. There are here numerous cracks in the ground, from which powerful jets of steam constantly spout high into the air. These are known as *soffioni* (blowers), and for many years boric acid and borax have been extracted from the steam.

This steam is now used for generating power. According to Professor Luiggi, in *Engineering*, credit for this use of the steam on a large scale is due Prince Ginori-Conti, who has been experimenting in this district since

1903. Holes from 12 to 20 in. in diameter were bored in the ground, and pipes were driven down to the source of the steam, which is under a stratum of hard rock 300 to 500 ft. below the surface. The steam issues from these holes at pressures of two to three atmospheres and temperatures of 150° to 190° C. New borings do not seem to affect the supply, so long as the distance apart of the holes is not less than 50 ft.

It was attempted to use the steam direct to drive a 40-hp. steam engine, but the borax salts and the gases mixed with the steam, especially sulphureted hydrogen and traces of sulphuric acid, had a corrosive action on the metal parts of the engine. The difficulty was got around by applying the superheated volcanic steam to a boiler; that is, substituting it for fuel in an ordinary multitubular boiler in which steam was produced at a pressure of two atmospheres, then passed through a superheater where it was dried by volcanic-steam heat and was then used to drive a 300-hp. condensing steam turbine, directly connected to a three-phase electric generator, which supplies the works and villages around about Larderello.

This plant proved so successful that, when the war broke out and prices of coal soared, Ginori-Conti decided to carry out the work on a large scale. Three 3,000-kw. turbo-generators were ordered, from the Tosi works of Legano, designed to operate with superheated steam at 1½ atmospheres, generated in specially constructed multitubular boilers having aluminum tubes for the better utilization of heat and better resistance against corrosive action of the volcanic steam. In the boiler the steam temperature was reduced from 180° to about 120° C., and borax was extracted from the exhaust.

One of the 3,000-kw. units has been at work since January, 1916, the second since April, and the third has very recently been put into service. The three-phase electric current is generated at 4,500 volts, 50 cycles, and stepped up to 36,000 volts for transmission to Florence, Leghorn, Volterra, Grosseto and other towns in Tuscany.

New Shop Instruction Method Tried at University

To reduce the amount of instruction necessary in the engineering shops and to save students' time, an interesting scheme of shop instruction has been worked out by William L. Dabney, shop instructor at the University of Wisconsin.

That experience gained in one line of work can be carried over into a new kind of work in the particulars in which the two are similar (the principle formulated by Prof. Edward L. Thorndike, the well-known psychologist) is the basis. The scheme worked out by Mr. Dabney picks out the points of likeness in all the machines which the students must learn in the shops and arranges the work so that the student does not have to start at the beginning in learning each new machine, but can carry over some of the experience gained in previous work.

Experimenting done on the work of students in the engineering shops at the university showed the value of the plan. The results of the experiments have been written up in the form of a thesis and later will probably be put in a form suitable for the use of all shop instructors.

Bigelow Boulevard is the name given the former Grant Boulevard, Pittsburgh, Penn. The name has been changed by a city ordinance in honor of the late Edward M. Bigelow, M. Am. Soc. C. E., who was Director of the Department of Public Works for many years. The boulevard which now bears his name was laid out and constructed during his administration.

The Air Breakwater that protects the Standard Oil pier at El Segundo, Calif., described in "Engineering News," June 22, 1916, p. 1166, was recently completed at a cost of $10,000 for the 1,700 ft. of pipe involved. The pipes are 4-in., having ¼-in. perforations 6 in. apart. A compressed-air plant furnishes air to the pipe system, and it is this air rising through the water that is intended to calm the surface sufficiently for loading or unloading the tankers.

The Old Slip South Tunnel headings were holed through on Dec. 19. This is one of the eight new rapid-transit railway tunnels being built under the East River at New York. The Old Slip pair of tunnels will connect the Seventh Avenue Subway, which extends through Varick St., West Broadway, Park Place, William St. and Old Slip, with the Brooklyn subway lines of the Interborough Rapid Transit Co.'s present subway system, via the river tunnels, Clark St. and Fulton St. The tunnel is being constructed by the Flinn-O'Rourke Co., of New York.

Completion of the Engineer Post and School of the United States Army at Washington Barracks is recommended by Gen. W. M. Black, Chief of Engineers, and estimated to cost $202,500. This includes $125,000 for an administration building (housing also laboratories, printing shop, etc.), $55,000 for completing the West barracks and moving the hospital, $20,000 for a quartermaster's corps barracks and $2,500 for a fuel shed. A $100,000 school building has already been erected. Engineer troops and officers are trained here; all items of engineer equipment for the seacoast defenses of the country and possessions are purchased and distributed from here.

A Proposed Water-Power Law to take the place of those now pending in Congress on which a deadlock seems likely was suggested to the President by Secretary Lane on Dec. 21. The proposed law reads as follows:

> The Secretary of War, the Secretary of the Interior and the Secretary of Agriculture shall compose a Water Power Commission. This commision shall have power to grant leases for the use of all public lands (including reservations) and navigable streams for the development of water power under such terms and conditions as shall be by them prescribed by general regulation, no such lease to extend for longer than 50 years.

Secretary Lane suggests that this act would eliminate all controversy in Congress over details, and by the regulations imposed the Commission could impose everything that is sought by the Ferris, Myers, Adamson or Shields bills.

Enlargement of the Bethlehem Steel Corporation was described by Charles M. Schwab at a dinner in New York on Dec. 21. In 1915 the Corporation employed 23,000 men, the total pay roll was $22,500,000 and the average earnings of each wage earner were a little over $900 per man. In 1916 the corporation employed some 70,000 men, the pay roll is about $72,000,000 per annum and the average earnings are nearly $1,200. The Corporation has undertaken to construct at a cost of $4,500,000 a plant to build 16-in. guns. In remarks by the president of the company, Eugene G. Grace, he stated that when Mr. Schwab went to Bethlehem the town had 13,000 inhabitants; today the employees of Bethlehem Steel alone are sufficient to make a city of 150,000 people. Ten years ago the annual sales of Bethlehem products were $10,000,000. Last year they were $230,000,000.

Two Iowa Railways have recently been abandoned, the Chicago, Anamosa & Northern, a line 35 mi. long in eastern Iowa, which was built in 1903-04 and never earned anything but a deficit. Two years ago the road was sold under judgment proceedings and the purchaser has now sold the entire outfit, including rails, bridges and rolling stock, for shipment to the war zone. The Atlantic, Northern & Southern Ry., in western Iowa, a 37-mi. line which was built in 1910 largely by labor contributed by the farmers living along the line, has been in financial difficulties ever since its construction. Its operation was stopped on Dec. 31, 1914. The Iowa Railroad Commission, in response to a petition by those living along the route, ordered a part of the line to be operated, but this order was annulled by both the State and Federal Courts. On Dec. 9 the Federal Court issued a decree authorizing the dismantling of the property and the sale of the rails and rolling stock.

Damage Suits Follow Dam Failure—In an endeavor to decide the liability of the City of San Diego, Calif., for the destruction of property in the Otay Valley at the time of the failure of the Lower Otay dam on Jan. 27, 1916, a test case has been filed in Los Angeles by Mrs. Mary H. James, asking for $10,763 85 for damages to her orchard. Until this suit is ended other damage suits amounting to over $500,000 will be held in abeyance. There are about 60 of these. In Mrs. James' complaint she alleges the dam was faultily constructed; the slopes of the fills were inadequate and too steep to support the dam against the rush of waters; the iron core walls of the dam and the concrete walls were of inadequate dimensions; the dam was not protected by suitable spillways; the blow-off valves were improperly constructed and the material used in the construction of the dam was of inferior quality The suit is expected to be one of the most involved and most costly ever participated in by the City of San Diego. The suit is brought in Los Angeles because of the provisions in the statutes requiring such cases to be tried outside the county in which the defendant resides.

Progress on the Calaveras Earth Dam, which will be when completed the highest earth dam in the world, was described by T. A. Elliott, engineer of the Spring Valley Water Co., before the San Francisco members of the American Society of Civil Engineers on Oct. 17. The dam when completed will contain 3,100,000 cu.yd. of material, will have a height of 240 ft. above bed rock, a crest length of 1,300 ft. and a base width of 1,300 ft. The upstream slope is 1 on 3; the downstream slope 1 on 2½. Practically all the material placed in the dam by hydraulic fill has been pumped. In only one of the eight borrow pits was the elevation sufficient for material to be carried to the dam by gravity. The material placed by hydraulic fill has been carried from 1,000 ft. to 4,500 ft. Two shifts of men per day are worked; the total force is 60 men. With this force an average of 3,600 cu.yd. of material per day has been excavated and placed in the dam, being transported an average distance of 3,000 ft. The direct cost of sluicing the first 1,000,000 cu.yd. of fill was about 25c. per cu.yd. This is the operating cost and does not include interest, overhead, superintendence, insurance or auxiliary cost of building roads, trails, camps, etc. The dam is now completed to 140-ft. elevation and contains 1,750,000 cu.yd. At the present rate of progress the dam will probably be finished in 1918. According to present indications, the total cost will be about $2,500,000. The work on the dam was described in "Engineering News" of Oct. 1, 1914, and Dec. 30, 1915.

A Patent Decision of Great Importance affecting the metallurgical industry was made by the Supreme Court of the United States on Dec. 11, sustaining patent No. 835,120 on the flotation process of mineral separation. According to the "Engineering and Mining Journal," which comments on the decision in its issues of Dec. 16 and 23, about 25,000,000 tons of ore were treated by this process in 1916, about half under license and the remainder in defiance of the patentee. The litigation over the patent has been in progress more than five years. In 1913 the District Court held the patent to be valid. This decision was reversed a year later by the Court of Appeals, and many mining companies concluded that the patent was void and therefore ceased to recognize it. Ordinarily, the Court of Appeals' decision is final. In this case appeal was taken to the Supreme Court of the United States because of the international character of the invention, the patent being owned by Englishmen and having been sustained by an appeal by the British House of Lords. An unprecedented feature in the case was that demonstrations of the patented process were made before the judges of the Supreme Court. The process covered by the patent is the so-called flotation process and its essential feature is the use of a very small amount of oil, less than 1% of the weight of the ore treated. Various other methods of ore separation by the use of oil have been previously invented and operated in which a much larger quantity of oil was used, and the essential feature of the patent now sustained is the use of an extremely minute quantity of oil, which is beaten up with the ore to form a very light froth.

PERSONALS

William H. Marshall has resigned as President and Director of the American Locomotive Co., New York City.

S. H. Taylor, Sales Manager of the S K F Ball Bearing Co., Hartford, Conn., has been elected Vice-President of the company.

L. D. Hollingsworth has been appointed Division Engineer of the Department of Public Roads of Kentucky, with headquarters at Paducah, Ky.

Henry B. Joy has resigned as chairman of the Board of Directors of the Packard Motor Co., Detroit, Mich., owing to the pressure of other work.

George F. Blackie, Engineer of Roadway and Track of the Nashville, Chattanooga & St. Louis Ry., has been promoted to be Assistant Chief Engineer.

C. P. Ross, formerly of the engineering department of the Union Pacific R.R., has been appointed Industrial Agent, with headquarters at Omaha, Neb.

Edwin G. Foster, Assistant Engineer of the Buffalo, Rochester & Pittsburgh Ry., has been promoted to be Valuation Engineer, with office at Rochester, N. Y.

L. D. Busby, Chief Sanitary Inspector of the Bureau of Sanitation of Dallas, Tex., has resigned, and the office has been taken over by the Superintendent of the Street Department.

Christopher H. Snyder, M. Am. Soc. C. E., Designing and Consulting Engineer, San Francisco, Calif., has been appointed Lecturer in Civil Engineering at the University of California.

G. A. Engar, formerly representative of the S K F Ball Bearing Co., of Hartford, Conn., in Cleveland, Detroit and Pittsburgh, has been appointed Technical Manager and Chief Engineer of the company.

Frederick G. Keyes, recently Chief Engineer of the Cooper Hewitt Electric Co., has been appointed to take charge of the research laboratory of physical chemistry at the Massachusetts Institute of Technology.

H. H. Trabue, Assistant Chief Engineer of the Nashville, Chattanooga & St. Louis Ry., with headquarters at Nashville, Tenn., has been appointed Real Estate Agent, reporting directly to the President of the company.

T. H. Shertzer, Assoc. M. Am. Soc. C. E., of the Texas Company, New York City, has been appointed City Manager of Portsmouth, Va. This position was advertised in "Engineering News" of Sept. 21, and there were 157 applicants.

William S. Murray, F. Am. Inst. E. E., has resigned as Consulting Engineer of the New York, New Haven & Hartford R.R., effective Dec. 31. From 1905 to 1914 he was in charge of the electrification of the New York division of the railway from New Haven to New York.

Otto H. Kahn, a New York City banker, has been elected a life member of the corporation of the Massachusetts Institute of Technology. The corporation of the institute now includes such well-known financial leaders as Theodore N. Vail, Frank A. Vanderlip and Coleman and Pierre du Pont.

Joseph H. O'Brien, M. Am. Soc. C. E., Managing Engineer, Westinghouse Church Kerr & Co., New York City, has been elected Vice-President of the reorganized Central Construction and Supply Co., Harrisburg, Penn., which will engage in general contracting under the name of the General Construction Corporation.

Morse W. Rew has accepted a position as assistant engineer with the Transit Commission of the City of Pittsburgh, of which E. K. Morse is the Commissioner. Since August, 1913, Mr. Rew has been an Assistant Engineer with the Cincinnati Rapid Transit Commission, and prior to this with the Boston Transit Commission.

Thomas H. Means, M. Am. Soc. C. E., of Symmes & Means, Consulting Engineer, San Francisco, Calif., has been appointed Consulting Engineer of the Anderson-Cottonwood Irrigation District, Redding, Calif., succeeding H. H. Henderson, M. Am. Soc. C. E., resigned. **E. R. Davis** has been appointed Superintending Engineer of the project.

E. W. P. Smith, Assoc. Am. Inst. E. E., for the past three years City Electrician of Cleveland, Ohio, has resigned to accept the position of Consulting Engineer of the Elliott Electric Co., Cleveland. He is a graduate of Colorado College, Colorado Springs, and has had experience with the Westinghouse Electric and Manufacturing Co. and in the mechanical department of the Lake Shore & Michigan Southern Ry.

George B. Tripp, Assoc. Am. Inst. E. E., Vice-President of the United Gas and Electric Corporation, a management company, of New York City, has reorganized and is to be President of the Central Construction and Supply Co., of Harrisburg, Penn. The new concern will be called the Central Construction Corporation and it will engage in a general contracting business. The capital is to be $600 000.

Frank B. Jewett, F. Am. Inst. E. E., former Assistant Chief Engineer of the Western Electric Co., New York City, has been made Chief Engineer to suceed C. E. Scribner, whose resignation was noted in these columns Dec. 21. He is a graduate of Throop Polytechnic Institute and of the University of Chicago, where he received a Ph.D. degree in 1902 For two years following he was an instructor at the Massachusetts Institute of Technology and then became connected with the American Telephone and Telegraph Co., where he had charge of transmission development work. In April, 1912, he was appointed Assistant Chief Engineer of the Western Electric Co.

E. R. Gayler, M. Am. Soc. C. E., Civil Engineer, United States Navy, has been appointed by the President an Engineer Advisor to direct the public-works improvements of Hayti, in accordance with the treaty recently ratified between this country and the West Indian republic. Mr. Gayler was graduated from Washington University in 1895. He entered the Navy as an Assistant Civil Engineer in 1902. His duties since then have been particularly along the lines of developing new naval stations. He did much of the pioneer work at the Naval Stations at New Orleans, Charleston, S. C.; and Pearl Harbor, Hawaii. For the last two years he has been on duty at the Navy Department in Washington in connection with the dry dock at Pearl Harbor, H. I.

OBITUARY

Otto C. Wolf, Architect and Engineer, of Philadelphia, Penn., died Dec. 19, aged 60 years.

George R. Sawyer, a civil engineer, of Pendleton, Ore., died Dec. 13. He was formerly County Engineer of Lincoln and Franklin Counties, Washington.

Harry L. Hollman, a civil and mining engineer, of Pittsburgh, Penn., died Dec. 18 at his home in that city, aged 51 years. He was graduated from the Western University of Pennsylvania (now the University of Pittsburgh) in civil engineering. After a short time with the Pittsburgh & Lake Erie R.R. he was chiefly engaged in coal-mine engineering.

Roberdeau Buchanan, Astronomer and until about five years ago Mathematician of the Nautical Almanac Office, U. S. Naval Observatory, Washington, D. C., died Dec. 18, aged 77 years. He was graduated from Lawrence Scientific School, Harvard University, in 1861. He became connected with the Nautical Almanac in 1879, and for many years made computations for it.

George S. Haley, President of the General Engineering and Management Corporation, of New York City, died Dec. 3 from injuries received by a motor truck on a New York street. He was born at Manchester, N. H., and was graduated from the University of Iowa. For a number of years he was Manager of the City Electric Co. and of the Rutland Railway, Light and Power Co., Rutland, Vt. From 1912 to June, 1916, he was Vice-President and General Manager of the Texas Power and Light Co., Dallas, Tex.

Harry C. Francis, a well-known Mechanical Engineer, of Philadelphia, Penn., died in that city Dec. 18. He was born in Philadelphia in 1842. He was graduated from the Central High School and his first engineering experience was with the Baldwin Locomotive Works. Later he was with William Sellers & Co. He is said to have had charge of engineering work in connection with the installation of the first electric street lighting in New York City. He was one of the organizers of the Kensington Engine Works, Ltd., of Philadelphia.

Thomas E. Calvert, Chief Engineer of the Chicago, Burlington & Quincy R.R., died at his home in Lincoln, Neb., on Dec. 19. He was born at Philadelphia in 1849. In 1870 he was graduated from Yale University, and in 1871 he began his railway career in the engineering department of the Chicago, Burlington & Quincy R.R. In 1875 he was made Division Engineer of the Nebraska division, and later became General Superintendent of the lines west of the Missouri River, retaining this position until 1905, when he was appointed Chief Engineer.

Henry E. Fairchild, Vice-President of the H. Wales Lines Co., Meriden, Conn., died Dec. 16. He was born in Woodbridge, Conn., in 1838, and as a youth learned the trade of a mason. In 1868 he became connected with the firm of Perkins & Lines, building contractors, of Meriden. Upon the retirement of Mr. Perkins, Mr. Fairchild became a member of the firm under the name of H. Wales Lines & Co. Later the H. Wales Lines Co. was incorporated. Mr. Fairchild was Superintendent of Construction of the company for a number of years. About eight years ago he retired from active work.

Ferdinand M. Hausling, head of the F. M. Hausling Co., building wrecking engineers and contractors, died Nov. 24. He was born in Newark, N. J., in 1860. He was educated at Heidelburg, in Germany, at Stevens Institute of Technology and at Columbia University. His first engineering experience was in mining work in Gunnison County, Colorado. After several years' experience in various branches of engineering and chemistry he became interested in building construction and demolition. He organized the F. M. Hausling Co. to scientifically tear down buildings and salvage the materials. This company removed many famous old buildings in New York City, including the former New York Life Building. He was of a scientific and analytical disposition and gave much time to a study of waterproofing methods. In 1904 he entered the field of waterproofing engineering with a process generally known as the Hausling method of waterproofing. Since then he largely devoted himself to this work, and at the time of his death was President and General Manager of the Anti-Hydro Waterproofing Co. of New York City.

ENGINEERING SOCIETIES

SOCIETY OF AUTOMOBILE ENGINEERS.
Jan. 11. Annual meeting in New York City. Secy., C. F. Clarkson, 129 West 39th St., New York.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION.
Jan. 15. Fourth annual meeting in New York City. Secy., O. S. King, 120 Broadway, New York.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 17-18. Annual meeting at Society House, New York City. Secy., Charles Warren Hunt, New York.

WESTERN BRICK MANUFACTURERS' ASSOCIATION.
Jan. 20. Meeting in Kansas City, Mo. Secy., G. W. Thurston, 416 Dwight Building, Kansas City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 23-25. Annual meeting in Montreal, Can. Secy., C. H. McLeod, 176 Mansfield St., Montreal.

ILLINOIS SOCIETY OF ENGINEERS.
Jan. 25-26. At Chicago. Secy., E. E. R. Tratman, Wheaton, Ill.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 5-9. Eighth National Good Roads Show, in Boston, Mass. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Feb. 7-9. Midwinter convention in New York City. Secy., F. J. Hutchinson, 33 West 39th St., New York City.

TENTH CHICAGO CEMENT SHOW.
Feb. 7-15. In Chicago. Under management of Cement Products Exhibition Co., 210 South La Salle St., Chicago.

AMERICAN CONCRETE INSTITUTE.
Feb. 8-10. In Chicago at La Salle. Secy., H. D. Hynds, 30 Broad St., N. Y.

NATIONAL BUILDERS' SUPPLY ASSOCIATION.
Feb. 12-13. In Chicago at Sherman. Secy., L. F. Desmond, 1211 Chamber of Commerce, Chicago.

WISCONSIN ENGINEERING SOCIETY.
Feb. 15-16. At Madison, Wis. Secy., L. S. Smith, 939 University Ave., Madison, Wis.

SOUTHWESTERN CONCRETE ASSOCIATION.
Feb. 19-24. Southwestern Concrete Show in Kansas City, Mo. Address Chas. A. Stevenson, 1413 W. 10th St., Kansas City.

The American Economic Association will hold its 29th annual meeting meeting in Columbus, Ohio, Dec. 27 to 30, at the Hotel Deshler. The secretary is Allyn A. Young, Cornell University, Utica, N. Y.

The Illinois Section of the American Water-Works Association will hold its next meeting at the University of Illinois, Urbana, Mar. 13 and 14. The section secretary is Edward Bartow, Director State Water Survey, Urbana.

The Mining and Metallurgical Society of America has made the following nominations for officers for 1917: For president, W. R. Ingalls, Seeley W. Mudd and H. V. Winchell; for vice-president, Waldemar Lindgren; for secretary, Louis D. Huntoon.

The Illinois Association of Members of the American Society of Civil Engineers held its annual meeting in Chicago on Dec. 11. The officers for 1917 are as follows: President, C. F. Loweth; vice-presidents, A. N. Talbot and A. S. Baldwin; secretary, E. N. Layfield, Chicago.

The American Association of Engineers will hold a national convention Feb. 8 to 10 in Chicago, at the Hotel La Salle. It is stated that work of a promotional nature will constitute the greater part of the program, which will be held under the slogan, "For the Good of the Engineer."

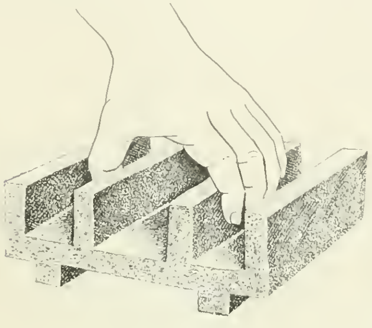
The Idaho Society of Engineers will hold its seventh annual convention in Boise, Jan. 18 to 20, in conjunction with the Operation and Maintenance Conference of the United States Reclamation Service, which is to be held Jan. 16 to 18. The secretary of the Idaho Society is Ira Shaffner, Boise.

The Providence (R. I.) Engineering Society was recently reorganized and its membership increased by nearly 300. Regular monthly meetings are now held either at Brown University or at Memorial Hall, while frequent meetings will be held in the club rooms, at which there will be informal discussions and talks on engineering topics of a more specialized nature. The society has been divided into five sections, all members of the society being invited to all section meetings. These sections are as follows: Fire Insurance and Fire Protection; Machine Shop; Designing and Drafting; Efficiency and Scientific Management; Structural Engineering. The president of the society is Prof. J. A. Brooks, Brown University; the vice-presidents are Robert W. Adams, George A. Carpenter, Wayland T. Robertson; the recording secretary is William A. Kennedy; corresponding secretary, Albert E. Thornley, Narragansett Machine Co., Pawtucket, R. I.; the treasurer is Alfred H. Whatley.

Appliances and Materials

Tapestry-Brick Building Tile

An interlocking channel brick with "tapestry" surface is being made by Fisk & Co., of New York and Boston, under the trade name "Fisklock." As seen from the accompanying sketch, every brick mechanically is both a header and a stretcher; a wall laid up of these tiles is in effect a double wall with a 2-in. air space between, the lower ribs and mortar filling the outer channels. For corners, window jambs, arches, belt courses, ornamental panels, etc., solid blocks of the same texture and shade are used, obviating the necessity of a variety of shapes and sizes. It is claimed that such a wall has double the strength of the solid and 125% the strength of one of hollow tile. The air cells being horizontal prevents internal air currents. Plaster may be applied directly to the inside of such walls without furring.

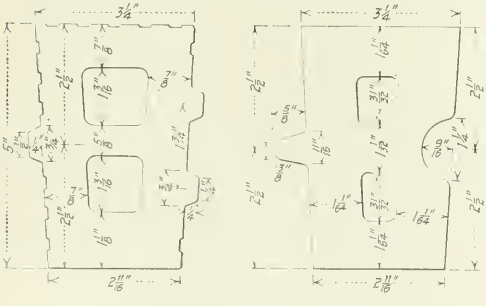


INTERLOCKING CHANNEL BRICK

* * *

California Radial Brick for Sewers

The accompanying sketches show the sectional outlines of new radial bricks being made by the Los Angeles Pressed Brick Co., of Los Angeles. The brick at the right is an improved type for storm drains, etc. The surface has roughing grooves for bonding the mortar; the tongue and groove are replaced by side buttons. The number of brick per linear foot runs from 54 for a 36-in. conduit to 90 for a 60-in.



FROST RADIAL INTERLOCKING BRICKS

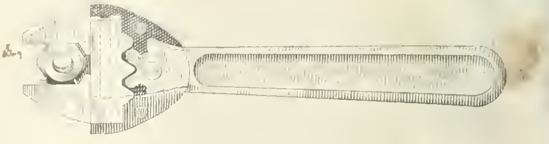
* * *

New Four-Cylinder Automobile Engine

The White Co., of Cleveland, maker of automobiles and motor trucks, announces that it has developed a new four-cylinder gasoline engine with increased power, speed, pick-up and silent operation. The prominent feature of the new engine is the use of 16 valves in place of the usual 8, making valve capacity better proportioned to cylinder displacement and rendering it unnecessary to resort to more than four cylinders for the larger powers.

Quick-Acting Wrench

A new three-piece quick-acting nut wrench has been put out by the Cochran Pipe Wrench Co., 7800 Woodlawn Ave., Chicago, under the trade name "Speednut." As may be seen in the accompanying sketch, one jaw is fixed and the other jaw slides in guides, being moved by a rack on it and a gear segment on the handle, which is pivoted.



COCHRAN "SPEEDNUT" WRENCH

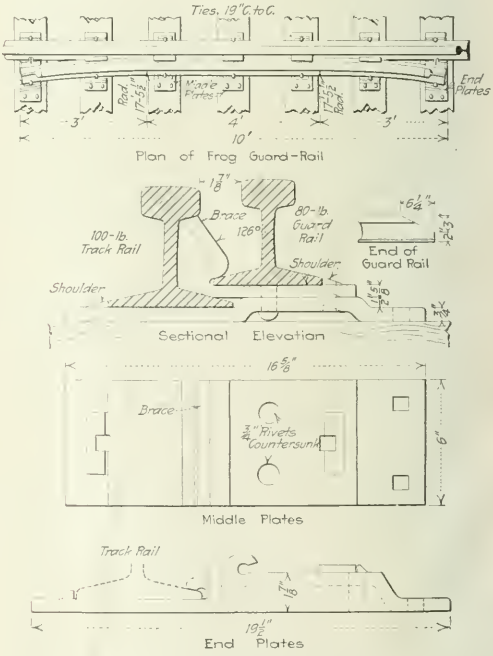
* * *

Guard-Rail Holder for Frogs and Curves

The Betts guard-rail construction shown herewith has long tie-plates with supporting chairs so arranged that the guard rail may be of less height and weight than the track rail and yet have its top ⅜ in. higher than the head of the latter. Thus, an 80-lb. guard rail may be used on track laid with 100-lb. rails. This construction is adapted for the guard rails at frogs and those used on sharp curves.

For use at frogs, as shown in the drawing, the guard rail is 10 ft. long, straight for 4 ft., and supported on seven ties, with tie-plates extending under both rails. On the three ties at the middle, this rail has the inner edge of its base held by inclined braces that fit under the head of the track rail. On the two plates at each end, it is held by a hook or lug. On each plate there are lugs to engage the outer edges of the guard rail and the track rail. The end plates also have a fastening for the metal footguards. The ends of the guard rail are cut at an incline, so as not to catch hanging break-beams, etc.

This device is being used by a number of trunk-line railways and also by such terminal lines as the Chicago Junction Ry. and the Terminal Railroad Association of St. Louis. It is manufactured by the W. M. Mitchell Co., of Louisville, Ky.



THE BETTS GUARD-RAIL CONSTRUCTION

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